1. Introduction

The amazing prosperity of the small 'Republiek der Zeven Provinciën' and its exceptional position among the European powers during most of the seventeenth century, has fascinated generations of historians. In spite of the abundance of research they have accomplished on the subject, resulting in a huge amount of valuable knowledge and understanding, this historical phenomenon cannot be considered fully explained. Recent publications added new insight on the topic and disclosed original views about the economic and social development. The more comes in the open about the thriving Dutch Golden Age society, the more intriguing the question becomes, how so small a population (a million and a half at the vertex of its power) could manage to play leading parts on almost every scene of human activities. Looking around in the recent world, one easily discovers that even very few men are able to do big jobs making use of additional energy, i.e. replacing and amplifying their individual limited powers by means of other sources of energy. This study intends to investigate whether the seventeenth century Dutch had similar opportunities at their disposal, from which their contemporaries had to abstain. An analysis of energy consumption in the Republic reveals a so far overlooked foundation for its economic and cultural wealth.

To the extent that attention has been given to energy as a factor in the history of the Republic this had been concentrated almost exclusively on the national symbol, the windmill. It is undeniable that the Dutch played a pioneering part in the application of wind energy to industrial purposes. For some time they undoubtedly had a lead in this respect over other countries. Their windy climate and flat, mostly treeless landscape were advantageous in this regard. Still, these favourable conditions can only provide a partial explanation of the extraordinary prosperity of their society in the seventeenth century. This is evident in the first place from the limited number of industrial windmills in existence in the Republic. (The basis for this assumption will be discussed below in section 8).

* The author is most grateful to Prof. dr. A. M. van der Woude for his keen interest and valuable suggestions and for teaching a land- and watermanagement specialist the basics of the historian's idiom. He feels equally indebted to Prof. dr. J. de Vries who suggested substantial improvements of the English presentation.
As a matter of fact the peak of windmill application did even not occur in the seventeenth century but, rather, in the second half of the nineteenth. Then some 9,000 windmills operated for industrial and land drainage purposes. Also only then had technical improvements been achieved that permitted them to attain their biggest energy producing capacity. Another fact to keep in mind is that Holland was not the only region of Europe with favourable conditions for the exploitation of windmills. By 1900 a total of 30,000 windmills were at work around the Northsea. Together they represented a constant effect of 100 megawatts, an average of 3.33 KW per mill. Clearly, any examination of the energy supply situation of the Republic should be placed in a broader framework than that of wind energy alone.

2. ENERGY, NEEDS AND SOURCES

By systematizing the different sorts of energy man needs, we can clarify the nature of the problem at hand. No society can do without the following:
1. *maintenance energy,*
in general solar energy accumulated through photosynthesis in vegetable and animal products. This is needed for food, clothing and shelter;
2. *heating energy,*
normally also solar energy, but especially in the form of fire-wood for domestic uses and for the heating of materials in manufacturing operations;
3. a. *stationary motion energy,*
in which originally solar energy also played the leading part in the form of human and animal muscular strength. These were complemented in a rather early stage in many societies by waterpower and windpower, which also derive their energy from the sun.
3. b. *mobile motion energy,*
for carrying or dragging loads, for plowing etc. Here again human and animal power played the major role. In land transport this was until recently the only possibility. In water transport, on the other hand, friction-resistance is sufficiently small that the wind can nearly always move floating loads. Skippers therefore enjoyed significant advantages over wagoners. A quantitative approximation of this advantage will be calculated below (section 7).

This short survey of energy provision shows that, in principle, a society depends on the productivity of the soil on which it lives for the acquisition of energy and, thus, for the attainment of a given level of economic and social development. A limit is imposed on its economic possibilities, determined by the number of productive hectares of its territory, by the productivity and fertility of these hectares and by the
simple fact that a hectare destinated to the production of food, is not available to yield fire-wood or fodder for draughthorses. The different sorts of energy are mutually exclusive!

During the sixteenth century the countries of Southern and Western Europe hit this development limit as a consequence of continuing deforestation. Particularly in the large centres, wood for burning and construction material became progressively more expensive as a consequence of the ever increasing distances over which it had to be conveyed. Deforestation proceeded not only to satisfy wood demands, but also to augment supplies of maintenance energy through the clearing of woodland in favour of agriculture. Around 1640 the Dutch stock of harvestable wood lots had been reduced practically to zero. Before that time already, rising prices of heating energy caused by growing transport cost created problems in the densely populated parts of Europe.

3. Peat

Yet a chance of escape from these problems seemed to be near at hand. Millions of hectares of peat exist north of the Alps. This enormous amount of potential fuel has however remained virtually untouched in the course of time. At best some of it was dug here and there for local use. Only since the end of the nineteenth century has its exploitation intensified with the introduction of mechanical peat digging for the sake of local industry or for firing electrical power plants. Transport of the thus obtained energy by way of the power grid is cheaper than moving a vast mass of turf by road. Only one exception exists to this general picture. In the Netherlands nearly all usable peat has vanished. In remaining Dutch peat areas, the peat is either mixed with too much clay or too salty, so that its combustion would yield too much ash. Only the Netherlands, of all European countries, came to supplement its soil-dependent energy resources with the large-scale exploitation of its peat stock. In this way it succeeded in breaking through the development limit. The vital question which ultimately has to be answered is, thus, why where the Dutch able to make use of their peat, while the rest of Europe had to abstain from it?

The determining factor was not the peat quality. Growing conditions of peat had been virtually the same everywhere, so that all the peat had comparable properties. The only exceptions were those few places where rivers could deposit their clay in the peats, like in the above mentioned areas in the Netherlands where the peat still exists. The only real difference is, that peat deposits do not all lay on the same elevation with respect to sea level. The Dutch had the good fortune to find their peat very near to, partly even just below the overall water table. This fortunate situation was caused by the rising of the sea level during the holocene.
In this country the digging of navigable canals in the peat areas and, more important, the linkage of these canals to the already existing, extensive network of natural waterways was easily done. Since these natural waterways gave access to all important cities, the turf could be directly transported by ship from the peatery to the consumer.

The history of the Peel, the only Dutch peat area located at a significant elevation (30 m above sea level, 15 m above the near-by flowing river Maas) is instructive in this connection. Its history runs parallel to those of foreign peats. In 1573 an attempt to link 's-Hertogenbosch with the Peel by making the river Aa navigable failed. The city remained dependent on turf from Holland. A description from 1670 shows that local people dug peat on the fringes of the Peel, not only for their own use but also to cart it for sale to near-by villages. Eindhoven also made energetic efforts for a great many years to achieve a water connection with the Peel. In 1816 the cloth-manufacturers of that city complained about the expensiveness of Peel turf, which had to be brought in by road (distance only 25 km!). Other fuels, they stated, were even more expensive. Large-scale peat digging begun in the Peel only after 1853 in which year it was connected by a canal to the Zuid-Willemsvaart, a through-traffic waterway, finished in 1826 and passing by the Peel at a distance of less than 15 km. Finally in 1880, when the Peel was completely opened up by digging canals through the area itself, were the conditions created which other Dutch peat regions had enjoyed for centuries. Since, peat digging on a fairly large scale continued in the Peel till 1942.

4. PROCESSED VOLUME OF PEAT

At one time there must have existed some 175,000 ha of high peat in the Netherlands, of which at present only some 5,000 ha may be left in a more or less undisturbed state. Confining the calculations to the main bodies of peat (see fig. 1), it can be stated that in Southern Groningen and Eastern Drente ca 100,000 ha has disappeared and in Western Drente, Friesland and Overijssel ca 70,000 ha. The other important deposit of high peat, the Peel, measures only 6,000 ha. Since it was mainly exploited during the last century, it can stay out of consideration. The peat of South-Eastern Drente has received a thorough study of its natural conditions. Its original thickness was on average 4.5 m. This, however, is not the thickness one can use to reckon the total volume of usable peat. Before being cut the peat was partially dehydrated by digging 1.5 m deep drainage trenches in its surface. In the course of some years this caused a shrinkage to \( \frac{2}{3} \) of \( \frac{3}{4} \) of its original thickness. To avoid overestimation, a reduction factor of \( \frac{5}{6} \) will be applied. Thus, the peat actually cut, had an average thickness of some 3 m. Regulations often obliged peat cutters to leave the upper-most half meter of peat to facilitate
the later reclamation of the denuded underlaying sand. Although they did not always do this, in fact, this half meter will also be subtracted from the average thickness. The usable peat corresponds, therefore, to an average thickness of over 2.5 m, so that this peat region must have yielded at least $100,000 \times 10^4 \times 2.5 \times 2.5 = 2.5 \times 10^9$ m$^3$. This will be called the rated volume, because peat cutters worked on piece rates according to it.
The other high peat region covered 70,000 ha, but it consisted of discrete deposits of varying size scattered over a wide territory (approximately staked out by the towns of Zwolle, Steenwijk, Drachten, Assen, Coevorden and Almelo). Since the numerous deposits each had borders along which the peat thickness gradually reduced to zero, the average rated thickness in this region must have been less than in the precedingly discussed coherent region. We will estimate the thickness at 1.5 m instead of the 2.5 m of the previous region. Using this estimate, the total rated volume of this second high peat region comes to 70,000 ha \times 10^4 \times 1.5 \text{ m} = 1.0 \times 10^9 \text{ m}^3.

There are also two main low peat regions. By far the more important of the two lies within the polygon Naarden, Utrecht, Gouda, Rotterdam, Delft, Leiden, Haarlem, Alkmaar, Amsterdam. Here more than 61,000 ha of land was turned into water by peat dredging. The average depth of these artificial lakes amounted to 4.3 m below mean sea level, but the total thickness of the removed peat should be estimated somewhat greater. Since the region was able to drain sufficiently well (natural drainage over rather long distances) to support a rather prosperous agriculture before dredging started, the surface level of the dredged peat must have been at least a few decimeters above sea level. In low peat turf making, the dredged substance was puddled and trodden in wooden troughs to make it cuttable. It can therefore be assumed that the reduction factor of $\frac{2}{3}$ also applies in this case. The average rated thickness is, thus, $\frac{2}{3} \times > 4.3 = 3 \text{ m}$. The total output of this region can then be estimated at $> 61,000 \text{ ha} \times 10^4 \times 3 \text{ m} = 2.0 \times 10^9 \text{ m}^3$.

The other important low peat area is located in North-Western Overijssel and Eastern Friesland. Here about 47,500 ha of peat land must have been exploited. The average thickness of the removed layer can only be roughly guessed because of this regions complicated geography. Especially in the Friesian area farmsteads and other patches of land were often left between the dredged areas. The topographic map suggests that the average rated thickness cannot have been much more than 1.5 m, bringing the total volume to 47,500 ha $\times 10^4 \times 1.5 \text{ m} = 0.7 \times 10^9 \text{ m}^3$.

Before summarizing the results of these calculations, it should be stated that several less important peat regions have been left out of consideration. It is known that in other parts of Friesland and North-Holland, as well as near Veenendaal in Utrecht, near Roosendaal in North-Brabant, in Zeeland, and elsewhere peat extraction took place, mostly for local and regional use. This is another reason to regard the total peat extraction estimate of table I as conservative. The roman figures in table I indicate the peat regions as they are identified on the map of figure 1.
TABLE I. Summary of total estimated rated\(^1\) volumes of peat extracted in the Netherlands.

<table>
<thead>
<tr>
<th>Region</th>
<th>Volume (10^9 m(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>I High peat region of Groningen and Eastern Drente</td>
<td>2.5</td>
</tr>
<tr>
<td>II High peat region of Western-Drente, Friesland and Overijssel</td>
<td>1.0</td>
</tr>
<tr>
<td>III Low peat region of Holland and Utrecht</td>
<td>2.0</td>
</tr>
<tr>
<td>IV Low peat region of Friesland and Overijssel</td>
<td>0.7</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>6.2</td>
</tr>
</tbody>
</table>

\(^1\) to approximate the volume of the geological formation removed, the figures have to be multiplied by \(\frac{3}{2}\).

5. CHRONOLOGY OF PEAT EXPLOITATION

Determining the rate of peat consumption in different periods, is a difficult task. A description of the used method to approximate the timing of peat extraction will be given first as a general introduction to the subject. The starting years of canal digging in different areas were plotted on a map (scale, 1:200,000). With an eye on the type of landscape indicated on the map, lines were drawn around areas of which the marked year dates fall within the same period of 50 years. The outlined areas were then measured by counting square centimeters on a sheet of transparent millimeter paper covering the map. This worked out rather well for the regions I, II and IV (see table I), especially because in all these cases clear-cut periods of increased activities could be distinguished. Region III required another approach, which will be discussed later.

The story of the exploitation of the Groningen-Drente peat region (region I) can be summarized as follows.\(^{16}\) It started in the North where monks dug peat from the fifteenth century and before, on a relatively small scale. In 1600 companies of businessmen, most of them from Holland, began to dig canals which opened up the main body of the peat deposit. When this activity finished abruptly in 1649, some 30,000 ha of peat, including strips along natural streams could be reached for shipping the turf. Between 1770 and 1820 the canal system was extended, opening up another 10,000 ha. Finally, between 1850 and 1950 some 45,000 ha were made accessible. The rest, 15,000 ha, can be considered as the sum of what was cut before 1600 plus what was used in the course of the ages by local people living on the fringe of the peat plus what is still remaining today. To estimate the progress of peat consumption it has been assumed that additional canals were only dug when the exhaustion of earlier opened up areas created the need therefore. As far as the first mentioned 30,000 ha is concerned, we can be quite certain that this assumption is valid. It is a known fact that the peat in this first part of the region was completely exhausted before 1800. On the basis of this assumption, the following figures are generated as average extraction estimates:
Considering the fierce canal digging activity between 1600 and 1650 and the dropping of the number of ha/year in the eighteenth century, it seems reasonable to assume that during the seventeenth century an average of 200 ha/year of peat was cut to be exported from this region.

In region II local peat cutting is known to have started in some places around 1300. On a commercial scale the first efforts were made in 1551. Before 1600 a total of about 14,000 ha might have been cut or made accessible. Between 1600 and 1670 canals were dug to reach some 30,000 ha; between 1750 and 1800 an additional 14,000 ha were made accessible, while another 12,000 ha became accessible only after 1860. Because of the earlier mentioned dispersion of peat areas within this region, the historical picture is less clear. But here, as in region I enhanced activities can be noted in the first half of the seventeenth century and in the second half of the eighteenth. The chronological distribution of peat extraction might have proceeded as follows:

\[
\begin{align*}
30,000/170 &= 175 \text{ ha/year for 1600–1770} \\
10,000/80 &= 125 \text{ ha/year for 1770–1850} \\
45,000/100 &= 450 \text{ ha/year for 1850–1950}
\end{align*}
\]

For the same reasons as in region I—i.e. the intense canal-digging activity of the second half of the sixteenth and the first half of the seventeenth century, and the reduction of extraction after 1750—it does not seem an exaggeration to accept an average extraction of 200 ha/year also from this region for the period 1600–1700.

Since low peat areas can be reached by shipping without the execution of expensive, and for the contemporary observer impressive, undertakings like digging canal systems, its history drew less attention. As a result, the datings of starting activities in low peat areas can hardly be reconstructed. For region IV (the Friesland-Overijssel low peat region) the following indications could be found. Small-scale peat winning was practiced since the Middle Ages, especially in its Overijssel part. There a canal was constructed across the peat region to the port of Zwartsluis in the sixteenth century. During the next century some small natural waterways were widened. From the Friesian side of the border it is mentioned that in the second half of the seventeenth century some low peateries existed. In 1751 dredgers from Overijssel, notably from Giethoorn, came to Friesland to introduce their special way of dredging. Thereafter, low peat exploitation in Friesland became more important. It is hard to establish the chronological distribution of the exploitation of the 47,000 ha of dredged peat on the basis of so little
information. The year 1751 seems to be a crucial point. The migration of the Giethoorners indicates that the Overijssel area was nearly exhausted by then. Assuming that before 1550 peat was dug for local use only, the following guess may not be unreasonable for Overijssel:

\[
\begin{align*}
2,500/250 &= 10 \text{ ha/year for } 1300-1550 \\
12,000/200 &= 60 \text{ ha/year for } 1550-1750 \\
2,000/200 &= 10 \text{ ha/year for } 1750-1950
\end{align*}
\]

In Friesland 31,000 ha must be distributed, apparently between about 1600 and 1950. The description of the dredging methods employed indicates that there must have been a marked difference between the yields before and after 1751. A fair guess about the Frisian low peat area might be:

\[
\begin{align*}
6,000/150 &= 40 \text{ ha/year for } 1600-1750 \\
25,000/200 &= 125 \text{ ha/year for } 1750-1950
\end{align*}
\]

The seventeenth century output of region IV could then reasonably be set at 60 + 40 = 100 ha/year.

The reclamation for agricultural use of a great part of the dredged-out area in this region IV did not occur until after 1890, when drainage and polder construction was an unemployment relief measure. In these rather scarcely populated parts, reclaiming of the sandy bottoms of the lakes was not economically attractive. In the other low peat region (region III) however, circumstances were completely different. There, in the most densely populated western part of the country, the artificial lakes posed a threat at the same time as they held a promise. As their waves ate away the soft peaty lake-shores, the lakes tended to widen themselves, often interrupting roads and undermining dwellings. Whole villages were swallowed and cities endangered by the 'waterwolf'. On the other hand the lake bottoms in these parts consisted chiefly of good clay soils, the reclamation of which could give valuable support to the food-supply. Even the general amenity of living-space exerted some attraction already in the seventeenth century. These were the main reasons for people to be eager to pump dry these lakes soon after peat dredging was finished. The technical means were available at an early date. As a matter of fact the first lakes had already been pumped dry in the second half of the sixteenth century.

An exact picture of the progress of peat exploitation in region III is hard to come by. Even if one should be able to study maps of different dates, these maps would not show water-depths, i.e. they would not indicate how far dredging had proceeded. The only set of data known with a great measure of certainty is formed by the years of reclamation of pumped dry polders. The fat line in figure 2 represents the cumulation of the areas of reclaimed artificial lakes (natural lakes having been left out) of successive 50-year periods, thus indicating the latest years in which peat dredging could have been finished in a given number of hectares. Because of the threat and the promise just mentioned, it seems
reasonable to suppose that few lakes created by peat digging would long have remained undrained. Consequently, the real dates of exhaustion of the peateries must not have preceded the reclamation dates by much. Other data related to turf winning in this region as a whole, are only available in a descriptive form. It started in the Middle Ages with digging, which removed the upper layers above the natural water table. During the fourteenth, fifteenth and sixteenth centuries dredging of peat was practised, which created lakes of ever increasing size; around 1600 they occupied most of the area between the rivers Oude Rijn, Gouwe and Hollandse IJssel and threatened the villages of Nieuwerkerk, Zevenhuizen, Moerkapelle and Waddinxveen. In 1630 the church of Jacobswoude, north of the Oude Rijn, was pulled down because by then the rest of the village had been swallowed by the waves of encircling man-made lakes. Around 1550, when pumping mills came into full operation, peat winning operations could be intensified through deeper dredging after lowering the water table in the peatery by pumping it down. In the course of the seventeenth century apparently only a few new peateries were started in this region, still fewer in the eighteenth and nearly none in the nineteenth century.

Quantification of this description will be performed with the aid of a calculation model, the input of which will be the 61,000 ha of peat-land brought into peateries in the course of time. Two sets of assumptions are made for the situation in 1600: a lower estimate of 25,000 ha incorporated in peateries by that year (about the area as measured from the map around and between the aforementioned villages, including Jacobswoude) and an upper estimate of 55,000 ha of peateries in 1600. The lower estimate is indicated in figure 2 with white dots, the upper estimate with black. It is further assumed that before 1600 the area of peateries grew linearly (dotted lines) since 1300, around which year peat dredging seems to have started. But, before ca 1550 deep dredging could not be practised. We have assumed, therefore that the peateries only produced one half of their peat content before they could be pumped down. The solid lines before 1600 reflect this adjustment; their sharp upward bend after 1550 indicates the intensification of peat winning after that date. The difference between the ultimate 61,000 ha and the figures assumed for 1600 are divided in such a way that the extension of peateries in the seventeenth century is three times as big as that in the eighteenth century. By 1800 all peateries in this region are assumed to have been started.

The horizontal distances in figure 2 between the input lines and the fat curve showing the progress of the drainage of artificial lakes, correspond to about 300 years for the higher and to about 200 years for the lower assumed input. The calculation models for both situations are based on this observation. They are shown schematically at the bottom of figure 2. It is assumed that during the average duration of life of
FIG. 2. Computation of the progress of peat exploitation in the Holland-Utrecht low peat region.

The right-hand fat line indicates the known cumulation of pumped dry artificial lake areas. The left hand straights represent two different assumptions for the cumulation of areas incorporated in peateries. The central, s-shaped curves are computed cumulations of full-depth hectares of dredged peat. Models for gradual average exhaustion of started peateries, used in the computations, are shown at the bottom. Fuller explanation in text.

peateries their yield fell off linearly. The hypotenuses of the triangles indicate this falling off. Calculations were performed in 50-year intervals. The figures within the triangles enumerate the percentages of total yield of peateries for subsequent intervals. These percentages were applied as multiplicands for constant mean input quantities, obtained for subsequent intervals by quantitative transformation of the sloping input lines into histograms. The results of these calculations are shown in the two S-shaped curves. The parts of the curves between the dots hold the answer to the
question how great peat extraction was in this region in the seventeenth
century. The calculation for the lower assumption resulted in 21,280 ha
for the whole century, that for the higher assumption gave 21,540 ha.
The truth may be supposed to lie in between, so that an average peat
extraction of 2,000 ha/year seems a modest figure for region III in the
seventeenth century.23

Table II summarizes the results which have been described in this
section. Reference is made to table I for explanations.

Table II. Summary of estimated rated volumes of peat extracted in the Netherlands
in an average year between 1600 and 1700.

<table>
<thead>
<tr>
<th>Region</th>
<th>ha/year</th>
<th>mean depth(^1)</th>
<th>m(^3)/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>200</td>
<td>2.5</td>
<td>5 \times 10^4</td>
</tr>
<tr>
<td>II</td>
<td>200</td>
<td>1.5</td>
<td>3 \times 10^4</td>
</tr>
<tr>
<td>high peat total</td>
<td>400</td>
<td></td>
<td>8 \times 10^4</td>
</tr>
<tr>
<td>III</td>
<td>200</td>
<td>3.0</td>
<td>6 \times 10^4</td>
</tr>
<tr>
<td>IV</td>
<td>100</td>
<td>1.5</td>
<td>1.5 \times 10^4</td>
</tr>
<tr>
<td>low peat total</td>
<td>300</td>
<td></td>
<td>7.5 \times 10^4</td>
</tr>
<tr>
<td>grand total</td>
<td>700</td>
<td></td>
<td>15.5 \times 10^4</td>
</tr>
</tbody>
</table>

\(^1\) see section 4.

6. FOSSIL ENERGY IN THE GOLDEN AGE

Besides turf, some coal, mainly imported from England and Scotland,
was used in the Netherlands during the seventeenth century. Quantities
are unknown, but coal consumption could not have been very important.
Blacksmiths used coal and sometimes some brewers, notably those work­
ing in crowded cities, where room was lacking to store large volumes of
turf (1 m\(^3\) of coal provides six times as much heat as 1 m\(^3\) of piled up turf).24
The brewers, however, restricted their coal use to the winter months.
They generally preferred turf because it apparently was far cheaper.
Comparative prices are not available. Another indication that coal
consumption in the seventeenth century must have been rather unim­
portant, can be derived indirectly from the first complete statistics about
fuel consumption in the Netherlands.25 From a total consumption of
6,084 \times 10^9 kcal around 1840 only two fifths was supplied by coal. This
means that there was still a great dependence on turf even at that time,
despite the fact that coal had become much cheaper than it could have
been two centuries before while turf, on the contrary, is known to have
become more expensive especially during the second half of the eighteenth
century.26, 27 From these considerations it seems clear that between
1600 and 1700 the contribution of coal must have been negligible except perhaps for some special situations like in the years 1621 and 1622, when turf supplies were abnormally small after some extremely wet summers.28

The stream of imported coal — however small or big — might have been — was opposed by a stream of exported turf, whose quantity is, likewise, unknown.29 Turf skippers, mainly from Groningen and Friesland went as far as Antwerpen and other Flemish cities to sell their cargo. After 1648 they served in the same way the markets of Emden, Bremen and Hamburg, whose forests had been destroyed during the Thirty-years war. Though considerable deposits of peat existed in the hinterlands of these cities they could not be exploited because these deposits were in the same position as the Peel, described in section 3. In relation to the overall picture of Dutch peat consumption the quantitative aspect of this turf export is not essential. However big it might have been during certain periods, it did contribute to the national income of the country, the more so, since the whole turf trade was apparently in Dutch hands. Besides there was this mutual compensation of turf exports and coal imports. Therefore both will be neglected in further considerations.

The next step is to translate the rated volumes of peat, summarized in table II, into labour requirements, transport requirements and heat contents. In high peat digging a ‘day-work’, performed by 6 to 7 men, generally contained 110 rated m³ of peat.30 The average annual peat production of 8 million m³ from table II, was equal to about 72,500 ‘day-works’, which required about 7 times as many, i.e. 500,000, man-days or when 300 working days are reckoned in one year, about 1,600 man-years. (Actually four times as many workers were required for peat digging, since this activity could only be practised during a period of about three months in spring and early summer. However, as seasonal workers did do other jobs during the rest of the year, throughout this study all labour requirements are expressed in man-years for the sake of simplicity and for mutual comparison).

No figures could be uncovered describing productivity in low peat winnings. However, we know that the cutting of the peat could only start after it had been dredged (requiring one man), puddled and trodden (requiring another man). High peat, on the other hand, could be cut directly in its natural position. It can be accepted, therefore, that labour requirements in low peateries were about three times as high as in high peateries. This is confirmed by turf prices.31 Consequently the labour requirement for the processing of 7,5 million m³ of low peat could have required \((3 \times 7.5 \times 1,600)/8 = 4,500\) man-years, making the grand total for both types of peat 1,600 + 4,500 = 6,100 man-years. To complete the picture of labour needs in turf production it should be remembered that the peat had to be dried. Turning and piling up of turfs on the drying field was mainly done by women. As a guess 900 man-
years per year could be attributed to these and other supplemental activities, bringing the total labour requirement of turf winning in the seventeenth century to about 7,000 man-years per year.

Conversion figures to weights and heat equivalents for rated volumes of peat can be reckoned as follows: 110 m³ of peat (1 day-work) give as an average ca 42 m³ of piled up turf (or 65 m³ of dumped turf) weighing 11,000 kg or 11 tons, while 1 kg of high peat turf has a heating value of about 3,700 kcal, this being 4,000 kcal for low peat turf (both medium quality).32 (The other mentioned figures are good approximations for turf of both origins). Volumes of stored turf are mentioned here only for the sake of completeness; the weights are more to the point for the calculation of comparative transport needs. So table III only contains the weights and heat-equivalents for the turf yields in the different regions (see again table I for fuller explanations). It is striking that the last figure of table III coincides with the earlier mentioned total fuel consumption around 1840, when population was one and a half times that of the seventeenth century but economic activities were at a low level.

**Table III. Summary of estimated weight and heat-equivalent of turf consumption in the Netherlands in an average year between 1600 and 1700**

<table>
<thead>
<tr>
<th>Region</th>
<th>peat m³/year</th>
<th>turf tons/year</th>
<th>heat equivalent kcal¹³</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>5 x 10⁶</td>
<td>0.50 x 10⁶</td>
<td>1.850 x 10⁹</td>
</tr>
<tr>
<td>II</td>
<td>3 x 10⁶</td>
<td>0.30 x 10⁶</td>
<td>1.110 x 10⁹</td>
</tr>
<tr>
<td>high peat turf</td>
<td></td>
<td>0.80 x 10⁶</td>
<td>2.960 x 10⁹</td>
</tr>
<tr>
<td>III</td>
<td>6 x 10⁶</td>
<td>0.60 x 10⁶</td>
<td>2.400 x 10⁹</td>
</tr>
<tr>
<td>IV</td>
<td>1.5 x 10⁶</td>
<td>0.15 x 10⁶</td>
<td>600 x 10⁴</td>
</tr>
<tr>
<td>low peat turf</td>
<td></td>
<td>0.75 x 10⁶</td>
<td>3.000 x 10⁸</td>
</tr>
<tr>
<td>grand total</td>
<td></td>
<td>1.55 x 10⁶</td>
<td>6.000 x 10⁸</td>
</tr>
</tbody>
</table>

¹ 1 ton = 1,000 kg
³ 3,700 kcal/kg for high peat turf and 4,000 kcal/kg for low peat turf

7. **The Importance of Turf Shipping**

To appreciate the significance of turf in the seventeenth century world and of its easy transportability by water, two assumptions will be made in succession. The first one is that the Netherlands could not have used any turf in the seventeenth century, but would have had to produce an equal amount of energy mainly with fire-wood like other countries. In that case the Dutch would have had to practise forestry to satisfy their for that time enormous energy consumption. As the heat-
contents of wood and turf are nearly equal, they would have had to produce 1.55 million tons of wood every year. The annual growth of forests in those days will have amounted to ca 2 ton per ha. The Netherlands would, therefore, have needed a permanent forest reserve of 800,000 ha, which means that a quarter of the present area of the country would have had to have been covered completely with producing forest, in which every cut-down area would have had to have been replanted immediately. The labour requirements for such activities can only be guessed. In modern forest management one man per 75 ha is a normal standard. In those days, without mechanised tools and means of transport a standard of one man per 25 ha seems appropriate. This would bring the total labour requirement for fire-wood supply from organised forestry to 30,000 man-years per year. It is assumed that the transport and distribution of fire-wood require efforts equal to those computed for turf in the next paragraph.

The second assumption is that in the Netherlands no coherent system of waterways had existed. Then the turf transport would have had to have taken place by road, as in other countries. The calculations presented in table IV are intended to provide an impression of the magnitude of this transport problem.

The calculation combines the turf production estimates of table III and a rough allocation of turf consumption. The allocation is based on the fact that half of the seventeenth century population lived in Holland, where most of the economic activity occurred as well. The calculation in table IV also assumes that the influence of minor volumes destined to cities in the northeast of the country is compensated by that of, equally small quantities going to Zeeland and other regions in the south. The calculated transport capacity of $240 \times 10^6$ tonkm per year can also be expressed as 800,000 tonkm per day over 300 working days.

Figures related to road transport possibilities under seventeenth century circumstances can be derived from the agricultural tradition of a hundred years ago. Then, to move a loaded wagon of 1 ton over unmetalled roads with a mean velocity of 4 km per hour, 2 horses were needed. Since a horse could work 6 hours a day, 2 teams were required.

Table IV. Scheme of efforts to be made for turf transport in the Netherlands in an average year of the seventeenth century

<table>
<thead>
<tr>
<th>From region</th>
<th>to cities of Holland and Utrecht</th>
<th>average distance (km)</th>
<th>weight of turf (tons)</th>
<th>transport capacity (tonkm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td>250</td>
<td>$0.50 \times 10^8$</td>
<td>$125 \times 10^8$</td>
</tr>
<tr>
<td>II + IV</td>
<td></td>
<td>200</td>
<td>$0.45 \times 10^8$</td>
<td>$90 \times 10^8$</td>
</tr>
<tr>
<td>III</td>
<td>Holland and Utrecht</td>
<td>40</td>
<td>$0.60 \times 10^8$</td>
<td>$24 \times 10^8$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$240 \times 10^6$</td>
</tr>
</tbody>
</table>

17
to perform 50 tonkm in a 12-hours working-day. Providing the full 800,000 tonkm per day would therefore have required $4 \times 800,000/50 = 64,000$ horses. The empty wagons and the horses had to return, of course. We can assume that turf transport would have been part of a more general transport system. If we suppose that half of the wagons would have managed to find suitting return-freight and, further, that the extra loading and unloading times required for that would have been compensated by a somewhat greater velocity of the empty returning wagons, then $1.5 \times 64,000 = 100,000$ horses should be layed directly to the charge of turf transport. A daily working, medium sized horse needs 8 kg of hay, 4 kg of oats and some straw, in total ca 5,000 kg per year including 3,000 kg of hay and 1,500 kg of oats. Both of these latter quantities represented under seventeenth century conditions the yield of at least 1 ha. A modest estimate of the land needed to maintain a working horse is therefore 2 ha, which implies a total of 200,000 ha for the total required number of horses. This should be supplemented by 10 or 20% for breeding and nursing of young animals (a horse works from its third to its tenth year), which brings us to 230,000 ha. Since in those days even on the best soils only 40% of the cultivated area of a farm could be designated to the growing of market-crops, a total cultivated area of $2.5 \times 230,000 = 600,000$ ha would have been involved.

This cultivated area in its turn would have been part of a region in which also dwelling centres, roads etc. occurred and especially waste lands. Even by the end of the eighteenth century one third of the country’s total land area of about 3 million ha laid waste because it could not be reclaimed as long as modern chemical and technical means were lacking. For this reason the 600,000 ha of cultivated area would have represented at least 900,000 ha of geographical area, from which the forage produced in it, would have to be transported, again with horses, to the relay-stations along the turf routes. For 100,000 turf horses at 50,000 kg each this means another 500,000 tons. If this supply would be moved over an average of 25 km (taking into account that the wagons had to return empty) it would ask for a transport capacity of another $25 \times 10^6$ tonkm per year, equal to 10% of the turf transport capacity itself. Ultimately, then the turf transport by road would have occupied 110,000 horses and, for their maintenance, the complete yield of market crops of $1.1 \times 900,000 = 1$ million ha or one third of the countries total area.

How many people would have been involved in these imaginary transport activities? True enough, on the long stretches not every turf wagon would have needed a driver, but on the other hand one should not forget stablemen at the relay-stations, people attending young horses, keeping up roads etc. When as an average 1.5 men are reckoned per 2 teams of working horses, this would result in a labour requirement of $1.5 \times 110,000/4 = 40,000$ man-year for the assumed turf transport by road. From these figures it is clear why other countries, depending on road
transport, could not draw on their peat deposits in the seventeenth century. The enormous transport problem involved could only be tackled with the use of ships, as the following estimation shows. Round 1848 turf skippers from Hoogeveen and Meppel made as an average a good twenty trips per year each to Holland. By reckoning the distance per trip at 200 km the yearly distance covered per skipper comes to 4,000 km, and the average daily performance over 300 working days amounts to 13 or 14 km. For their colleagues of two centuries before with their smaller ships, 12 km per day does not seem unreasonable. Since in those days the average size of ships in inland navigation was about 25 tons, the daily transport capacity of a turf vessel can be set at 300 tonkm. Using assumptions that conform to the calculations of horse numbers made above (introducing a factor 1.5 in connection with available return freight), \(1.5 \times 800,000/300 = 4,000\) ships would have been needed for turf transport. Most of the skippers had their wife as only crew-member. Only on some of the bigger ships were two men involved. Keeping in mind that in the course of time people had to be employed in digging and keeping up canals and improving other water-ways, the total man-power involved in turf transport by water still would not have exceeded \(1.5 \times 4,000 = 6,000\) man-years per year. Just as cartwrights etc. were overlooked in the calculations on road transport, the workers on ship-yards are forgotten in this case.

8. THE IMPORTANCE OF WIND-POWER

With regard to wind-power, the quantity of energy it produced is less interesting in the framework of this study than the degree to which it was able to replace manpower and energy yielding hectares. Wind-energy originates from two sources: stationery motion energy from windmills and mobile motion energy from sailing ships. For neither category could statistics relating to the whole country be found in literature relating to the seventeenth century. From personal communications I have gained the impression that 3,000 to 4,000 wind-mills were operating in the Netherlands of the seventeenth century. From this total the few hundred polderdrainage windmills must be subtracted. However important they were to the Dutch economy by raising the quality of low lying land to a standard comparable with that of land found naturally in higher lying regions, they could not make any net contribution to the national energy supply. Subtracting these polder-mills from the total, about 3,000 are left consisting of flour- and oil-mills of local and regional service together with real industry-mills of many different types, working for the national and world markets. These 3,000 mills can be reckoned to have contributed to the national energy supply.

In section 1 it was mentioned that around 1900 a windmill had a
capacity of 3.3 kW. Seventeenth century windmills will have been less effective. Let them be put at 2.5 kW as an average. This means an energy yield per working day of $2.5 \times 24 = 60$ kWh, or per year converted to kcal $300 \times 60 \times 859$ kcal/kWh = 15 million kcal per mill. For 3,000 mills it amounts to a total of 45 milliard kcal, which indeed sinks into insignificance besides the 6,000 milliard kcal found for turf in table III. As a matter of fact the figure of 45 milliard looks even more unimportant in international comparison. Windmills (and watermills of course) also existed in other countries, although it can be taken for granted that their number per capita was nowhere as high as in the Republic. The favorable characteristics of its climate and landscape, the extensive transport facilities by water, which often allowed ships to reach the door of the mill itself, and the thriving industrial climate evoked by turf (see also section 9) all contributed to a comparatively high concentration of industrial windmills in the Republic. For the study of energy relations within this country it is interesting to investigate what the Dutch milling business meant as a substitute for human or animal labour.

A well fed man can, without hurting his health, give at best a continuous daily performance of not more than 0.6 kWh. Since the comparable figure for the stationary motion energy production of an average windmill was 60 kWh, its replacement with men would have required a gang of over $60/0.6 = 100$ men. This means that other things remaining equal but without mills at least $3000 \times 100 = 300,000$ extra labouring people would have had to have been employed for the maintenance of an equal industrial production. If animal power (e.g. horse-mills) had been used instead of human power in the preceding exercise, the following calculations could be made. One farm horse of three years and older can perform 0.6 kW as a constant average. In a six-hour working day this gives 3.5 kWh. The performance of a windmill would answer to that of $60/3.5 = 17$ horses; the replacement of all mills would have required $3,000 \times 17 = 50,000$ horses. The land required for the maintenance of these horses calculated in the same manner as for the fictitious turf transport by road (where 100,000 directly involved horses were found to ultimately require a geographical area of 1 million ha) amounts to 0.5 million ha, or another sixth of the total land area of the Netherlands. It is interesting to note how small a yield of stationary motion energy (only 45 milliard kcal per year) suffices to create such enormous savings in human and animal labour.

To appreciate the energetic importance of inland navigation an impression of its total volume is needed in the first place. In this case nothing more can be expected than a rough guess. Besides turf a great diversity of goods found its way by water. All together, they most likely represented many more tons in weight than the turf. On the other hand their average transported distances would have been shorter. One could perhaps double the 4,000 turf-ships computed above as an approximation
of the total fleet of inland sailing vessels. If, following our earlier calculations, these 8,000 ships are again assigned a productivity of 300 tonkm per day over 300 working days, they would have had a collective transport capacity of $720 \times 10^6$ tonkm per year. A global standard for energy need of a modern inland ship is 50 kcal per tonkm. Though it is not quite correct to apply this figure on the far smaller ships of those days, its use once again permits us to observe that the 36 milliard kcal needed for the $720 \times 10^6$ tonkm, is dwarfed by the turf figure. But is not the attraction of navigation as a substitute for road transport precisely its small energy requirement? Once again, the land and labour saving character of inland shipping should be stressed. The estimated size of the inland shipping fleet, double the number of turfships, can be assumed to replace double the amounts of hectares and manpower computed for the imaginary turf transport by road. So, as 8,000 inland ships seems to be a modest estimate, total inland navigation can be reckoned to have saved at least a geographical area of 2 million hectares and 80,000 male workers.

9. THE GOLDEN AGE BORN OF TURF

The seventeenth century Republic produced a, for that time, tremendously wide variety of goods and services, partly for inland consumption, partly to obtain on the world market those commodities which the country could not itself produce in sufficient abundance. This production was accomplished by the exertion of its inhabitants, by the application of additional energy in processing raw materials and by the manipulation of expedients resulting from these activities. However, in consequence of the exceptional geophysical construction of their territory, the Dutch were able to save human and animal energy to a degree unprecedented in those days.

The importance of their applying additional energy can best be appreciated by comparison with contemporary conditions elsewhere and with the present day conditions. To start with the latter, the yearly total of inanimate energy consumed in the seventeenth century Republic was computed at $6,000 \text{(turf)} + 45 \text{(mills)} + 36 \text{(inland navigation)} = \text{over 6,000 milliard kcal}$ for a population of a good 1.5 millions. This amounts to an annual consumption of 4 million kcal per capita. The comparable figure for the Netherlands in 1973 was 50 million kcal and for India 2 million kcal per capita.

For the comparison with seventeenth century circumstances outside the Republic, tables V, VI and VII can be of use. It goes without saying that the presented figures must not be regarded as exact in view of the assumptions and estimations upon which they are based. They can however be looked upon as mutually comparable to a sufficient degree.
TABLE V. Approximating survey of labour and hectares the Netherlands spent on the acquisition of additional energy in the Golden Age.

<table>
<thead>
<tr>
<th>For:</th>
<th>man-years per year</th>
<th>geographical area ha × 10⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. heating energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>from turf</td>
<td>7,000</td>
<td>none</td>
</tr>
<tr>
<td>B. mobile motion energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>from inland navigation</td>
<td>12,000</td>
<td>none</td>
</tr>
<tr>
<td>C. stationary motion energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>from windmills</td>
<td>3,000</td>
<td>none</td>
</tr>
</tbody>
</table>

TABLE VI. Approximating survey of the sacrifices the Netherlands would have had to make to acquire equal energetic possibilities, without having the disposal of their special resources.

| K. heating energy                          |                    |                          |
| from firewood                             | 30,000             | 0.8                      |
| L. mobile motion energy                   |                    |                          |
| from horses (and wagons)                  | 80,000             | 2.0                      |
| + p.m.                                    |                    |                          |
| stationary motion energy                  |                    |                          |
| M. from human labour                      | 300,000            | none                     |
| N. from horse-mills                       | p.m.               | 0.5                      |

Explanation to tables V and VI:
- a see section 6
- b see section 7: 6,000 for 4,000 ships means 12,000 for 8,000 ships (section 8); horse towed vessels are considered to be left out of the number of 8,000.
- c see section 8: 3,000 mills with one man per mill to keep it going day and night; other workers in mills were not occupied with winning of energy but only with applying it in the industrial production process.
- d see section 7
- e see section 8
- f 'p.m.' stands for a great many people, in fact for the complete active rural population of the area mentioned in the right hand column. That area would not have been able to contribute to the national economy any other market crop but horse fodder. Therefore all its labour force has to be attributed to this commodity.

TABLE VII. Summary of computed efforts needed to get the disposal of equivalent quantities of energy under different circumstances.

<table>
<thead>
<tr>
<th>For:</th>
<th>man-years per year</th>
<th>geographical area ha × 10⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td>X = C + K + L</td>
<td>113,000 + p.m.</td>
<td>2.8</td>
</tr>
<tr>
<td>Y = K + L + M + N</td>
<td>260,000 + p.m.</td>
<td>3.05</td>
</tr>
<tr>
<td>Z = A + B + C / 2</td>
<td>22,000</td>
<td>none</td>
</tr>
<tr>
<td>X + Y / 2</td>
<td>165,000 + p.m.</td>
<td>2.93</td>
</tr>
</tbody>
</table>
Confidence may also be given to their order of magnitude. The first two of the tables speak for themselves with the aid of the explanation presented in notes a–f. Table VII summarizes the results of all foregoing considerations and calculations. Situation X refers to an imaginary country (size, population and energy consumption equal to those of the Republic) with windmills but without navigable inland waterways and without access to turf. In situation Y conditions are the same as in X with the exception that all mills are missing as well. It is assumed that in this latter case half of the mills would be replaced by human, the other half by animal labour. Situation Z represents the actual situation in the seventeenth century Republic. As mills were used in all surrounding countries, though less frequently than in the Republic, intermediate circumstances (between X and Y) seem to offer the best base of comparison. This suggestion is presented in the term (X + Y)/2 in the bottom line of table VII. Subtracting situation Z yields the differences which show the savings in labour and in hectares the Republic was able to enjoy. It should be emphasized that the figure in the last column represents the Netherlands complete land area of ca 3 million hectares. This means that ‘p.m.’ in this bottom line (see note f for explanation) stands for at least the whole active rural population of the Republic, while the other 165,000 can easily represent its active urban population.

In regard to heating energy the Dutch lived a style – measured to contemporary foreign criteria – as if they used the greater part of their territory for nothing else but energy production and distribution. They were apparently able to command energy sources that replaced 0.8 million ha of permanent forest and 1.0 million ha of area that should have produced fodder for turf horses. Under these conditions they could easily run industries based on thermal processes. Breweries, brick-, roof- and paving-tile, pipe-, stoneware- and faience-factories, salt refineries, madder- and chicory-works, bleachers, dyers and printers of textiles are all mentioned as being big turf consumers. Other users of turf were furnaces, kilns, cookeries, bakeries, distilleries, drying-houses and roasters and smelters processing a great variety of materials and products, even charcoal-burners applying turf to heat their wood-stocks.

Thanks to the cheap fuel all these activities were able to produce goods that could easily compete on the international market. Add to this the cheap transport facilities by water, from which these products in their turn benefitted, and one has to expect a very profitable commercial climate along with the favourable industrial one, each pushing the other up. Under these circumstances one must also expect a relatively high price of labour, which stimulated, in turn, capital intensive investment. In this context and helped by the geophysical climate, the Dutch were able to make a special success of designing and building dozens of types of industrial mills to run, for the first time in history, a large-scale industrial sector based on dynamic processes without human or animal force as the
motor. It should be kept in mind that the building of a mill, and particu-
larly a specialized industrial mill, must have been very expensive. As was
stated before, such a development based on so high an energy consump-
tion would have lead to impossible consequences without inland naviga-
tion and turf. According to the bottom line of table VII it would have
absorbed the productive capacity of the whole territory of the country.
In reality the Dutch could realize all this and at the same time keep all
their fertile hectares for a normal, all-round agriculture. Indeed, they
could even devote a portion of their land to the production of important
raw materials for processing in their mills (e.g. colza).

It would not be correct to summarize this analysis with the observa-
tion that the Dutch lived as if their country was twice its actual size. A
larger territory would have meant longer transport distances, conse-
quently higher costs and thereby smaller possibilities of development.
One should put it like this: the Dutch lived (again, measured by the
standard of countries without turf and inland navigation) as if their
country had two floors, as if every hectare yielded a double crop: one
of that which was actually grown (on the ground level) and the other a
full harvest of fire-wood and horse fodder (on the imaginary first floor).

How about the people? In this respect a similar phenomenon occurred.
It was noticed before that the 165,000 + p.m. of table VII represent
something like the complete active population of the country. Without
turf and inland navigation this would again create an impossible situa-
tion: all inhabitants would have had to have occupied themselves with
the winning and transporting of energy sources; nobody would have been
left to apply this energy in industrial processes or to perform other social
activities. Again, it would be misleading to conclude that the Republic
acted as if it had twice its actual number of inhabitants. More people
would have meant that the possibilities for development would have
been fewer, because the provision with their primary needs of a double
population would have absorbed a far greater part of the general resources.
The situation can best be understood if one imagines that the Dutch
lived as if each one of them led a double existence. In the first place they
carried on with undivided attention their own professions (on the ground
level); in the mean time everyone’s alter ego seemed to perform a full
job in nursing, harvesting and transporting the crops of the imaginary
first floor. Compared with other countries the Republic offered its in-
habitants in this way twice doubled opportunities for development, based
on both the double apparent yield of its hectares and the double apparent
achievement of its active population. This can explain the explosion of
creative power, referred to in the introduction. Among the computed
165,000 + p.m. people we recognize those who manned ships and ex-
plored the world, who pursued commerce and science, who printed books
and maps, who made arms and clocks, who painted or served other Muses,
who pumped dry polders and pursued all the other activities, most of these lucrative activities at that, which helped to push the spiral of prosperity vigorously upward. But at the base of all this the sailing inland skipper with his deck-load of turf was holding the helm.

10. CONCLUSIONS

This study was motivated by the historical problem of why around 1600 the Republic assumed the mantle of leadership on the path of mankind's economic and social development. The answer is: because it was able to extensively apply inland navigation and, by that, to fall back on its peat deposits when everywhere (also in the Netherlands itself) deforestation had progressed to such an extent, that wood had become an expensive fuel. Its exceptional position becomes even more evident, when it is considered that at the beginning of the Dutch explosion of prosperity each one of the cities in the ring Amsterdam, Utrecht, Gouda, Rotterdam, Delft, Leiden, Haarlem had an abundance of easily transportable (low peat) turf of excellent quality within a few kilometers of its gates. No wonder, that the centre of gravity of economic development became located in this part of the country.

To round off the argument, the further developments are recalled in a broad outline. Toward the end of the seventeenth century the Republic started to loose its dominant position. Some of the reasons are: turf became gradually more expensive because of increasing difficulties in supplying it to the main centres of consumption. Also, the application of wind energy in transport became more and more expensive to the Dutch, as harbours and rivers became shallower by silting. Examples of this added expense are the ship's 'camel', needed to drag vessels across the sandbank of Pampus near Amsterdam, and the costly dredgings in several other waterways and harbours. To these internal causes of retardation must be added a growing foreign competition, notably from the side of Britain, whose development was based on an increasing use of pit-coal. In the field of navigation the Dutch position was worsened still more severely, as most other countries did not have troubles with the depth of their harbours. They could turn to better sailing, heavier-draught ships, which made mobile motion energy even cheaper to them. Just as it is unjustified to ascribe exceptional qualities to the Dutch at the origin of the Golden Age, so their slowly stepping back from the van of technological and social progress should not be blamed on their failing judgment or initiative. It was not the people who changed but the circumstances.

These observations concerning Dutch history can be generalized to the rest of the world. As was already stated, the British took over the torch when
a more advanced technology made the winning, distribution and application of their coal gradually more easy. In addition they were able to improve their navigation. As an energy-bearer coal had advantages over turf; it is more compact and easier to handle, therefore asking less effort per kcal. What can be said for coal when compared to turf applies with equal strength to oil and natural gas, in comparing to coal. On oil and natural gas the succession of the United States to the leadership of economic development was in large part founded. Another important feature in this latter case was the cheap maintenance energy derived from the exploitation of vast and initially fertile prairie-lands. Finally, the flourishing of Western Europe and Japan after 1950 can be ascribed to the discovery of quantities of easily exploitable oil in the technologically undeveloped Middle-East. This oil-stream sought its way to places where sufficiently advanced knowledge was available to make it profitable.

These considerations lead to the following general rule:

In a given period the greatest prosperity (with opportunities for the advancement of technological and social attainments) arises in the area, where — depending on geophysical circumstances governing the winning and transport of energy — the acquisition and application effort (in the light of already available skill) per serviceable energy-unit is the smallest. The economic decline of an area is inevitable as soon as these circumstances become relatively less favourable in that area.

Abundant evidence to support the validity of this general rule can be traced in the history of mankind. If somewhere a less troublesome, therefore more profitable, possibility of energy-acquisition arises, that fits into the development-pattern already reached, then prosperity increases there. Here are a few examples: agriculture was invented on fertile, naturally well-drained, loess-soils with good water-holding capacity; the steam-engine was invented in a coal-mining area; tracts of fertile land, streams of irrigation water, deposits of fuel, natural harbours were discovered, often stumbled upon unexpectedly. They determined the attainability and profitability of maintenance-, heating- and motion energy and consequently the outline of the distribution of prosperity on the earth’s surface. The reverse also occurred. Lands eroded, irrigated areas grew saline, harbours silted up, mines had to be deepened, all of which made energy application more difficult and less profitable.

Some final remarks are due in this context. Of course, the general rule presented here only gives the rough background of historical phenomena. In its application all kinds of details have to be filled in in accordance with specific political, religious and other interhuman influences. Geology, geography, topography, climatology, hydrology, however, are setting the stage and delimiting the boundaries of the possible. Perhaps the most important feature to be stressed is, that for understanding the pace of development it is not the volume of an energy-deposit which is of primary importance, but the smallness of the efforts for its exploitation.
and application. Remember the contrast between the historical developments of Dutch and other European peats! Quantities of energy-bearers only come into the picture when the continuation of an already attained thriving situation is at issue. The smaller the volume of easily attainable energy, the sooner recourse has to be had to more costly ways of energy-acquisition, with its apparently inevitable adverse consequences. Extrapolation of the general rule to the future raises the intriguing question of what path the future of mankind will take, given the increasing difficulties in the obtaining of energy, which have now, for the first time in history, arisen on a world wide scale.

February, 1976
Department of Land and Water Use
Agricultural University, Wageningen.
NOTES


2. Export prohibitions for mills and mill parts can be regarded as indirect proof.


6. A. Hausing, Handbuch der Torfgewinnung und Torfverwertung, Berlin 1917, p. 15. The author mentions the following figures in millions of hectares: Northern Germany 2.4, Southern Germany 0.2, Austria 0.4, Sweden 5.0, Norway 1.0 to 1.5, Denmark 0.1, Finland 10.0 and Russia 17.0.

7. Because peat business as meant in this study is an uniquely Dutch activity, it is difficult to describe it in English. For the sake of clarity, we make the following distinctions: 
- peat - the geological formation,
- turf - material noun for the dried substance,
- a turf - a block of dried peat,
- low peat vs high peat - refer to its position in respect to the general water table of the area. This distinction does not coincide with bog peat and moor peat, as the latter distinction refers to the growing conditions (conf. eutrophic vs. oligotrophic),
- low peat turf - in general the same as dredged turf, though in low peat areas some of the peat was situated so high above water that it could be cut or dug. Most of this upper layer disappeared however before 1500,
- high peat turf - in general the same as cut or dug turf, though in high peat areas some of the peat stays under water. From the nineteenth century on these soaked layers might be dredged, but seventeenth century cutters left them in place.


A review is presented of the different layers of which the profile is composed. Aggregating the maxima and minima indicated for the layers, the height of the profile runs between 2.62 and 6.35 m, the average being 4.5 m.

12. See 11, p. V 244.

13. See 11, p. IV 304. A table is given of all lakes south of the IJ pumped dry between 1610 and 1941. Their total area amounts to 78,143 ha. Some of them are known to have been natural lakes (often evident from the names: 'meer' instead of 'plas'). Subtracting the total area of these natural lakes amounting to 27,230 ha, leaves 51,000 ha. The last figure is too small because many of the natural lakes are known to have been widened by peat dredging. Artificial lakes covering 8,500 ha continue to exist today. North of the IJ some 1,500 ha have been dredged out. Thus the total area for this part of the country comes to > 51,000 + 8,500 + 1,500 = > 61,000 ha.

14. P. R. Bos, Schoolatlas der gehele aarde, 35th ed., Groningen 1936. On its map 13 surface level marks are indicated for 21 spots in pumped dry artificial lakes. They average at 4.3 m below mean sea level.

15. See 11, pp. V 71-72. A quantitative enumeration of 'veenpolders' (peat polders) in
Friesland is given. Total area 29,000 ha in the south-eastern part of the province. Some other partly dredged-out areas more to the north are only mentioned. They consist of real mixtures of land and water. A rough estimation based on the map indicates ca. 2,000 ha of land-loss is these areas. The Overijssel low peat area forms a coherent rectangle of about 16,500 ha. Thus the total area of region IV adds up to 29,000 + ca. 2,000 + ca. 16,500 = 47,500 ha.

16. See 11, pp. V 141–155 for historical data; numbers of hectares cited were measured from the map.
18. See 11, p. V 71 for data on Friesland; see 11, pp. VI 248, 249 and 300 for data on Overijssel.

Also:
21. See 19, p. 56.
23. See 8, p. 146. According to Van Schaik peat dredging in the west of the country did not really start before 1530. He presumes that before that date peat only was dug. This would imply a tremendous expansion of dredging activity after 1530 since it is known that several villages were threatened by artificial lakes around 1600. It also would mean that the lower parts of the input lines of figure 2 would be far steeper and that consequently the peat consumption in the seventeenth century would have been considerably more than the 200 ha/year estimate according to the description in the text.
27. As a consequence of improvements in winning and transportation procedures coal must have become cheaper between the middle of the seventeenth and the middle of the nineteenth centuries. Moreover, since coal could be used to produce motion energy in the 19th century, it had become, through its versatility, more profitable than peat. The 6,084 × 10^6 kcal did contain a portion of motion energy. The rise in turf prices after 1750, claimed to have been considerable, must be due to the near exhaustion of the most productive peat deposits. Concerning region III see figure 2, in which the output curves become more flat. The description of region I in section 5 demonstrates that the most easily accessible part of it was exhausted by then.
28. See 24, p. 228.
29. See 8, pp. 198–199.
30. See 10, p. 44.
31. See 25, p. 169. Turf prices on the spot in the peatery are given for the middle of the nineteenth century: high peat turf 14 to 20 cents per turf-cask (200 liters), low peat 40 to 60 cents. Since labour costs are the chief determinants of spot prices, these prices confirm a 1 to 3 labour ratio. The more expensive low peat turf had better burning qualities. It was used for domestic heating. High peat turf was nearly synonymous with industry turf. The difference is similar to the one between anthracite and bituminous coal.
32. See 10, p. 44 and see 25, p. 181.
33. Data on forest management are mainly based on personal communications from Ir. J. J. Westra of the Department of Forestry of the Agricultural University, Wageningen.
34. C. Baars, *De geschiedenis van de landbouw in de Beijerlanden*, Wageningen 1973, p. 130.
35. See 8, p. 196.
36. Inquiries were made with the society ‘De Hollandsche Molen’ at Amsterdam. They gave as a maximum the figure of 3,000 or 4,000, stressing that there were rather few polder-mills in those days. Prof. A. M. van der Woude in a personal communication made some approximating extrapolations based on the few known figures. He agrees with the total of 3,000 to 4,000 and distinguishes ca 1,800 windmills of local and regional importance, ca 1,500 industrial mills and some 500 polder-mills. To stay on the safe side the total of mills contributing to the producing capacity (including local industries) was put at 3,000.
37. See 8, p. 197. Van Schaijck comes to the conclusion that a large, if not the largest part of inland navigation in those days on the Zuiderzee can be ascribed to turf shipping. The proportion of other cargo in the mutual traffic between the cities in the western part of the country and between these cities and their surroundings (food supplies, industrial goods) must have been greater than in the trans-Zuiderzee traffic.
40. These difficulties not only increased when turf provision was shifted to peat deposits in distant parts of the country, but also from the necessities of deeper dredging, of extending approach canals to and within peat areas and of other circumstances raising labour requirements per energy-unit. In addition to the already mentioned considerable rise of turf prices in the second half of the eighteenth century there was a gradual rise from the sixteenth century on. Relative turf prices in the Republic were (see 24, p. 223): 1585–1589 = 100; 1600–1604 = 145; 1665–1669 = 284. This effect cannot be ascribed to rising wages. Baars (see 34, pp. 193–194) showed that wages of agricultural labourers remained constant at least from the beginning of the seventeenth to the middle of the nineteenth century. Seasonal workers in the peateries and on the farm were largely the same people. So it is not likely that wages in the peateries showed substantial changes over time either, before 1830.
BARGES AND CAPITALISM
PASSENGER TRANSPORTATION IN THE
DUTCH ECONOMY, 1632–1839

JAN DE VRIES
# TABLE OF CONTENTS

## PART ONE: PASSENGER TRANSPORTATION IN THE DUTCH REPUBLIC

### I. THE TREKSCHUIT ERA, AN INTRODUCTION
- 1.1 The world of the trekschuit
- 1.2 Passenger transportation in the early seventeenth century
- 1.3 The desire for improvement
- 1.4 The uniqueness of the trekschuit as an innovation

### II. THE PASSENGER TRANSPORTATION SYSTEM
- II.1 The development of the trekvaart network
  - II.1.1 Early trekvaarten
  - II.1.2 1632–1647, the first boom
  - II.1.3 1648–1655, hiatus
  - II.1.4 1656–1665, the second boom
- II.2 The network described
- II.3 The dynamic of trekvaart construction
- II.4 A description of the new technology
  - II.4.1 Trekvaarten
  - II.4.2 Trekschuiten
- II.5 The development of the other modes of passenger transportation
  - II.5.1 Sailing vessels
  - II.5.2 Road transportation

### III. ECONOMIC AND SOCIAL CHARACTERISTICS OF PASSENGER TRANSPORTATION
- III.1 Passenger-carrying capacity
- III.2 The 'time-frame' of the Dutch Republic
- III.3 Travel costs
- III.4 Who traveled on the trekschuiten and why?

## PART TWO: A PRE-INDUSTRIAL BIG BUSINESS?

### IV. THE CONSTRUCTION AND OPERATION OF THE TREKVAARTEN
- IV.1 Capital investment
- IV.2 The management
- IV.3 Revenues
- IV.4 Expenditures
- IV.5 The accounts

### V. THE OPERATION OF THE TREKSCHUiten
- V.1 The skippers
- V.2 The business of the skippers' guild
- V.3 Revenues
- V.4 Expenditures
- V.5 Skippers' incomes
VI. THE MICROECONOMICS OF THE TREKVAART INDUSTRY

VI.1 The productivity of labor
VI.2 Variable, fixed, and total costs
VI.3 The demand curve
VI.4 Determining the price
VI.5 Determining the supply
VI.6 The aims of municipal policy

VII. THE DECLINE OF AN INDUSTRY

VII.1 The decline in demand
VII.2 Contemporary explanations of decline
VII.3 Responses
VII.4 Technological change
VII.5 An assessment

VIII. SOCIAL SAVING TWICE CONSIDERED

VIII.1 The concept of social saving: its uses and limitations
VIII.2 The social saving of the trekvaart network in 1670
VIII.2.1 Direct resource saving
VIII.2.2 Consumers' surplus
VIII.3 The introduction of a new mode of transportation
VIII.4 The economic impact of an obsolete industry
VIII.5 The social saving of the railroad in the movement of passengers
VIII.6 The penalties of the pioneer

PART THREE: TRENDS, CYCLES, AND STRUCTURAL CHANGE IN THE ECONOMY OF THE DUTCH REPUBLIC

IX. LONG-TERM TRENDS IN THE DUTCH ECONOMY

IX.1 The evidence
IX.2 The evidence as an economic indicator
IX.2.1 Intermodal competition
IX.2.2 Towpath toll receipts
IX.3 The value of other quantitative indicators
IX.4 The analysis of long-term trends in the per capita income of the Dutch Republic
IX.4.1 The model
IX.4.2 Price changes
IX.4.3 Population
IX.4.4 The gravity model
IX.4.5 An application to the railroad network, 1857–61
IX.4.6 An application to the trekvaart network, 1660–1800
IX.4.7 The role of price and population in explaining the demand for intercity passenger transportation
IX.5 The residual and the per capita income of the Dutch Republic

X. CYCLICAL AND RANDOM VARIATION

X.1 Did the pre-industrial economy experience business cycles?
X.2 The cycles of demand for intercity passenger transportation, 1648–1817
X.3 The influence of random variables
X.4 The influence of economic variables
X.5 Conclusions
INTRODUCTION

Several years ago while I pursued research on another subject, an entry in a Haarlem municipal archive inventory caught my eye. It claimed to provide the financial result of a municipally-owned canal for every year from 1657 to 1795. Such material was, at best, tangential to my research project, but I asked to see it anyway, probably out of a curiosity about just what types of information such a document might contain. What I found was a remarkably detailed account of the tolls collected and maintenance expenditures disbursed. Moreover, the documents made clear that the chief function of this canal was not the movement of freight. No, it was almost exclusively dedicated to the movement of people; indeed, the account books meticulously recorded month-by-month the number of passengers carried.

Most people who have some familiarity with Dutch history (or, for that matter, Dutch art or literature) are aware that passenger transportation before the railway age made much use of the Netherlands' numerous waterways. Perhaps because this knowledge is so obvious no one has ever made very much of it in social or economic histories of the Dutch Republic: travel by water was as natural as life itself, like breathing and sleeping. Why should one write the history of such a commonplace?

The documents I had read continued to fascinate me, but it remained unclear how they might be of historical importance, for the scarcity of any serious literature dealing with waterborne passenger transportation made it difficult to appreciate fully the phenomenon.

As I continued my original project, my attention kept being drawn back to the canals. In every municipal archive I entered, I found records similar to those that had caught my eye in Haarlem. Indeed, it came to seem that canal administration and passenger service regulation had been a consuming interest of Dutch municipal officials, so voluminous were the extant records. I had unthinkingly assumed that people had traveled by making informal use of largely natural water routes. Instead, the documents gradually revealed to me a large-scale, highly organized passenger transportation system making use of specially constructed and dedicated canals. The system arose in the mid-seventeenth century and lived on for two centuries before dying in the face of railroad competition in the mid-nineteenth century.

Instead of something so obvious as to be trivial, I found myself confronted with a unique phenomenon which raised many interesting questions touching on historical geography, economic history, and social history. It became my goal to understand as many facets of this phenomenon as were within my power. Hence this thirteen chapter study.

It is one thing to wish something and quite another thing to achieve it. Standing between the two is a chasm that I could never have bridged
alone. The list of people who have encouraged and assisted me is longer than even I realize. But however incomplete my acknowledgements must be, I cannot refrain from attempting to indicate the scope of the assistance that I have received. The documentation on which this study is based is drawn from dozens of archives. The invariable willingness of archivists and staff members to accommodate my sometimes unusual and burdensome requests – to the point of lugging hundreds of pounds of dusty volumes and remaining at one's post after the closing hour – has imposed on me a debt that I cannot adequately repay. I do not believe that there are many peoples in the world that make historical research materials at the local level as accessible as do the Dutch.

To process and analyze these voluminous materials I found myself calling on my family, my students, and my colleagues. My wife and Dutch relatives are, I hope, aware of my appreciation for their crucial assistance. Among the colleagues upon whose expertise I have called are the geographer Allen Pred, the economists Richard Sutch, Nicholas Crafts, and Ronald Lee, the historian D. J. Roorda, the computer specialists Hugo Uyttenhove, H. J. Blanksma, and Eric Bakker, and my research assistant Mary Cookingham.

The opportunity to expand my initially modest project (what is essentially chapter IX) into the present study was provided by a year's stay in the Netherlands at the Netherlands Institute for Advanced Study (NIAS) and the Agricultural University at Wageningen. The director and staff of NIAS made it possible to do a great deal in an all-too-brief period of time and the fellows of the Institute provided many helpful suggestions. Through frequent, always stimulating conversations at the Agricultural University with A. M. van der Woude, H. K. Roessingh, J. A. Faber and the other faculty and staff of the Department of Rural History, my ideas and initial conceptualizations were allowed to mature and assume the form observable here. This work is therefore dedicated to my Dutch colleagues and friends without whose support it could never have been realized.

May, 1977
Berkeley, California.
PART ONE

PASSENGER TRANSPORTATION IN THE
DUTCH REPUBLIC
CHAPTER I
THE TREKSCHUIT ERA, AN INTRODUCTION

1.1. THE WORLD OF THE TREKSCHUIT

A mid-seventeenth century traveler who found himself in Dunkirk and wished to travel to the Dutch province of Groningen could have proceeded as follows. Presuming that Louis XIV's expansionist wars in Flanders did not complicate our traveler's plans, he very likely would have arisen very early one morning and boarded a passenger-carrying barge bound for Bruges. This barge, pulled by a horse, left at 5 or 6 a.m. It moved along a canal, dug in 1640, whose course never strays far from the coastline. After pausing in the towns of Veurne and Nieuwpoort, this barge, the only scheduled conveyance of the day, would at long last come to the sas, or sluice, at Plasschendaele, near Oostende. After transferring to another barge on the other side of the sluice, our passenger would arrive at Bruges in the evening, in time, if all went well, for a late supper. For this 67 km voyage our traveler would have to pay 26 stuivers, reckoned in Dutch currency: 1 guilder = 20 stuivers (st.), 1 stuiver = 16 penningen (p.).

The following morning our traveler could linger over his breakfast and embark at 11 a.m. on a barge bound for Ghent. This barge, and the canal over which it traveled, offered him an experience very different from the previous day's. In the place of the small cramped barge and the narrow, winding canal from Dunkirk, there now appeared a barge 20 meters long and 5 meters wide that was regarded as 'the most remarkable boat of the kind in all Europe; for it is a perfect tavern divided into several appartments, with a very good ordinary at dinner of six or seven dishes, and all sorts of wines at moderate prices'. This splendid vessel was pulled by no fewer than four horses along a broad and deep canal that had been dug between 1613 and 1623. It took 8 hours to cover the 44 km distance to Ghent and performed this service for a basic fare of 12 stuivers. The elaborate meals served on board were, of course, extra.

After spending the second night in a Ghent inn, our traveler faced a choice of alternative routes to Rotterdam, his next destination. He could have taken the morning barge to Sas van Ghent, from which point sailing vessels maintained regular communications with several Zeeland ports. From such Zeeland ports as Middelburg and Veere, (and the Brabant port of Bergen op Zoom) ships departed at least daily for Dordrecht or Rotterdam. The duration of such a trip would be very hard to predict, so an alternative route, although more costly, might still have gained our traveler's approval. He boards the daily coach bound for Antwerp, or rather the village on the opposite bank of the Schelde from Antwerp.
This vehicle, making its way as best it can over the 54 km of unpaved roads separating Ghent from Antwerp is uncomfortable and expensive, the cheapest seat costing 42 stuivers. With some luck, our traveler would arrive in Antwerp early enough in the afternoon to board a sailing vessel departing for Holland that night. Beurtschippers sailed regularly, every so many days, to many cities in the northern Netherlands. In addition, private vessels also plied the waters of the Delta region. Freight transport was the chief function of beurtschippers and private captains alike, but they also carried passengers. The most frequent sailings were to nearby Bergen op Zoom and the more distant Dordrecht. To the latter ships departed daily from the Heude van Brussel at the Nieuwe Brugge. With the cooperation of the tides and the winds, our traveler could expect to cover the 93 km to Dordrecht within 24 hours of his departure from Antwerp. For a fare of 18 stuivers he could spend this time in a roef, or cabin, equipped with benches, heated in winter, and supplied with beer and food, which the skipper was enjoined by municipal ordinances to sell at reasonable prices.$^2$

Our traveler might have had to spend the next night at Dordrecht. Four sailing vessels departed Dordrecht daily for Rotterdam and their departure times depended on the tides. Because of the irregularity of the departures, the city employed a Ty-meester, or Roeper to announce impending departures for the benefit of passengers and sailors alike. With luck, however, our traveler may have been able to catch the last departure to Rotterdam. The 24 km voyage along the Noorder and Nieuwe Maas would have cost him only 4 stuivers.

The next morning, the fifth of the trip, our traveler would have encountered a transportation system qualitatively and quantitatively different from that which he had used in Flanders and Brabant. His travels would no longer be governed by the tides and winds, and his schedule would no longer be dictated by the single daily departure on a given route.

Our traveler could choose between two routes to Amsterdam, his next destination. Eight wagons per day departed for Gouda, connecting there with barges, called trekschuiten, to Amsterdam. The other route, which we will have him take, began with hourly trekschuit departures for Delft. The first of these left Rotterdam at 5 a.m.; the fare was 5 stuivers. In Delft, one and three-quarter hours and 15 kilometers later, our traveler would have to walk through the city to the departure place for trekschuiten to Leiden. These barges departed 9 times per day, scheduled to connect with arriving barges from Rotterdam. The fare, 7 stuivers 2 penningen, permitted our traveler to take a seat in the covered ruim of the long, narrow trekschuit which covered the 21 km in three hours. In Leiden another 9 barges per day departed for Haarlem, 29 km and four hours away. The fare was 12 stuivers 10 penningen. In Haarlem our traveler had once more to walk across the city to the Amsterdam
gate, where hourly barges, the last leaving at 8 p.m. would carry him over the last 19 km in two and one-quarter hours and for a fare of 5 stuivers. If our traveler arose early enough to catch the 5 a.m. barge from Rotterdam to Delft, he could have arrived in Amsterdam at 6.15 p.m. Had he elected the route via Gouda, he would have arrived at about the same time, for about the same fare, and without having to make his way by foot through the intervening cities.

We might imagine that someone traveling for five days without interruption would welcome an opportunity to pause, particularly after arriving in one of the largest cities of Christendom. But if he had the stamina, our traveler could have continued his trip immediately upon arrival in Amsterdam. Here, again, he had a choice. He could have boarded the night barge — an overnight trekschuit equipped with primitive beds — for Hoorn. From Hoorn wagons would have taken him to Enkhuizen where beurtveren maintained regular services to several Friesian ports. But, if the weather were decent, a more convenient means of reaching Friesland was to board one of the half-dozen Zuider Zee sailing boats that departed Amsterdam every night with the closing of the city gates. Our traveler will select the ship to Workum, which 'normally' reached its destination the following morning. (In the other direction one had to count on a travel time of about 24 hours.) The basic cost was 15 stuivers; if he wished the comfort of sleeping space in the kooi and a blanket, an extra 12 stuivers would have been due.

On the Zuider Zee our traveler would once again be subject to the vagaries of the weather. But if the ship succeeded in reaching Workum the next day, he could spend the night in a Workum inn and return, the following morning, to the clockwork regularity of the trekschuit. On this seventh morning of his trip, our traveler could board the first of the four daily trekschuit departures for Bolsward. The barges on this short, 11 km, route all connected at Bolsward with barges bound for Leeuwarden 27 km distant. Thirteen stuivers sufficed to pay for these trips, which would bring our traveler to the capital of Friesland by 1 p.m. There he could catch the last of the four daily departures for Dokkum, which he would reach 8 stuivers poorer and three and one-half hours later.

The following morning our traveler would board the first of three barges to Groningen. The trekschuiten traveling through this rural area stopped in villages to pick up and set off country folk, giving the vessels a rather different atmosphere from those of urban Holland. But in other respects these barges were the same, offering punctual, frequent service, traveling at an average speed of about seven kilometers per hour. Our traveler would have covered the 46 km separating Dokkum from Groningen in seven hours, for a fare of 15 stuivers. Here he could board the third of four daily departures for Winschoten, in Eastern Groningen. The 35 km trip would take him through a ‘new country’ of settlements
only recently created in the process of digging up and exporting the peat that covered much of this region of moors. The trip to Winschoten, which cost 11 stuivers, would bring our traveler to within 13 km of Nieuwe Schans (or Lange Akker Schans, as it was then known) on the border with the German province of East Friesland. If our traveler made his trip after 1695 he could have covered this last stretch by trekshuit as well but in the mid-seventeenth century this was not yet possible.

In eight days our hardy traveler would have covered a distance of 578 kilometers. There existed, already in the last third of the seventeenth century, a few ways to save at least a day from this time span, but they would all have added considerably to the cost, and the low cost of this trip is one of its most notable features. The fares totalled 174 stuivers, or 8 guilders and 14 stuivers. Of course, the full cost of the trip would have been rather more than this: accommodations in inns and on overnight vessels, meals, baggage charges, tips—all of these would have increased considerably the cost of this trip. But judging from the coach fares prevailing in England, France, and the Dutch Republic itself, the cost of travel over a comparable distance anywhere else in western Europe would have cost three times this amount. Moreover, in the many areas where scheduled services did not yet exist, travel costs were higher still.

Fernand Braudel, in his classic historical work, *The Mediterranean and the Mediterranean World in the Age of Philip II*, speaks of a world, a Mediterranean world, whose dimensions could best be expressed in time rather than in distance. Travel from one end of the Mediterranean to the other took from 40 to 60 days. This time dimension, says Braudel, was unaltered from the time of the Roman Empire. We are here concerned with a rather smaller ‘world’ whose size, measured along its longest axis, was about eight days. It could also be measured in cost; let us say a minimum travel cost of about ten guilders.

Were we to call into being another fictive traveler to make his way across this world a century later, the mid-eighteenth century, we would not have to change more than a few trivial details in our account. The time and cost, the departure times and frequency of services were all practically identical to the situation a century earlier. Indeed, we could send a traveler over the same routes in the 1820’s and, again, little would have to be changed in our account. By then the fares had floated upward a bit with the general rise in price levels, and in many areas there were notably more coach services available as alternatives to the predominantly waterborne routes of our traveler. But, once again, the mid-seventeenth-century itinerary could be duplicated in almost all of its details. Our eight day, ten guilder world, stretching from Dunkirk to the border of East Friesland, was politically fragmented. But the landscape forms lent it a certain unity which was bolstered by a common language and by a network of canals and inland waterways that formed a transport system unique in Europe if not the world. This transport
system, as it affected passengers, took shape in the middle third of the
seventeenth century and kept that shape until the coming of the railways,
beginning in the 1830s. Thus, we can speak of a ‘trekschuit era’ lasting
for nearly two centuries, which endowed the Low Countries, but especi­
ally the Dutch Republic, with a unique capacity for human interaction
that profoundly affected both economic and social life.

This study will examine the Low Countries’ transportation system,
and especially the role of the trekschuit within it, from several perspectives.
The trekvaart network was, in the first place, a geographical phenomenon.
Therefore, the network’s development and performance as well as its
impact on the spatial, economic, and social organization of the Dutch
Republic will be treated from the perspective of the geographer.
Secondly, it constituted an economic innovation and functioned as an
industry. This dimension of its existence lends itself to analysis from the
perspective of business history. Finally, the abundance of quantitative
evidence generated by this industry permits it and, through it, the Dutch
economy as a whole to be analyzed.

In each of these ways the trekvaart network will be seen both as an
active agent in the creation of that ‘material texture of social life which
made the Republic special’, and as a mirror – more aptly a distorting
mirror – reflecting in its peculiar way both the structure and the evolu­
tion of the Dutch economy.

1.2. PASSENGER TRANSPORTATION IN THE EARLY SEVENTEENTH CENTURY

Before the establishment of the passenger transport system used by our
Dunkirk to East Friesland traveler, it was by no means impossible to
move about in the Low Countries. On the contrary, this region was,
relative to other parts of Europe, an easy one in which to travel. The
maze of natural water routes in this delta region, plus the busy harbors
of the numerous cities, offered the traveler an abundance of travel
possibilities. In the late sixteenth and early seventeenth centuries this
‘natural’ abundance was in the process of being regularized. After the
worst years of the Dutch Revolt the cities of this very urban region began
negotiations with their most important trading partners. They aimed to
conclude agreements whereby a regular, regulated transport service
could be established between them. The idea was to reach bilateral
agreements by which each city would appoint a specific number of
skippers who, together, would exercise a monopoly privilege to carry
goods and passengers between the contracting cities. A characteristic of
these agreements was that the appointees of the two cities took turns in
maintaining the scheduled services. Hence, they were called beurtveren,
and the skippers, beurtschippers (beurt: a turn). The origins of this legal
device to control inter-city common carrier transportation fade into a
difficult-to-date medieval past. Already in the fifteenth century Amster-
dam seems to have concluded such agreements with both Utrecht and
Dordrecht while her agreement with Hoorn dated from 1529. But only
after the 1580s do these agreements become numerous. Between then
and the mid-seventeenth century beurtveer agreements proliferated;
every important city could boast of a regulated beurtveer with most of
its important trading partners. By the second half of the seventeenth
century such agreements were also concluded with cities in neighboring
countries.

Amsterdam's first known efforts to bring order to its transport links
with nearby Haarlem date from 1520; a real beurtveer was established
only in 1598. Leiden's transport links with Delft were covered by such
an agreement in 1583; her regulated links with Utrecht date from 1596,
when two sailing vessels per day were supposed to depart in each direc-
tion. Leiden's beurtveer with Haarlem dated from 1607, when, again,
two vessels — either sailing or rowing vessels — were scheduled to depart
daily in each direction. In addition to this proliferation of beurtveren,
the early seventeenth century also witnessed the establishment of market
boat (marktschip) services between the cities and the villages of their rural
hinterlands. The judicial quality of villages together with the nature of
the traffic between cities and villages made the normal beurtveer
agreements unsuitable to the needs of rural-urban transport links.
Instead, the cities arranged for the appointment of the skipper in a given
village who was given the exclusive right to carry villagers and their
goods to the city in question on its market days.

The combination of beurtveren and market boats provided a quite
remarkable service. In 1765 Jan Wagenaar, in his history and descrip-
tion of Amsterdam, reckoned that no fewer than 800 of these vessels
departed his city each week giving it direct connections with 180 separate
places.

In the early seventeenth century the available services were less
extensive than this, but they were still impressive by the standards of
the time. The journeys of Fynes Moryson, an Englishman who traveled
extensively through Europe in the 1590s, are testimony to the comparative
ease of traveling in the young Dutch Republic. His travels in Germany,
France, and elsewhere are characterized by danger (he sometimes
traveled in disguise and often feared for bandits), discomfort, and great
expense. Once he arrived in Dutch territory from Germany he no longer
felt obliged to hide under the freight of wagons, he had no trouble
finding wagons and boats to transport him, and he traveled more
cheaply.

This last point, the cost of travel, is worth pursuing a bit further. The
theoretical availability of transport services is of little use if it is coupled
with prohibitive prices. What did it actually cost to travel in the Low
Countries in the late sixteenth century? The travel costs of two municipal officials of the city of Oudewater (in Holland) who traveled to Brussels and back in 1564 have been preserved. They traveled by a combination of sailing vessel and wagon. The various segments of their trip cost highly varying amounts, but the overall average for this 340 km round trip came to 5.8 p. per km, or 2.9 p. per km per person. Fynes Moryson’s 1593 travels in the Republic were sufficiently extensive to permit a separation of wagon and water rates. For wagon transport he paid an average of 3.9 p. per km; on sailing vessels he paid an average of 2.7 p. per km.10

Passenger transportation in early seventeenth-century Holland was, if Fynes Moryson’s judgment is any guide, cheap and plentifully available. The existence of the waterways made cheap water transport available almost everywhere, and this competition seems to have kept wagon tariffs low. Moreover, the beurtveer agreements were being concluded between more cities every year. It is noteworthy in this regard, that Moryson paid little more than the travelers to Brussels paid 30 years earlier, despite the rapid inflation of the intervening years.

Still, it is possible to identify shortcomings. The ‘natural’ system of water routes was, of course, not without its man-made improvements and modifications. The most important of these modifications were imposed by three cities – Dordrecht, Gouda, and Haarlem – which had for centuries been invested with the rights to levy tolls and so to limit the use of the waterway system as to ensure that their toll receipts would be maximized. Ships sailing from South Holland (for instance, Rotterdam) to North Holland (Amsterdam or points further north) were required by these cities to follow the Hollandse IJssel to Gouda (where a toll was paid), follow the Gouwe to Alphen aan den Rijn, thence along the Heemswetering to the Brassemermeer and the Oude Watering, and then across the Haarlemmermeer to the Spaarne, along the Spaarne (where a toll was paid at Haarlem) to the IJ, and thus to Amsterdam. There existed other routes. The Schie from Rotterdam to Delft, the Vliet from Delft to Leiden, and the Haarlemmermeer directly to Amsterdam would have provided a useful alternative to the circuitous route described above were it not that the toll-levying cities prevented its full exploitation. For example, to protect the interests of Gouda, a dam blocking the Vliet was preserved against ceaseless efforts by Delft and Leiden to build a sluice in its place.

These restrictions had the effect of exacerbating the natural circuity of the existing waterways, which gratuitously added time and cost to transportation within Holland.

Another problem was posed by the large bodies of water that divided Holland. The Haarlemmermeer and the IJ in particular were regarded as treacherous waters. Passengers and skippers alike thought twice about navigating them in inclement weather. What ordinarily functioned as natural links between the Dutch cities could, for long periods
of time each year, function as natural barriers. These problems, added to the inevitable variability of winds and weather, made travel slow and unpredictable.

The slowness of sailing vessels navigating rivers and canals (in contrast to open seas) is illustrated by one of the few extant regulations of a beurtveer service dating from the early seventeenth century. The service between Leiden and Utrecht was maintained by two daily sailboats in each direction. They followed the course of the Oude Rijn river for a distance of 57 kilometers. One boat departed with the opening of the city gates each morning and was supposed to arrive at Utrecht the same evening. The second boat departed at noon and was to be in Utrecht when the city gates opened the following morning. This indicates a scheduled time of 14 to 18 hours, or an average speed of, at best, 4 km per hour.\(^{11}\)

Finally, we can point to the variability and unpredictability of travel costs as an annoying shortcoming of early seventeenth-century transportation. The published tariffs for travel between Amsterdam and Haarlem as established in the beurtveer agreement of 1612 feature a minimum rate for either wagon or water travel of 5 stuivers per person, or 4.2 p. per km. But, if the weather were bad (as gauged by the measures taken to control windmills) the skippers were empowered to double their rates, and if fewer than five passengers showed up to take the wagon the teamster charged each passenger a supplement to the minimum tariff that had the effect of forcing the actual passengers to pay for the 'missing' passengers. A passenger traveling alone had to pay nearly five times the minimum rate.\(^{12}\) Precisely this problem sometimes plagued Fynes Moryson in the 1590s. He traveled at the cheap rate of 3 to 4 p. per km, except when he was the only passenger, or was forced to hire a wagon or boat rather than use a scheduled service. Then he faced tariffs that averaged 13 p. per km.\(^{13}\) Needless to say, one could not always predict when, or even how often, this problem would arise. In regard to both speed and cost, the early seventeenth-century transportation system was, from a modern point of view, characterized by unpredictability.

This description of early seventeenth-century passenger transportation suffers from the limited number of available sources. Sketchy though the picture presented here is, it is of importance for understanding why an extensive new passenger transportation system was constructed in the middle decades of the seventeenth century. However, the limitations of the existing service do not indicate why and when it was replaced. We must also be able to characterize the more dynamic sources of dissatisfaction that spurred the political and economic leaders of the Republic to invest, as we shall later see, millions of guilders in a new system.

Any answer to why seventeenth-century political and economic
leaders became sufficiently dissatisfied with their transportation system must be found in the context of the society in question. The judgment of adequacy depends on the characteristics one deems essential. The subjective character of this question makes the answer more difficult but also more interesting. The identification of the criteria used to justify the creation of a new system not only explains why a new system was created, it also tells something about the character of the economy and society that gave validity to those criteria.

I.3 The desire for improvement

The chief source of information at our disposal revealing the motives of the backers of trekvaart construction are the requests for octrooi. These were memorials addressed to the provincial Staten (legislative assembly) in which the cities request the right to build, and the power of eminent domain needed to clear the way for, the new canals.

The 1631 octrooi request of Haarlem and Amsterdam to connect their two cities with a trekvaart stressed the need for a means of communication that was safe, convenient, and fast. A 1629 sailing accident on the IJ in which Frederik I, the Elector Palatine and (Winter) King of Bohemia narrowly escaped death and his son, Hendrik, drowned, seems to have stimulated interest in the creation of a safer route between the two cities than the existing route over the often turbulent IJ. This interest is reflected in the accord (agreement) between the two cities preliminary to the drafting of the octrooi request. It stressed the 'desirability of preventing the many and various inconveniences and undesirable conditions that face the traveler both on water and on land'. Also mentioned was the fact that the new trekvaart 'would make the passage much shorter'.

The agreement between Leiden and Delft for the 1636 request to convert the canal connecting their cities to a trekvaart stressed the need for regularity and all-year mobility. Inherent in the use of sailing vessels, they wrote, was an intolerable uncertainty about the length of the journey (because of wind direction and velocity). Just as bad, they went on, was the influence of winter weather which could interrupt communications altogether. A trekvaart was attractive to these cities as a solution to these problems. Leiden used the same argument in its other requests for trekvaarten.

In 1640 some fifty of the chief merchants of the rapidly growing textile city of Leiden made a formal request to their municipal government urging the construction of a trekvaart to Haarlem. In their petition competitive factors received much attention: a trekvaart would attract not only local traffic but through traffic which until then followed other routes. But the time factor also struck them as crucial. By reducing the time needed to travel to and from Amsterdam they argued, Leiden
would become a more attractive commercial center. Important Amsterdam merchants would transfer agents and establish subsidiaries in Leiden.\textsuperscript{16}

The decisions to dig trekvaarten between Amsterdam and Weesp and between Amsterdam and Naarden were taken in 1637 and 1640, respectively. Amsterdam, with well over 100,000 inhabitants and growing rapidly toward the 200,000 level, felt an understandable need for improved access routes. Already before 1599 it had equipped the Amstel river, leading to agricultural and fuel-producing areas to the south of the city, with a towpath. Now it wished to secure access to the east. Military factors also played a role. Naarden and Weesp functioned not only as gateways to the eastern provinces but also as fortresses guarding against (at this time) Spanish invasion threats. For Naarden and Weesp the decisions to build were essentially competitive: the city without the new connection to Amsterdam was sure to wither in economic importance.\textsuperscript{17}

The ‘Trekvaart fever’ observable in Holland by 1640 also stirred the Friesan cities to action. Harlingen and Leeuwarden received an octrooi which pointed to the ‘praiseworthy examples of the other cities in the neighboring provinces’. The new service, by serving the inhabitants as well as the foreign travelers, would increase the general welfare and sow the seeds of commerce. Here, again, we see an expression of the promise of the trekvaart as an agent of economic development. Later Friesian requests say much the same thing, with the addition, in Bolsward’s request of 1646 for a trekvaart to Leeuwarden, that it would permit one to ‘travel with greater speed and dependability’.\textsuperscript{18}

The cities of Hoorn and Enkhuizen requested permission to link themselves together with the digging of a trekvaart in 1660. They began their petition with the observation that travelers, both local inhabitants as well as strangers, suffered great discomfort in traveling between their cities, particularly in the winter season. What was needed, they emphasized, was a trekvaart that would ‘pleasantly and comfortably accommodate passengers throughout the entire year’.\textsuperscript{19}

In reviewing all the petitions and agreements three themes can be identified. First, and least prominent, is the desire for a speedy means of travel. Second, and more prominent, is the desire for a dependable year-round means of travel. A means of travel less vulnerable than wagons and sailing vessels to the winter, and to the windless (or too windy) days was sorely missed; almost every city mentions this need. Finally, and also very conspicuous, was a general expression of belief that the trekvaart would stimulate commerce. The proposed trekvaarten were primarily dedicated, as the expression went ‘tot gerijf van de Reysende Luyden’ – to accommodate with comfort the traveling man.

Sometimes the requests seem to promise nothing more than a more comfortable and dependable means of transportation for the merchants;
in other cases an expectation of economic development in the broad sense of the word is expressed. Thus, the city of Groningen justified the toll revenues from the extensive network of trekvaarten that it dug into the Veenkoloniën pointing to the economic benefits of its canals both to the inhabitants of what would otherwise have remained isolated areas—in the winter season virtually cut off from the outside world—and to the merchants of the city, who could now profit from an extensive, accessible hinterland. Every year from 1655 until the nineteenth century the city’s scribes recorded the yearly toll receipts in the municipal account books only after writing out a lengthy preamble which expressed these justificatory sentiments. This third, economic development theme is itself a reflection of the desirable technical characteristics of the trekvaart. Supposedly, commerce would be advanced by a means of transport that was speedy and, above all, dependable.

Other themes are noteworthy precisely because of the lack of emphasis placed on them by the municipal petitions. No requests point to the reduction of travel costs as an important reason to build trekvaarten, while military considerations played a role in only one instance. In sharp contrast to the road building programs of many governments in early modern Europe, the trekvaarten (built by municipalities rather than territorial authorities) were desired almost purely for commercial rather than strategic reasons. The one partial exception to this generalization concerns Amsterdam, the only city large enough to concern itself directly with its military position.

These requests and plans to improve passenger transportation occurred in a period of intense population growth, a growth confined, moreover, in large part to the cities. This growth, in turn, occurred simultaneously with the well-known, explosive growth of the Dutch economy. Between the census of 1622 and the 1660s, when population seems to have reached a peak, Holland’s population grew by some 30 percent; her urban population accounted for nearly all of that growth, rising from under 400,000 in 1622 to over 560,000 in the 1660s. Just how this population growth affected the demand for inter-city transportation will be given careful consideration in Chapter IX; here we can accept as a first approximation that the need for inter-city communication will grow as rapidly as population, and that urbanization and the rise of a multi-sectored, sophisticated economy will increase the demand for dependable, year-round transportation. What we know of the economic and demographic background of the second third of the seventeenth century and the assessments of contemporaries about their transportation needs agree nicely with one another.
1.4. THE UNIQUENESS OF THE TREKSchUIT AS AN INNOVATION

The new demands being placed on the transportation system by a growing and developing economy were such that contemporaries came to regard the development of a trekvaart network as crucial to the satisfaction of those new requirements. In what sense did these trekvaarten constitute a transportation innovation? The component parts of this mode of transportation were, of course, not new: horses, barges, and canals had long existed. The towpaths built along the canal (and thus creating a trekvaart) were also not new. Some harbor entrances had been equipped with towpaths already in the sixteenth century and a 1554 proclamation of Emperor Charles V mentions a towpath along the Rijn in Gelderland. We have already noted that Amsterdam had built a towpath along the Amstel to Uithoorn before 1600. Moreover, if we look beyond the borders of the Dutch Republic, we can find horse-drawn barges providing scheduled passenger services in the early sixteenth century between Venice and Padua. In contrast to technological innovations that provide a new way to produce a long-existing product, the Dutch trekvaart was an organizational innovation that used long-existing component parts to produce a new product — the dependable, convenient, and cheap movement of a large volume of passengers over an extensive, interconnected network of routes.

When the municipal petitioners proposed the construction of trekvaarten, they expected these new canals to increase the speed and, particularly, the dependability of passenger travel and thereby assist the commercial development of their cities. Indeed, dependability, regularity, and something approaching year-round service were unique features of the new innovation. The ordinances under which the trekschuiten operated stipulated the exact time of their departure and the maximum duration of their trips. Bells were rung to announce the departure time, and foreign observers frequently marvelled at the fact that the barges actually observed their published schedules. ‘The hour for the Boat coming in, and going out, is so punctually observed, that upon the Ringing of a Bell it goes off, without staying for any person whatsoever’. To facilitate the maintenance of the schedules en route many barges were equipped with hourglasses (zandlopers), and to encourage the observation of these requirements the skippers faced heavy penalties for failure to depart or arrive on schedule.

All of this contrasts starkly with travel outside the area served by trekschuiten. There, the departure time of coaches was commonly established vaguely as ‘in the morning’, while the boats sailed with the tides. The evolution of important changes in the apprehension of time in western culture has been traced over many centuries. By the mid-seventeenth century ‘the image of the clock-work extends until, with Newton, it has engrossed the universe’. Still, the suppression of irregularity
and spontaneity at the level of ordinary day-to-day activities and the concommitent establishment of time as an economic concept ("time is money") is generally regarded as coming with the spread of modern industry in the nineteenth century. Consequently, the importance attached to precisely these qualities by seventeenth-century trekschuit operators and passengers is all the more remarkable.

But the attention paid to dependability and regularity is not the only characteristic that makes this innovation unique for its time. Although the municipal petitioners never mention this fact, the construction of trekvaarten required a large-scale investment from which the investors could hope to earn a return only if the mass of the population could be drawn into the scope of the traveling public. The fact that the initial trekschuit schedules invariably offered a large – often too large – transportation capacity bears witness to the likelihood that the municipal authorities were conscious of this fact. The economic climate of pre-industrial Europe is often described as one in which the business strategies of businessmen strive to maximize profits per unit of sale rather than maximize aggregate profit through the creation of a large-volume business. Moreover, in this economy very little capital took the form of fixed capital investment. In such a context, the economic logic behind trekvaart investment is conspicuous: its success required the management of a large, fixed capital stock and the creation of a mass market. No less interesting are the social implications of this innovation, which offered mobility to a large majority of the population.
CHAPTER II

THE PASSENGER TRANSPORTATION SYSTEM

II.1. THE DEVELOPMENT OF THE TREKVAART NETWORK

II.1.1. Early trekvaarten

The trekvaart as an innovation in passenger transport can be compared to the railroad which proceeded through several preliminary forms between the wooden tracks of the coal mines and the Liverpool and Manchester Railway. The first waterways on which horses and barges were used to provide a regular scheduled passenger service are to be found in the Southern Netherlands. The belief that the Flemish economy collapsed after the Dutch Revolt would not encourage us to look in this direction. This durable myth notwithstanding, scheduled passenger barges began plying the Willebroek canal – which had been built before the Revolt, in 1522–61 – in 1618. Two daily boats made their way through the four sassen (sluices) of this canal to the Ruppel River, 30 kilometers north of Brussels, where connections were made with river vessels that proceeded to Antwerp. At the same time canals were being dug between Ghent and Bruges and between Bruges and Oostende with a view to providing the Flemish cities with an access route to the sea that bypassed territories controlled by the Dutch. These canals were thus not built primarily to carry passengers, but in 1623 (apparently) daily passenger barges began connecting Ghent with Bruges and Bruges with Oostende.

In the young Republic the first trekschuiten glided along the waters of the canal from Groningen to Zuidbroek, dug in 1618–22 as part of the large-scale peat digging industry then underway in what would later come to be known as the Veenkoloniën. The unexpected innovativeness of this remote region can be explained by the almost total impossibility of penetrating the high moors of east Groningen by any other means.

In the Holland-Utrecht urban heart of the Republic trekvaart development began in 1626–28 with the construction of towpaths along the Vecht and the cutting of new canals to shorten the distance from Utrecht to Amsterdam.

II.1.2. 1632–1647, the first boom

In all of these early trekvaarten the movement of passengers was not the primary motivation for the investment of capital, and the services provided were quite modest. In 1631–32 we have the first canal dug almost exclusively to render passenger transport services, and to do so on a truly large scale. The Amsterdam-Haarlem trekvaart replaced the sailing vessel route over the IJ and the Spaarne with an almost perfectly
straight canal. The canal’s towpath provided a direct road connection to replace the land route that had followed the dike along the meandering shore of the IJ. By breaking the trekvaart midway, where the waters of the Haarlemmermeer emptied through sluices into the IJ, and by stopping its Amsterdam end short of the point where it could communicate with that city’s canal network, the trekvaart’s usefulness was limited to the movement of passengers and parcels. These self-limiting measures were insisted upon by Haarlem to ensure that heavy freight would continue to follow the old route via the Spaarne and the IJ, upon which Haarlem collected tolls. The governments of the two cities felt that the construction cost of 266,000 guilders was justified by the superior service that could be provided to passengers. Trekschuiten departed hourly from the time the city gates opened in the morning until 8 p.m. Here, then, we have the first high volume passenger service using a dedicated right of way – and the true beginning of the trekschuit era.4

The innovation proved to be an immediate success. Before the construction of the trekvaart was completed, barges pulled by men rather than by horses were put into service. The slowness of this preliminary service apparently made it unattractive. In the six months before June, 1632, only 9058 passengers made use of it. Then the barges began to be pulled by horses, and a demand quickly materialized to match the enormous capacity of the new service. (See figure 2.1.) The all-weather service of the trekvaarten also proved to be an attractive feature. In the winter months, when ice sometimes forced the suspension of trekschuit service, (December 1633, for instance), travelers crowded onto the towpath. The tollgates registered the passage of more pedestrians and wagons in December, January, and February than in any other months (35% of total annual receipts were collected in these three winter months in 1633–41).5

The intense demand for the services of the Amsterdam-Haarlem trekvaart was matched by a handsome return for the municipal government which had invested the capital. (In the initial years of operation the return averaged 6 to 7%, while prevailing interest rates were no more than 4%). The demonstration of these two facts – high demand and financial viability – apparently spurred other cities to action.

In 1636 the cities of Leiden and Delft agreed to reconstruct as a trekvaart the Vliet, an old canal connecting their cities. In 1638 the Republic’s seat of government, The Hague, (a city in most respects but not legally recognized as such) requested to be connected to this route via a spur canal.6 This three-city enterprise was also an immediate success, and the next several years saw a trekvaart fever spread throughout the Republic. Perhaps this enthusiasm even spread to Flanders, for a lengthy canal was begun in 1638 connecting Bruges with Nieuwpoort, Veurne, and, in 1640, Dunkirk (then, of course, still part of the Southern, or Spanish, Netherlands). In the north, Amsterdam entered into negotia-
The maneuvering between the competing eastern gateways to Amsterdam – Naarden and Weesp – that characterized those negotiations now spread to the rest of the Republic. In 1639 Gouda and Amsterdam corresponded over the desirability of connecting their cities with a trekvaart. This may partially account for the eagerness with which Leiden’s merchants sought to convince their city government of the need to dig a trekvaart to Haarlem in 1640. In 1644, Rotterdam tried to interest Gouda in a trekvaart between their cities.7 None of these discussions proceeded beyond the feasibility planning stage in the 1640s.

But several other projected routes were actually built. Delft was connected with the important fishing port of Maassluis in the years 1643–46 and Utrecht reconstructed the Vaart, a canal linking the city with the river Lek in 1649.

FIGURE 2.1. Passengers carried on the Amsterdam-Haarlem trekvaart, per month, 1632-1634.

Source: G.A. Haarlem, Trekvaarten en veerdiensten, no. 13, 21, Rekeningen.
The major activity in these years took place not in urban Holland, but in the northern provinces of Friesland and Groningen. The 1640 decision of Harlingen and Leeuwarden to introduce the new transport mode to Friesland posed a threat to other cities that hoped to function as funnels for through traffic between Holland and the major cities of Leeuwarden and Groningen. Thus, in 1646, when the Harlingen-Franeker-Leeuwarden route was put into service, Bolsward and Workum were active opening a second route from the sea to Leeuwarden. Meanwhile, in Groningen, the capital city was at work transforming its river connection to the sea via Delfzijl into a trekvaart, and in the middle of the northern region the city of Dokkum already had its eye on the possibility of drawing through traffic between Friesland and Groningen to itself.

In 1646 this little city lost an important source of employment and revenue when the Admiralty of Friesland was transferred to Harlingen. The increasing unnavigability of Dokkum’s route to the sea made this step unavoidable, and the municipal government now sought to replace its lost seaborne prosperity with a new economic life based on inland transportation and distribution. To assist in this restructuring Dokkum called on the Friesian Stadholder, Willem Frederick, and the other Friesian cities for financial support in the construction of a new trekvaart to Groningen. Dokkum requested this aid as compensation for her loss of the Admiralty, but the negotiations showed the intended benefactors to be less than enthusiastic; Dokkum’s ambitions remained frustrated for lack of financial means.⁸

II.1.3. 1648–1655, hiatus

With the exception of the Groningen-Delfzijl project, which was not completed until 1650, trekvaart construction all but ceased after 1647. The ambitious proposals of 1639–46 had been shelved. In the Republic 15 cities had invested about 1.5 million guilders to build 243 kilometers of trekvaart. In Flanders canals with a total length of 117 kilometers were dug, all before 1640. But one cannot speak of a trekvaart network.

These canals were geographically isolated from each other (see map 2.1). Groningen, Leeuwarden, Amsterdam, and Delft, each functioned as the focal point for one of the four little systems (five, if the routes focused on Bruges are included). From the late 1640s to 1656 almost no trekvaart construction took place. The only exception is the elevation of the Schie between Rotterdam and Delft to trekvaart status in 1655, and this did not affect the existence of the separate systems. In these years the trekvaarten must have functioned primarily as vehicles of short-distance inter-city travel. It is difficult to resist drawing the conclusion that these discrete little systems indicate the division of the Low Countries into economic zones, each dominated by a major city. But this issue will be considered more systematically in chapter XII.
The meaning of the geographical isolation of the trekvaart routes in the 1650s cannot confidently be identified so long as the cause of the cessation of further construction remains unclear. Were the unrealized proposals dropped because of a belief that travel demand did not warrant them – that the existing beurtveren could handle interzone travel – or because of a downturn in the 'business cycle' which made it difficult to raise the needed capital for further construction?

The latter is an attractive argument, but difficult to substantiate. The First Anglo-Dutch War, fought in the years 1652–54, was the occasion for a sharp decline in Dutch foreign trade. But this well-known interruption to Dutch prosperity, during which no trekvaart construction took place, does not help explain the slackening of trekvaart activity in the late 1640s.

Nor do the few economic indicators at our disposal support the business downturn hypothesis. On the contrary, the years 1648 and 1649 are
conspicuous for their prosperity and economic expansiveness. Perhaps the explanation for the absence of trekvaart construction should be sought in the opposite direction: an investment boom that so overtaxed the labor market that labor-intensive trekvaart construction projects had to be postponed.

II. 1.4. 1656–1665, the second boom

Interest in trekvaarten revived in 1656–57. The conclusion of the first Anglo-Dutch War saw an economic revival that is reflected in the renewed growth of foreign trade volume (as reflected in the Convooien en Licentien receipts), Leiden textile production, and urban construction (as reflected in the production records of the Rijnland brick producers’ cartel). In this economic environment municipal authorities once again initiated discussions with likely partners to dig new trekvaarten. Conspicuous among entrepreneurial municipal governments were Dokkum in Friesland and Gouda in Holland. Both sought to build trekvaarten which would link up the hitherto isolated networks and thus channel through traffic via their cities.

Dokkum participated in large projects with Leeuwarden to the west and Groningen to the east. This small city finally was able to proceed with her long-held plans after receiving subsidies from several other Friesian cities and after herself assuming a dangerously large debt. The justification for this step was the need to secure for the city a new economic function as the intermediary between the two largest cities of the north. In 1656 the trekvaart to Groningen was completed.

The following year Gouda revived the negotiations with Amsterdam begun in 1639 and, as soon as agreement was reached, went on to open negotiations with both Rotterdam and Dordrecht. At the same time as these multiple efforts to channel north-south traffic via Gouda got underway, Leiden sought to attract such traffic to itself by entering into negotiation with Haarlem over the construction of a north-south route. These competing plans led to a legal tug of war in which the interested cities sought to influence the Staten van Holland to deny octrooi to their opponents. For this purpose the ancient toll-collecting rights of Gouda and Haarlem, which had already obstructed transport improvement for centuries, once again came into the picture. Haarlem opposed Gouda’s proposed canal to Amsterdam as an infringement of its toll rights on the Spaarne. Gouda opposed Haarlem’s canal to Leiden as a threat (in conjunction with the Leiden-Delft trekvaart where in 1648 the dam at Leidschendam had finally been replaced with a sluice) to its toll rights. Leiden entered the fray with objections of its own to the proposed trekvaart from Gouda to Dordrecht. The political weakness of a Republic in which the numerous cities possessed extensive powers all but unchecked by a central authority was well displayed in this wrangle. Given this political system it is remarkable, in retrospect, that any agreement could
be reached. An agreement was hammered out, but it came, just as earlier agreements, at the cost of some economic efficiency. Both north-south routes received octrooi and were opened for business in 1658, but there were conditions attached. The access to both canals was limited by fixed bridges of cramped dimensions. This ensured that only the low, narrow trekschuiten would be able to make use of the new routes. Thus, in 1658 one could travel from Amsterdam via the new Haarlem-Leiden trekvaart to Delft, The Hague, and Rotterdam, and also via the new trekvaart from Amsterdam to Gouda.

On the routes stretching south from Gouda the obstacle-ridden political system prevented the parties from reaching agreement. Leiden's opposition had been effective in stopping a trekvaart connecting Gouda with Dordrecht (which so angered Gouda's magistrates that they vowed to oppose any and all octrooi requests so long as their request remained denied), and Gouda's negotiations with Rotterdam broke down over Gouda's own jealous protection of its toll privilege. A trekvaart between Gouda and Rotterdam would have connected with existing waterways which would have made it physically possible for vessels to sail north from Rotterdam without passing the toll barriers at Gouda. To prevent this from happening, Gouda insisted that the route be broken in two, requiring passengers to change barges. This was the solution applied to a similar problem on the Haarlem-Amsterdam route, where Haarlem's toll revenues had been threatened. But what Amsterdam had been willing to accept in 1631, Rotterdam found unacceptable 30 years later. In the absence of waterways, Gouda did come to agreements with both Rotterdam and Dordrecht to maintain coach services. But these wagons, which lumbered over dike-top roads that were often impassable, did not offer a very competitive service for long-distance traffic.

As the dust settled over the struggle to control north-south passenger traffic, a series of new trekvaart proposals appeared in every section of the Republic. The years from 1659 to 1664 stand out as the most intense period of trekvaart construction. It also proved to be the culmination of trekvaart construction; only two minor canals were dug after 1664.

Encouraged by a loan from Utrecht, Gorinchem and Vianen established a trekvaart route which in conjunction with Utrecht's route to Vianen would, it was hoped, attract through traffic from Brabant and the Southern Netherlands to Amsterdam. At the same time in the far north, Groningen began pushing a three-pronged trekvaart route into the rich agricultural districts north of the city. In Friesland, Leeuwarden and Sneek built a trekvaart in 1661. In conjunction with Sneek's water route to the Zuider Zee at Lemmer, this trekvaart provided Leeuwarden with a third route to Holland.

In Holland, the one area where the trekvaart was conspicuous by its absence in 1660 was the Noorderkwartier, the peninsula to the north of the IJ. This situation was remedied in 1660 when the five cities of
Amsterdam, Monnikendam, Edam, Purmerend, and Hoorn agreed to share equally in the construction of a double route from Amsterdam (actually, Buiksloot on the north shore of the IJ, across from the city) to Hoorn. One route proceeded via Monnikendam and Edam while the other passed through Purmerend. Also in 1660 Hoorn sought to secure its connections to the other important cities of the peninsula, Alkmaar and Enkhuizen. Agreement with Alkmaar came quickly and construction began that same year. An octrooi request for a trekvaart to Enkhuizen was submitted in 1662, but hydraulic problems arose which caused this plan to be postponed. Even without this link, the cities of the Noorderkwartier (plus Amsterdam) invested nearly one million guilders in the routes constructed between 1660 and 1664.13

The cities south of the IJ were now supplied with north-south connections, but movement along the east-west axis continued to flow via sailing vessels on rivers, with their characteristic slowness and undependability. To remedy this, Leiden and Utrecht agreed in 1661 to cut a canal straight across Holland. This major project, for which a cost of 460,000 guilders had been estimated, did not receive an octrooi; the battles of 1656–58 were not yet forgotten. Gouda, Haarlem, Dordrecht, and Rotterdam all submitted objections to the request. As this proposal languished, the Heer van Alphen interested Leiden and Utrecht in a more modest venture: without octrooi the Oude Rijn River could be improved to serve as a trekvaart. This route was more roundabout than the proposed straight-line route and, hence, more time-consuming; but to compensate for this the Heer van Alphen, Hendrick Stevin (son of the mathematician, Simon Stevin), argued it would be a less boring route and would be cheaper (it ended up costing 294,000 guilders). It need hardly be added that it would also pass through Alphen. The village in which the promoter had such a strong interest stood to become a focal point of transport routes in central Holland. The argument proved persuasive: the new route was completed in 1664.14

The interest in trekvaarten extended beyond the regions discussed thus far, but the nature of the terrain and the more limited travel demand usually combined to make construction unfeasible. There existed two exceptions to this rule. In 1663 the city of Kampen, in Overijssel, improved the canals of the Mastenbroek polder to permit trekschuit services to the provincial capital of Zwolle as well as to Hasselt. The latter proved to be an important link in the overland route from Holland and Utrecht to the north which, as it passed the territory around Kampen, suffered from the often impassable conditions in this marshy landscape. Another isolated trekvaart had been built earlier in Gelderland, connecting the cities of Arnhem and Nijmegen.15

The second trekvaart boom ended in 1665. The outbreak of the Second Anglo-Dutch War in that year is probably sufficient to account for the cessation of trekvaart construction since the war brought with it a severe,
temporary economic contraction. But when the war ended and the economy revived, trekvaart construction did not revive. Virtually all potentially profitable trekvaart routes had been built: the chief gaps remaining in the network were routes where construction was obstructed by disputes among the cities or by technical problems. These gaps were filled after 1667 by the construction of roads. Hoorn and Enkhuizen bypassed their hydraulic problems by building a paved road in 1668. On this 21 kilometer paved road, the first of any length in Holland, a scheduled coach service was inaugurated in the same year. A year earlier Gouda and Dordrecht established a coach service between their cities, but the coaches had to lumber along unpaved dike-top roads. Proposals to pave the route never took concrete form. A scheduled coach service between Gouda and Rotterdam had existed since the 1650s; but, only in 1680, after Gouda and Rotterdam had finally built a paved road connecting their cities, did this service prove sufficiently attractive to make the north-south route via Gouda competitive with the route via Leiden.

By the late 1660s the trekvaart network achieved its ultimate form. The two routes constructed later, a line in Groningen extending east from Winschoten to the German border at Lange Akker Schans (Nieuwe Schans) built in 1695–97, and a line in Holland extending north from Alkmaar to the vicinity of Schagen, finished in 1703, were local feeder lines. They lent the network no significant new characteristics.

What had been achieved by the second trekvaart boom of 1656–65? Twenty-two cities of the Republic invested over three million guilders in the construction of 415 kilometers of trekvaart. This investment transformed the four discrete city-centered networks of the first boom into two networks, one blanketing Holland and Utrecht, another spanning the northern provinces of Friesland and Groningen. Although these two networks were geographically separated by the Zuider Zee, and can for various reasons be discussed best separately, one could legitimately speak of one network. As we shall see, the Zuider Zee acted more as a unifier, as a giant traffic interchange, than as an obstacle. The trekvaart systems' numerous contact points with this traffic interchange (two in Holland, three in Friesland) lent a certain unity to the two geographically distinct networks.

II.2. THE NETWORK DESCRIBED

How can we describe this trekvaart network? The questions we would like to have answered are:
1. Were all important cities served?
2. Were all important cities connected with all other important cities?
3. Were those connections made efficiently?

Once the network was completed, there were very few population centers of any importance which it did not touch. Dordrecht and the densely populated Zaan region were the most conspicuous absentees. In both cases, geographical conditions can probably explain the failure to build trekvaarten, and, again, in both cases, alternative transport modes offered reasonably good substitutes. Sailing vessels served the Zaan region with great frequency, but it is striking that this high-volume service connected the Zaan region with only one other point—Amsterdam. Apart from the daily sailing vessels from Amsterdam to Alkmaar that passed through the Zaan region, no other regular services existed. Thus, travelers from this region of over 20,000 inhabitants wishing to go to the other north Holland cities or to Haarlem and the other south Holland cities either had to go the long way via Amsterdam, or negotiate private transportation.
In a formal sense the industrial city of Schiedam was also excluded from the network, but in practice this was not the case. The Rotterdam-Delft trekvaart passed very near to Schiedam, and regularly boarded and debarked Schiedam passengers at the village of Overschie. Similarly, Brielle was connected to the trekvaart network by ferries crossing the Maas to Maassluis.

Of the many minor cities scattered across Holland, only three - Medemblik, Oudewater, and Schoonhoven - found themselves bypassed. In the case of each of these places, their small size is apparently sufficient to explain their omission from the network. The fact that documents sometimes mention a form of barge or wagon service to these places, and then at other times fail to do so, suggests that attempts to connect them to the network were actually made, but proved unsuccessful. None of these dwarf cities generated enough traffic to warrant a substantial investment of capital and the maintenance of a regularly scheduled service of any frequency.

In order to assess the 'completeness' of the network, we can begin with a formal, geographer's analysis. To do so we must first convert the map of the trekvaart network into a graph, and then present the graph in the form of a matrix. A graph consists of a finite number of nodes, or places, connected together by a number of routes, each joining two places. The places are, of course, towns or junctions of varying importance and physical size, and the routes are trekvaarten or paved roads whose geographical lengths can vary greatly one from another. But neither of these characteristics is relevant to the graph of a network. All places, regardless of their population, and all routes, regardless of their length, are treated equally. It should be noted here that a certain arbitrariness is inherent in the identification of the places and routes to be included in the graph. Moreover, the results of a graph analysis can be sensitively affected by small changes in these identifications.

Figure 2.2 presents the Holland-Utrecht and Friesland-Groningen trekvaart networks as graphs. The former consists of 18 places connected by 24 routes. Such a graphic representation of a network lays the basis for its formal description as a matrix. The matrices in table 2.1 present all of the information contained in the adjacent graphs. The places in the graph identify the rows and columns (origins and destinations) in the matrix, while the cells identify every possible 'trip' - i.e. every combination of origin and destination existing in the network. If a route exists directly connecting the origin and destination that identify a cell it is filled with a 1. If no such route exists it is filled with a 0. For example, cell $P_7P_{12}$ is filled by a 1 because a direct route connects Amsterdam to Haarlem, but $P_7P_{15}$ is filled with a 0 because Amsterdam is not directly linked to The Hague. In this way the matrix identifies all the places and routes that exist in a network.

With such a matrix two important characteristics of a network can
be measured: the network's connectivity and the centrality of the places within the network.

The matrix of a network of $m$ places contains $m \times m$, or $m^2$ cells. What is the maximum number of routes that could connect $m$ places? We can imagine a matrix in which every cell is filled with a 1 (except for the diagonal cells, where no route can exist since the origin and destination are the same place). Thus the maximum number of routes is $m^2 - m$ (the matrix - the diagonal cells). If, as is usually the case, the network is symmetrical (i.e., if route $i$ to $j$ can also be used to travel in the opposite direction, from $j$ to $i$), then all the cells below the diagonal become redundant for our purpose and we are left with $\frac{1}{2}(m^2 - m)$ as the maximum number of routes (the cells enclosed by the triangle in table 2.1).

The degree of connectivity of a network can now be expressed by
comparing the number of routes it actually had with the maximum number of routes possible. In this way a connectivity index can be devised ranging from 0 (absolute nonconnectivity) to 1.0 (maximum connectivity).

| Table 2.1. Matrices of the Holland—Utrecht and Friesland—Groningen networks. |
| City and identifying number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Alkmaar | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hoorn | 2 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Enkhuizen | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Purmerend | 4 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Edam | 5 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Monnikendam | 6 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amsterdam | 7 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Naarden | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Weesp | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Utrecht | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gorinchem | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Haarlem | 12 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Leiden | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| The Hague | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| Delft | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| Maasvlakte | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rotterdam | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Gouda | 18 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |

| City and identifying number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Harlingen | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Franeker | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Leeuwarden | 3 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| Workum | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bolsward | 5 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sneek | 6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dokkum | 7 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Groningen | 8 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| Delfzijl | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Zuidbroek | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| Winschoten | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Northern villages | 12 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |

68
In the extreme event of absolute nonconnectivity (where a network connects none of the places under consideration) \(0/\frac{1}{2}(m^2 - m) = 0\).

The minimum number of routes needed to connect all \(m\) places of a network can easily be shown to be \(m-1\). Thus, minimum connectivity is expressed by \(m-1/\frac{1}{2}(m^2 - m) = 2/m\).

The actual connectivity of a network is the observed number of routes/\(\frac{1}{2}(m^2 - m)\).

Finally, maximum connectivity is \(\frac{1}{2}(m^2 - m)/\frac{1}{2}(m^2 - m) = 1.0\).

In the case of the Holland-Utrecht network, a minimum connectivity network touching all 18 places could have been devised using only 17 routes. At the other extreme, a complete connectivity network could have been created with 153 routes. The minimum connectivity index is thus \(17/153\) or 0.111. The actual number of routes exceeds the minimum by 7, giving the existing network a connectivity index of 0.157. The Friesland-Groningen network consists of 12 places connected by 11 routes. In other words, the observed number of routes equals the theoretical minimum. Of course, the shape of a theoretical minimum network could have differed from the network actually built. The existing network can be described as a minimum solution to the task of connecting all 12 places with the added constraint that the two provincial capitals be given the most direct access to the other places in the network.

At first glance, it appears that both networks could be described as more or less minimally connected. But the Holland-Utrecht network differs markedly from a minimum solution. Although its connectivity index is much closer to the minimum than the maximum level, the difference is sufficient to give the bulk of the places connected very direct access to the rest of the system. This is particularly true for the major cities south of the IJ. The network extending south from Amsterdam, consisting of 10 places and 15 routes, has a connectivity index of 0.33.

The small number of 'extra' routes (the 7 routes in excess of the minimum required to connect all the places in the network) endowed the network's places with a much greater accessibility to the other places than was possible with a minimum network. The extent to which this is so, that is, the efficiency with which the network was designed, can be grasped by analyzing the possible route combinations of the network. We know that matrix \(A\) (table 2.1) identifies with a 1 every destination accessible from a given place of origin by traveling over one route. If we wish to know the destinations accessible by traveling over a two-route path we need only multiply matrix \(A\) times itself. The cells of the resulting matrix \(A^2\) would then identify those destinations accessible in a two-route trip. Cells with numbers higher than 1 indicate destinations accessible by more than one path. One can continue to raise the matrix to successively higher powers: \(A^3\) identifies destinations accessible by three-route paths, \(A^4\) identifies destinations accessible by four-route paths, etc. When these matrices are added together \((A + A^2 + A^3 + A^4 = B)\) we can read from the new
Table 2.2. Summation matrices of the Holland-Utrecht and Friesland-Groningen networks.

Matrix $B = A + A^2 + A^3 + A^4$, Holland-Utrecht

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(A) Summation of columns.
(B) Number of places remaining inaccessible after a four-move trip.
matrix \( B \) which destinations are accessible – and by how many different paths this is possible – by all paths whose route length does not exceed the highest power of the matrices included in the summation. Finally, when all the numbers in a given row of the new matrix \( B \) are summed, the resulting column vector reveals the ‘accessibility scores’ of each place in the network. The higher the score, the more accessible the place.\(^20\)

The summation matrices for the two networks under discussion, showing all possible paths up to four routes in length, are presented in table 2.2. At this stage certain destinations continue to be inaccessible for some places, but the basic pattern of centrality is clearly shown.

In the Holland-Utrecht network Amsterdam, not surprisingly, enjoys the greatest centrality. It can reach every place in the network within four moves, and the network grants it a larger number of paths to the other places than any other place. But Amsterdam does not stand head and shoulders above all other places in the network in this regard. Leiden is a very close second, and the scores of Gouda and Utrecht are not far behind. Moreover, all of these cities, plus five others, have access to the network in four moves. The three cities of southwesternmost Holland – Rotterdam, Delft and The Hague – are conspicuous by their low accessibility scores. These low scores are partly the results of arbitrary characteristics of the graph, but not entirely. The fact that this region was accessible via only two gateways – Leiden and Gouda – imposed a circuity to their paths leading to many destinations. In the case of Rotterdam this is not really serious. If the places to the south of it for which it served as a gateway were included in the network, Rotterdam’s score would be much higher. But Delft and particularly The Hague were truly disadvantaged by this situation. (Delft has had to wait until 1976 before the Dutch railway system could offer it reasonably direct access in an easterly direction.\(^21\) The fact that The Hague grew to be a large and important city despite its relative inaccessibility offers powerful testimony to the ability of politics to overrule the dictates of geography.

The Friesland-Groningen network, taken in isolation, is easy to describe. The observation made above that the network’s design offers minimum connectivity with the constraint that the provincial capitals be endowed with the most direct access to the rest of the network is confirmed by the accessibility scores: Leeuwarden, Groningen, and the intermediate Dokkum not only have by far the highest scores, but they are also the only places from which all other places in the network are accessible within four moves.

II.3. THE DYNAMIC OF TREKVAART CONSTRUCTION

Even without going to the pains of a formal matrix analysis, a glance at map 2.2 would permit us to conclude that the 658 kilometers of trek-
vaart, costing over 4½ million guilders endowed the Republic’s diluvial territories with a well-integrated passenger transport network. This achievement is remarkable not only because of its precocity. At least as remarkable is the fact that it was built without any overall plan and without any leadership from central authorities. The provincial Staten which granted octrooi did so exclusively in response to municipal requests. Initiative rested with the cities, altogether with 30 cities. Not only do we need to explain why 30 independent cities agreed to invest in and assume responsibility for portions of a network, we also need to explain why they were successful in coming to terms with the obstacles thrown up by the medieval heritage of toll privileges and the energetic defense of those privileges by Gouda, Haarlem, and Dordrecht.

To begin with, of course, there must have existed a strong motivation to supplant the existing modes of transport. The nature of that motivation has already been discussed in chapter I. Here it must be added that the independent participation of 30 cities in trekvaart construction indicates that nearly every city saw the advantages in approximately the same light.

Given the consistency in municipal assessments of what trekvaarten could mean for the urban economy, trekvaart construction seems to have been pushed in the course outlined above by three main factors. In the first place, the pioneer routes returned handsome profits to the investing cities. The early profitability of the Amsterdam-Haarlem route has already been noted. In the 1650s its rate of return on invested capital rose even higher than the 6–7% level of the 1630–40s. The Leiden-Delft/The Hague trekvaart appears to have been even more profitable. The financial accounts of a portion of that route, the 11 kilometers from Leiden to Leidschendam, show a rate of return on invested capital in excess of 15% from 1648 to 1660. Later in this study we shall have to consider how sensitive seventeenth-century town administrators really were to basic capitalist concepts. Nevertheless, the flourishing financial condition of the first major routes must have encouraged further interest in trekvaart construction.

A second factor affecting the course of trekvaart construction, particularly during the second boom, was competition. While the city-centered networks built by 1650 simply facilitated short-distance traffic from secondary centers to the dominant cities of the Republic, the promoters of the chief routes built in the second boom had their eyes on capturing long-distance traffic. In contrast to short-distance travelers, whose choice of route was strongly circumscribed by geography, through travelers could generally be attracted from one route to another by superior service. This traffic was thought sufficiently important to spur a large number of cities into action. The fear of being by-passed in favor of the superior services offered on another route must play some role in explaining why Leeuwarden was connected to Zuider Zee ports by three
routes, northern Holland was connected to southern Holland by two, and why three cities, Gorinchem, Dordrecht (in conjunction with Gouda), and Rotterdam sought to serve as gateways to the south.

In close association with this competitive factor—in fact, it was one of the forces making competition so intense—was the influence of municipal transport politics. In the absence of a strong central authority, transport policy was in municipal hands, and several cities, each for its own reasons, pursued very active policies of trekvaart—and other route—development. In the province of Groningen the city of Groningen unilaterally pushed trekvaarten into every corner of the province. Since this capital city completely dominated its province—there were no other cities of any importance—this policy cannot be explained in the context of competition; it seems more acceptable to view it as an expression of the more general policy of economic development that the city pursued on a long-term basis. Dokkum, in northeastern Friesland was also a conspicuous initiative-taker. In proportion to its economic capacity it made an enormous commitment (in the light of its later financial difficulties, an overcommitment) to trekvaart construction in the hope of breaking down its relative isolation. The high accessibility score achieved by Dokkum in table 2.2 shows that the policy succeeded in formal terms. Unfortunately, the economic benefits of this centrality never materialized.

In Holland conspicuous transport policies were pursued by Gouda, Leiden, and Delft. Gouda combined a tenacious protection of its ancient toll rights with a recognition of a new opportunity to increase its ‘centrality’ in the urban space of Holland between the IJ and the Maas. The transport roles of Leiden and Delft, on the other hand, had long been suppressed by Gouda’s privileges. The coming of the trekvaart was seen by these cities as a means of eroding and eventually sweeping away the restrictions imposed by Gouda on the north-south route via Leidschendam. Although the full potential of this route was not made available until late in the nineteenth century, this should not imply that the transport politics of Gouda and Leiden-Delft resulted in a zero-sum game. Through compromise both sides were able to share in the traffic created by the new means of passenger transportation.

These examples do not exhaust the list of cities with active transport politics, (Hoorn and Alkmaar could be included) but they suffice to show that the Republic, although it lacked the leadership of a central authority in matters of transport policy, was not without leadership altogether. Moreover, this leadership did not emanate only from the largest city, Amsterdam; on the contrary, there were a number of sources of initiative. These multiple sources of initiative, in the context of a competitive political structure, help explain why such a high-connectivity transport system could be created.
II.4. A DESCRIPTION OF THE NEW TECHNOLOGY

Before proceeding to a more general discussion of the development of the Dutch Republic's passenger transportation system, it would be well to pause for a moment to consider just what, in a physical sense, the exertions described above actually created. What were the trekvaarten and trekschuiten like? How did they function?

II.4.1. Trekvaarten

Since several of the trekvaarten have survived to this day without experiencing radical reconstruction, their physical appearance is no mystery. The train traveler between Haarlem and Leiden, the bicyclist between Leiden and Leidschendam and Muiden and Naarden, the tram rider between Delft and The Hague can each see at first hand the waterways on which many millions of seventeenth- and eighteenth-century passengers traveled. Even if these canals had all disappeared from the face of the earth, we would still be well informed about the trekvaarten. The officials who built and maintained them and the travelers who used them have both left abundant evidence.

The newly dug canals were generally drawn as straight as possible across the landscape to connect two cities in the shortest distance. Because of their straightness and their indifference to intermediate villages, these trekvaarten stand out on seventeenth- and eighteenth-century maps in the same way that limited access highways stand out on today's maps. Since the movement of heavy freight via the new trekvaarten was generally expressly forbidden, most of them took a form which limited their usefulness to trekschuiten and similar light vessels. The profile of the Haarlem-Leiden trekvaart can be taken as representative of these new waterways. Figure 2.3 is based on a placard distributed through Holland in the fall of 1656 to attract contractors to bid for the right to dig sections of the canal. For construction purposes, the route was divided into 100 roede (378 meter) sections. There were apparently many contractors and workers available, since sufficient bids were accepted to permit construction to proceed simultaneously on many of these 100 roede sections. This same procedure was followed on most of the trekvaart construction projects.

The profile of the Haarlem-Leiden trekvaart is measured in Amsterdam voeten, about the length of English feet. The breadth of the canal at water level was thus 18.3 meters, while its depth was 2.4 meters. Since the water level could be expected to rise right up to normal ground level in this low-lying region, the contractor had to use a portion of the excavated earth to build an embankment on one side of the rather shallow canal. On the other side a much larger embankment was to be built to accommodate a 6.4 meters wide towpath. Beyond the towpath embankment the contractor was to dig a drainage ditch. The total breadth of
Figure 2.3. Profile of the Haarlem–Leiden trekvaart (in Amsterdam feet of 28.3 cm.).

Source: G.A. Leiden, Trekvaarten en jaagpaden, no. 108, Leiden–Haarlem register, 'Besteedinge van 't graeven ende meekken van een Treck-wegh ende Treck-vaert...'
this right of way was 124 voeten, or 37.8 meters. To build the Haarlem-Leiden route a total of at least 110 hectares of land needed to be purchased. This area, stretching over a distance of 29 kilometers, had to be assembled through purchase from many landowners, making land acquisition one of the major expenses of trekvaart construction. The dimensions of the Haarlem-Leiden trekvaart were typical. A nineteenth-century navigation guide to Dutch canals shows most trekvaarten to vary from 15 to 18 meters in breadth. There was no systematic difference between canal dimensions in Holland-Utrecht and in Friesland-Groningen.

Where existing waterways were used, the land acquisition problem was diminished, but not eliminated. The construction of the towpath required land, of course, and judging from the records of the Utrecht-Leiden trekvaart, the acquisition of easements along an already busy waterway was costly and time-consuming. The towpaths along such trekvaarten generally required many more bridges than did the towpaths of newly dug canals. While the Haarlem-Leiden trekvaart required but 14 bridges (four over the canals, 10 to bring the towpath across important side canals), the Leiden-Utrecht towpath alone required over 100 fixed bridges.32

One other important characteristic of the trekvaarten was their physical isolation from the previously existing canal network. This was actually only true of the newly dug canals. A fixed bridge with dimensions that would admit nothing larger than a trekschuit prevented large vessels on the Leiden-Utrecht trekvaart (the Oude Rijn River) from entering the Gouda-Amsterdam trekvaart where they intersected near Alphen. Similar apertures limited the access to the Leiden-Haarlem trekvaart. The Amsterdam-Haarlem and Amsterdam-Hoorn trekvaarten, on the other hand, were physically blocked in the middle of their route, forcing passengers to transfer to waiting barges on the opposite side of the obstacle. This same maneuver was originally required of passengers on the Leiden-The Hague/Delft trekvaart, but here the cities managed in 1648 to have the dam at Leidschendam, where the transfer took place, replaced by a sluice. In 1682 Leiden and Delft even managed to enlarge the sluice. Not until 1877 was the capacity of this lock increased to the size warranted by the canal’s dimensions (a victory over municipal particularism that is commemorated at the ornate Leidschendam tollhouse), but the intermediate steps achieved in the trekvaart era were not insignificant.33 The trekvaarten following existing rivers and canals contrasted with those built from scratch in this regard; the former usually bettered navigation over the route for all types of vessels.

II.4.2. Trekschuiten

The physical remains of the 658 kilometer trekvaart network are still with us. Indeed, reconstructed portions of it continue to serve as important inland waterways. The towpaths are still with us too, many
offering bicyclists and motorcar tourists picturesque waterside routes for weekend excursions. What have vanished, however, are the vessels which for two centuries carried millions of passengers in (what most contemporary writers agreed was) home-like comfort. The trekschuiten were long, narrow vessels with a covered area in which the passengers were seated on benches that extended along the sides. The barge possessed a short, moveable mast to which a line was attached. The line led to a horse on the towpath which pulled the barge along. This general description applies as well to 1632 as to 1839: no technical changes of any significance occurred during the intervening two centuries. There were, however, minor differences among the barges plying the different routes. In addition, various superficial changes were applied to both the exterior and the interior of the barges in the course of time.

The overall dimensions of the barges can be read from the specifications of contracts with their builders. Table 2.3 provides a summary of the dimensions of barges used on various routes.

The smallest barges described in table 2.3 are those dating from 1638. Their space for the accommodation of passengers was only 17 voeten (5.2 meters) long. The space was called a tent for the good reason that the passengers were shielded from the elements by a simple canvas covering. These barges in use on the Leiden-Delft route were replaced

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<th>Table 2.3. Dimensions of trekschuiten (in Amsterdam feet).</th>
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<td>Width measured at the floor</td>
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<td>Length of passenger compartment</td>
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The Amsterdam foot = 28.3 cm. (English foot = 30.5 cm).

* The barges of this dimension were replaced by larger ones in 1648.

* These barges are described as seating 24 passengers. They are modelled after the barges used on the Haarlem–Leiden route, except that they are shorter.

* These barges seated 36 passengers: 8 in the roef and 28 in the ruim.

by larger ones (judging from their cost) in 1648 and again in 1662 when their passenger-carrying capacity was specified as 32 to 35. With enlarged barges came more substantial passenger compartments. The tents were replaced by a wooden compartment called the *ruim*. The canvas flaps that served as windows were gradually replaced by glass windows. Later still, (on most routes in the course of the first half of the eighteenth century) the passenger compartment was divided into two parts. The larger space, seating 24 to 30 passengers, continued to be called the *ruim*. A separate compartment at the rear of the vessel, usually seating 8, offered first class accommodations. It was called the *roef*.

An English traveler of the mid-eighteenth century described the trek-schuit in which he traveled as follows:

> The Roef, with access by a double door in the back, seats eight on upholstered benches. The tent, for common people, has windows of leather, and has little storage space. The roef is green, with a window on either side and a table at the far end and spittoons. The outside of the schuiten are painted green and red, and above is a varnish with crushed mussel shells sprinkled on it.

Although the roef accommodated eight, it could be rented in its entirety by a privacy-craving traveler. The ruim accommodated its approximately 24 passengers on benches running along both sides of the vessel. The available space was definitely limited. Foreign travelers, when they first used the trekschuiten, sometimes blamed the skippers for greedily taking on more passengers than could reasonably be accommodated. In 1768 an English traveler, Joseph Marshall, remarked bitterly:

> The trekschuit is drawn by a horse, and will hold about fifteen passengers in the cabbin, or covered room, with convenience; but the mischief is, that master, or skipper, will crowd it with twenty, and even twenty-five, on account of the profit of the fares; and indeed, I believe if he could pack them as close, he would stuff it as full as a barrel of herrings.

But if the barge was not crowded it offered an agreeable means of transportation. The authors of many eighteenth-century travel accounts were content to repeat the 1687 description of Maximilian Misson, who said of the trekschuit:

> Nothing could be more convenient. The Boats are drawn by Horses, and go off at set hours. You are seated as quietly in them as if you were at home, and sheltered both from Rain and Wind: So that you may go from one country to another, almost without perceiving that you are out of the House.

Another Englishman concluded his description of the trekschuit with the complementary observation that ‘This way of travelling is indeed far the most commodious, best regulated, and cheapest in Europe.’

The Dutch themselves were no less appreciative of their unique mode
of transportation. A late eighteenth-century poet exclaimed:

Wie kan de vinding van den Trekschuit ooit waarderen?
Men reisd als zat men thuis, geen schokken, draaijen, keren
Ontrust het lichaam, 't zij men vaart bij dag of nacht,
Men vindt al slapende zich op zijn plaats gebracht. 29

Who can ever fully appreciate the invention of the trekschuit?
You travel as though you were sitting home; no jolts, or turns
fatigue the body. Whether you travel by day or night,
You will find yourself brought sleeping to your destination.

The operation of a trekschuit required a crew of three plus a horse. On the barge itself worked the skipper and his knecht (helper) while on the towpath riding the horse we find the jager (jockey). John Smeaton, a most attentive English traveler noteworthy for his interest in technical details, offers us the best description of how the barges moved along the trekvaarten. As he traveled from Leiden to Haarlem in 1755 he wrote:

In this passage I could not help remarking the dextrous manner in which the Schuits (which are drawn by horses) pass the bridges: when the head of the Schuit comes near the bridge a person at the head unhooks the line which hangs by a button and loop and lets it run over the bridge and by such time as the rope is ready to drop on the other side of the bridge, the boat’s head is also through, and the person ready to catch it, who hooks it on again, and away they go without the Schuit, or the horse stopping. 30

The skipper was found at the stern, manning the rudder. His knecht was at the mast, ready to perform at every bridge the maneuver described by Smeaton. The jager was generally a young boy; the regulations governing the trekschuiten occasionally specified that he be no younger than eight years of age. He carried with him a horn ‘which he blew to warn of his approach to bridgekeepers and other boats’. 31

The problem posed by the passage of barges traveling in opposite directions on the trekvaarten which had a towpath on only one side of the canal was solved by the requirement that the mast (which was moveable to enable barges to pass under fixed bridges) of barges traveling in one direction always be higher than those of barges moving in the opposite direction. In this way the lines could cross without tangling. 32

To keep the barge moving as straight ahead as possible despite the fact that the horse was, of course, always pulling it toward the bank, a 20 meter long line was used, thus minimizing the angle formed by the line and the intended direction of the barge. On straight stretches of canal this worked well, but special measures proved necessary where the horse veered in one direction or another. Smeaton describes these measures as follows:

When the horse crosses a bridge, which is very frequent, there is a roller fixed upright on the middle of the rail of the bridge, against
which the line keeps bearing without going beyond the middle of the bridge.33

When Smeaton traveled from Amsterdam to Utrecht, a route that follows several twisting rivers, he observed that

Wherever the horse turned upon the convex shore, there was a post placed, with a roller before it standing perpendicular, for the cord to work upon, by which the Schuit was drawn. These rollers were about 6 or 7 feet long, and so guarded at the top and bottoms that the cord could not miss them. Indeed, the Dutch seem to have studied every contrivance to save the labour of Men, and even of Horses, but where the wind is to do the work, they have left it to encounter with a great deal of Friction.34

Smeaton was unimpressed by Dutch windmill technology, which, he thought, ignored the many possibilities for reducing friction through better lubrication.

Horses provided the motive power for the trekschuiten. According to Le Frank van Berkhey, whose *Natuurlijke Historie van Holland* devotes special attention to the *trekpaard* (pulling horse), specially trained horses were used to pull the trekschuiten. They were trained to move at a pace, or light trot, which would not exhaust the horse before the end of his relay.35 On most routes that pace sufficed to pull the barge along at an average speed (including intermediate stops) of about seven kilometers per hour.

We now know why the trekvaarten were built and when. We also know something about the technical and physical characteristics of the canals and barges, as well as the operating methods employed to move the barges over their assigned routes. But the trekvaart network was only one part of the total passenger transportation system. To understand more fully its function and its significance, the task remains of providing an account of the development of the other available modes of transportation.

II.5. THE DEVELOPMENT OF THE OTHER MODES OF PASSENGER TRANSPORTATION

II.5.1. Sailing vessels

The development of the trekvaart network between the 1630s and 1665 was contemporaneous with the development of beurtveer networks emanating from all the important cities. As noted earlier, the first beurtveren dated from much earlier times, but a great expansion took place in the course of the seventeenth century. Some trekschuit services were, indeed, extensions of earlier existing beurtveren. Thus, the skippers' guild of the Amsterdam-Haarlem beurtveer, which had long provided
service between the two cities via the IJ, added to its activities the main-
tenance of the hourly trekschuit service once the trekvaart was dug in
1632. From then on the old service, via the IJ, became known as the
buitenveer and specialized in the transporting of freight. The new trek-
schuit service became known as the binnenveer, carrying passengers and
parcels on the trekvaart.\textsuperscript{36} On several other routes a similar grafting of
the trekvaart service to a previously existing beurtveer organization took
place. But whether or not this occurred, the beurtveren invariably
continued to function, and new ones were created.

The sailing vessels, carrying freight as well as passengers, that provided
these services often maintained important links that supplemented the
trekschuit services described above. Although the reliance on sail made
it impossible for the beurtveren to attain the level of regularity and
dependability that characterized the trekschuit, they often provided
quite frequent services. For instance, the provision of passenger trans-
portation between Amsterdam and the important industrial district
around Zaandam was reorganized into a beurtveer in 1631. The vessels
were to provide hourly departures in both directions. To minimize the
effect of bad weather the skippers were required to maintain, along with
their regular sailing vessels, two 'tochtschuyten' and two 'roeyschuyten'.
The former were to be used during stormy weather, defined as weather
in which the operation of windmills had to be suspended. For their opera-
tion the skipper had to employ two or three extra men to 'assist the
voerlieden (bargemen) in doing their duty to the travelling man'. In
return, the skipper was empowered to charge a higher fare. The roey-
schuiten — rowing barges — were brought into operation when the wind
velocity was insufficient to set the sailing vessels into motion.\textsuperscript{37} All of
these special measures — with their attendant costs — were intended to
make this important service as dependable as possible given the im-
practicality of establishing trekschuit service between the two points.

By the mid-seventeenth century sailing vessels departed Amsterdam
daily for Alkmaar, Amersfoort (offering an alternative to the trekschuit-
coach route via Naarden) and Beverwijk. Daily sailings also departed for
Delft, The Hague, and Rotterdam. These beurtveren, which had provided
the chief links between Amsterdam and the cities of South Holland before
the construction of the trekvaarten, did not disappear when the faster,
more punctual trekschuiten were brought into operation. Instead, they
continued to carry merchandise and those passengers wishing to avoid
the higher fares or repelled by the severely limited storage space of the
trekschuit alternative.

In south Holland beurtveren continued to play a large role because the
many broad expanses of water made the effective use of trekschuiten
impossible. Sailings four times per day between Rotterdam and Dor-
drecht and daily connections between Rotterdam and Brielle, Vianen,
Gorinchem, and Nijmegen were established in the first half of the seven-
teenth century.

The routes mentioned here are only those of greatest importance as supplements to the trekvaart network. In fact, the hundreds of services formed a maze-like network too extensive to be described. Map 2.3 is intended to convey an impression of the character of beurtveer services. Map a shows the regular – at least once-per-week – services emanating from two south Holland places: Haastrecht, little more than a village, and Gorinchem, a regional market town of about 5000 inhabitants. Map b shows the places with direct access to Leeuwarden, the provincial capital of Friesland. Similar maps could be drawn for hundreds of towns and villages. Were they all to be superimposed on a single master map it would represent the Republic’s complete network of regulated transportation services.

There were, in fact, three overlapping shipping networks in the low-lying regions of the Republic. Most basic were the routes of the market boats connecting villages to their market towns. Then came the beurtveren, offering intercity connections between each city and its important trading partners. Finally came the trekvaart network, described earlier. The beurtveer and trekvaart networks overlap somewhat: marginal cases exist that seem to belong to both categories. But far more noteworthy than this is the essential difference in the nature of the service provided by the beurtveren and trekschuiten.

The beurtveren endowed each city with a more or less complete set of direct services to other cities in the manner shown by map 2.3. The frequency and timing of the sailings were geared to suit the requirements of the city markets. It is true that the rays emanating from each city would, when the routes of all cities are superimposed on one map, form a network far more complete than the trekvaart network (i.e. its connectivity score was much closer to 1.0), but the market orientation of the services and the infrequency of sailings over any given route made this network difficult to use for through travel. Here the trekvaart system was ideal. While the beurtveren served the cities as competing central places, the trekschuiten served them as members of an urban system. The fact that this ‘third network’ was built when the second already existed makes an important statement about the economy of the mid-seventeenth-century Republic. To this we will return in chapter XII.

In two large areas beurtveren continued to provide very nearly the only scheduled transportation service, services which provided crucial links between the Holland-Utrecht trekvaart network and the Friesland-Groningen network to the north and the Flemish network to the south. The first mentioned link was maintained by the beurtveren that plied the waters of the Zuider Zee.

The old Zuider Zee belied its appearance as a large obstacle placed in the heart of the Netherlands by functioning as an enormous traffic
MAP 2.3. Three examples of beurtveer networks.

a. Two South Holland beurtveer networks: Gorinchem and Haastrecht.

b. The beurtveer network of Leeuwarden.

Indeed, despite the fact that its shores are divided among no less than five provinces, the Zuider Zee litoral functioned to a not yet fully appreciated extent as a single economic and even cultural region. This unity was significantly reinforced by the large volume of passenger transportation made available by the beurtveren that connected the cities of the Zuider Zee with each other.

In Holland two cities served as gateways to the Zuider Zee: Enkhuizen and Amsterdam, of which the latter was by far the more important. The beginning dates of their beurtveren are unknown, but by 1669, at any event, ships set sail every evening at the official closing hour of the city gates for the Friesian ports of Harlingen, Workum, Staveren, and Lemmer (and on to Sneek), for Zwolle and Kampen in Overijssel, and for Harderwijk in Gelderland. In the summer months the route to Workum was actually served by two daily departures. In the winter, on the other hand, these departures became less frequent. (The official schedules always indicate specific days of departure in the winter, but travel guides and travelers’ diaries often give the impression that the ships departed only when the skipper was satisfied that the weather was good and he had sufficient passengers and freight to make it pay.)

From Enkhuizen daily sailings were available to Staveren (the nearest Friesian port) and Workum. In addition ships between Harlingen and Amsterdam often called at Enkhuizen. All together then, we can count in any non-winter week, some 40 sailings in each direction between Amsterdam and Friesland and an additional 14 from Enkhuizen to Friesland. Between Amsterdam and the ports of Overijssel and Gelderland 21 ships (24 counting the tri-weekly sailings to Deventer mentioned in the eighteenth century) set sail every week. These figures do not include the numerous once- or twice-per-week beurtveren connecting Amsterdam and Enkhuizen with the other cities in Friesland, Groningen, and Overijssel.

In the face of municipal competition for a share of the Zuider Zee traffic the relative importance of the various ports shifted in the course of the seventeenth and eighteenth centuries. By 1700 at the latest Workum’s two daily sailings to Amsterdam had been reduced to one, and not long thereafter Lemmer arose to become the major gateway to Friesland and Groningen. The entrepreneurial spirit of the Grietman of Lemsterland (the executive officer of local government in and around Lemmer) attracted increasing numbers of passengers to this route after 1709. It combined the shortest Zuider Zee crossing from Amsterdam and the most direct route to Groningen with ships of greater comfort than those of the other beurtveren.

The eighteenth-century dominance of Lemmer is apparent from the records of passagiegeld (transportation tax) collected at the various ports and border crossing points of Friesland. In 1747–48 Lemmer accounted for 30.4 percent of all passagiegeld revenues, three times that of its nearest
competitor, Workum. The number of passengers who departed Lemmer is known for only one month, May of 1748. Then 643 passengers paid the tax, a number that suggests an annual departure rate of about 6000.41

In 1793–94, the only other year for which the record of passagiegeld revenues are extant, Lemmer’s position had grown even stronger. Then Lemmer accounted for 47.2 percent of all passagiegeld revenues (which were now 3.9 times greater than in 1747–48) and continued to be three times greater than the nearest competing port, which was now Harlingen. The number of passengers departing Lemmer in 1793–94 is not known. The great increase in passagiegeld revenues in the second half of the eighteenth century – Lemmer’s collections rose six-fold – lend support to the view that travel between Friesland and Holland grew considerably, but whatever the statistics may show, this much is certain: demand was sufficiently large to generate a keen competition among the numerous Friesian ports.42

In 1712 the skippers’ guild of Harlingen went so far as to pay the Harlingen-Leeuwarden trekschuit skippers an annual subsidy of 150 guilders in return for the latter’s agreement to operate an overnight barge from Leeuwarden which would offer direct connections with the Harlingen skippers’ early morning departure for Amsterdam. This subsidy arrangement continued in force for a long time; in 1798 it was still a standing commitment of the Harlingen guild.43

The Friesian ports were not alone in competing for the Zuider Zee traffic. In Holland, too, the prize was deemed sufficiently attractive to move municipal officials to action.

In the seventeenth century Enkhuizen made a determined effort to become Holland’s gateway to Friesland. In 1682, after long and apparently difficult negotiations, the city fathers reached an agreement with their counterparts in Workum to establish a daily service between their two cities. Every day a ship would depart Enkhuizen at 9 a.m., after the arrival of the first coach from Hoorn, and it was to arrive at Workum no later than 6 p.m. The westbound ship left Workum at 11 a.m. (later, at noon), late enough to allow the boarding of travelers arriving from Leeuwarden on the 4 a.m. trekschuit. This vessel was supposed to reach Enkhuizen no later than 8 p.m.44 The two cities clearly designed this service so that it could be advertised as a dependable route, sharing the characteristic of the two trekvaart networks that it linked together. Why gamble on long delays on the ‘sea voyage’ from Amsterdam when a scheduled shuttle service featuring secure connections at both ends was available?

This shuttle service did not attract the hoped-for clientele. As we have seen, Workum did not hold its position as the chief port of entry in Friesland and travelers from Amsterdam preferred to set sail directly rather than proceed via Enkhuizen. Consequently, an ordinance of 1768 shows that the Enkhuizen-Workum service had long since dissappeared.
Then the much reduced position of Enkhuizen was such that it could only maintain a twice-weekly service to Staveren and to Lemmer (plus once-weekly sailings to a large number of other Zuider Zee ports).45

There were, of course, many other opportunities to sail on the Zuider Zee besides the scheduled services mentioned above. Beurtveren connected coastal points (Amsterdam to Enkhuizen, Enkhuizen to Medemblik, Enkhuizen to the island of Texel, Kampen to Elburg, Kampen to Lemmer, etc.); other vessels regularly made their way to the island fishing settlements, and thousands of coastal and ocean-going vessels on their way to and from foreign ports called at such seafarers’ headquarters as Hindeloopen and the islands of Vlieland and Terschelling. All of these vessels together made the Zuider Zee a heavily traveled body of water.

The second region where dependence continued to be placed in the beurtveren was the Delta: the island-filled area between the river Maas in the north and Schelde in the south. Here, Rotterdam and Dordrecht functioned as competing gateways to Zeeland, North Brabant, and the Southern Netherlands. The effective founding dates of the beurtveren are obscure here, as on the Zuider Zee. But by the mid-seventeenth century the pattern of services that prevailed into the nineteenth century had been established. Then, both Rotterdam and Dordrecht offered daily sailings to the island of Walcheren and Antwerp. Ships left Rotterdam for Middelburg every day but the departure time depended on the tides. Thus, a travel guide of 1689 had to explain in tedious detail, that the ships sailed at noon when it was New Moon, one hour later the following day, at 3 p.m. on the third and fourth days after New Moon, and so forth. From Dordrecht two ships departed daily for Veere, another port on the island of Walcheren. (The three cities of Walcheren—Middelburg, Veere, and Vlissingen—are all very close to each other and were connected by hourly wagon services over roads paved as early as 1647.) These ships, too, departed with the tides: at New Moon departure times were 10 a.m. (low tide) and 5 p.m. (high tide). In the winter half of the year—1 September to 30 April—only the first of these two departures was observed. Travelers to the Southern Netherlands could depart daily from either Rotterdam or Dordrecht for Antwerp (in 1693 departures from Dordrecht were reduced to three times per week). But these sailings to Antwerp did not exhaust the possibilities for travel to the Southern Netherlands. Once the traveler arrived on Walcheren he could depart Vlissingen every day for Sas van Ghent and Sluis. From each of these points twice-daily trekschuiten provided connections to Ghent and Bruges, respectively. In addition to these direct connections with the chief cities of Flanders, one could cross the Westerschelde to Breskens at almost any time. It is interesting that the Flemish trekvaart system was never connected to the canal and river network of Brabant, but did offer relatively frequent service via two routes to Zeeland, which, in turn, was well provided with services to Holland.
Map 2.4. Coach and sailing vessel services in the Dutch Republic in the mid-eighteenth century.
Finally, Dordrecht offered a wide range of sailings across the Hollands Diep to North Brabant: twice-daily sailings to Geertruidenberg and daily sailings to Klundert, and Bergen op Zoom.46

The closing of the Schelde, which limited Antwerp's direct international trade, made the Delta's numerous channels less busy traffic arteries than was the Zuider Zee, but here too, there were many other travel opportunities than the just mentioned services. The cities of Zierikzee, Goes, and Bergen op Zoom were all linked to Middelburg by regular sailings, and these and other lesser Zeeland cities all maintained beurtveren of less than daily frequency to the cities of Holland. Moreover, the islands were connected with each other by a phenomenal number of ferries. A legal history of these Zeeland ferry services identified 118 separate, officially sanctioned and regulated ferry services.47

II.5.2. Road Transportation

The multiple waterborne transportation networks with which the low-lying regions of the Dutch Republic were endowed by the mid-seventeenth century might be thought to close the door to the development of a road transport network, but that was not entirely the case.

We have already observed that, for various reasons, certain overland routes were incorporated into the trekvaart network. By 1680 coaches maintaining frequent schedules traveled over paved roads connecting Enkhuizen with Hoorn, Gouda with Rotterdam, and Rotterdam with Dordrecht (this last route remaining unpaved). But in addition to these short-distance services filling gaps in the trekvaart network, there arose in the decades after 1660 a whole network of longer-distance coach services. This development must be seen in the context of the Europe-wide inauguration of postal and passenger coach services which began with the end of the Thirty Years' War and gained momentum after the English Restoration. The imperial postal monopoly of Thurn und Taxis, the Road and Bridge Administration of Louis XIV of France, the turnpike authorities of England – these and other agencies acted to make scheduled public transportation available between many of Europe's chief cities in the last third of the seventeenth century. In this movement the Dutch Republic participated.

The first Dutch postal coach route, begun in 1660, connected Amsterdam with The Hague. This service is noteworthy because it was, until the end of the eighteenth century, the only coach route that competed directly with the trekschuit. These coaches left each city twice daily except during the court vacation in The Hague; then the service was reduced to once per day. In 1665 two new services were established connecting Holland with the eastern provinces: a twice-weekly service from Naarden (the eastern terminus of the trekvaart network) to Groningen via Amersfoort and Kampen and a thrice-weekly – quickly increased
to daily – service from Amsterdam to Arnhem.\textsuperscript{48}

In the decades after 1665 a whole network of postal coach routes was gradually created. The establishment in 1661 of a scheduled packet boat service connecting the Dutch Republic (at Hellevoetsluis) to England (at Harwich) and the simultaneous inauguration of overland postal service from Amsterdam to Hamburg served as the backbone for several of these new routes. By 1689 a travel guide listed coach services from both Amsterdam (or Naarden) and Utrecht to Deventer (and thus on to Hamburg) and Arnhem (and thus to the Rhineland). In addition, coaches connected the cities of the IJssel river valley with each other and with the Zuider Zee port of Harderwijk, and coach routes extended southward from Utrecht and Gouda to Breda, Den Bosch, Maastricht, and Antwerp. But the elaboration of a full-fledged coach network took a very long time. Non until the mid-eighteenth century were several crucial routes opened up. In 1731 the Lemmer-Groningen coach route was inaugurated, and direct Rotterdam-Antwerp coaches had to wait until 1751 – and then ran only in the summer months.\textsuperscript{49}

The demand for these services seems to have been very thin, a condition that is amply reflected in the checkered career of the Naarden-Amersfoort-Kampen-Groningen route. When put into service in 1665 this route was intened to cater to speed-conscious, long-distance travelers. To attract such travelers from the Zuider Zee boats a schedule was devised that forced passengers to board the coach in Groningen at 3 a.m. Only with such an early departure could the coach arrive at Hasselt, in Overijssel by 10 p.m. The passengers then boarded a trekshuit for the (one hopes, sleep-inducing) three-hour voyage to Kampen, where they were once again herded into coaches at 1 a.m. for same-day arrival at Amsterdam. One had to value one’s time very highly to put up with this 35 hour ordeal, and the evidence suggests that, as the century progressed, fewer and fewer people were disposed to travel in this way.

In 1691 the cities revamped the service. The coach then left Groningen at the more reasonable hour of 5 a.m. Its route then passed through Zwolle rather than Kampen, and since the trip to Zwolle took more than one day, the passengers stopped underway to spend the night at an inn. Arrival in Zwolle was late the following morning. Travel time to Amsterdam was now much greater than before, but the cities apparently hoped that the new schedule would attract more local traffic. This was not to be, however, and by 1703 the concessionaire of the coach service gave it up as unprofitable. From then on the cities operated the service directly. Not until 1830, when the road connecting Groningen and Zwolle was paved, was the travel time reduced to a single day.\textsuperscript{50}

Coach services such as described above could not hope to appeal to a large market in the face of waterborne alternatives. Indeed, a glance at map 2.4 makes clear that, with the exception of the Amsterdam-The Hague route, the entire mid-eighteenth-century network of coach routes
either supplemented trekschuit services or served areas not reached by them. Only in the last decade of the eighteenth century is a beginning made with the establishment of directly competing coach services in the region served by trekschuiten.

The Dutch Republic, despite its extensive network of waterways, participated with the other European countries in the ‘coaching era’, but it cannot be said to have assumed a particularly prominent place therein. The coaches hardly penetrated the most populous parts of the Republic and the combination of unpaved roads, frequent ferry crossings, and uncomfortable coaches gave Dutch road travel a bad name abroad. In the eighteenth century English travelers bemoaned the technological backwardness of Dutch coaches. They were ‘awkward and clumsy; without either braces or springs so that the motion is often painful’. Another Englishman, upon seeing the coach that stood ready to carry him from Hoorn to Enkhuizen, allowed his baggage to be put aboard but resolved to walk the 21 kilometer distance himself.51

Now that we have a picture of the composite public transportation system of the seventeenth- and eighteenth-century Dutch Republic, we might pause to consider the services available for travel to neighboring countries. Already before the seventeenth century one could, of course, go to a port and hunt for a ship sailing to one’s intended destination. By the second half of the seventeenth century this undependable possibility had been augmented by an array of regularly scheduled coaches and sailing vessels. Travelers to Germany could proceed via the trekvaart to Winschoten and Nieuwe Schans where coaches departed twice weekly to Leer, Bremen, and Hamburg.52 Further to the south, the postal coaches from Amsterdam left Deventer twice weekly for Osnabrück, Bremen, and Hamburg and for Münster. At Arnhem and Nijmegen weekly departures to Cologne and other Rhineland points were maintained.

Someone who made the three-day trip from Holland to the Dutch enclave of Maastricht would have found daily departures to Aachen and Liège and (beginning in the eighteenth century) to Tongeren and Brussels. Maastricht was better connected to Germany and the Southern Netherlands than to the Republic. The waterborne routes connecting Holland with the Southern Netherlands have already been described, but besides the numerous beurtveren and trekschuiten there also existed coaches. In the seventeenth century the only overland service consisted of a weekly coach from Breda to Antwerp. In 1719 another weekly coach to Antwerp, this time via Gorinchem and Breda, was established. As noted above, not until 1751 did it become possible to travel to Antwerp daily by coach, and then only in the summer months.53

One final ‘border crossing’ remains to be discussed: the packet boat to England. This service dates from 1661, when an agreement was reached between the Republic and England concerning the carriage of mail.
From then until well into the nineteenth century packet boats sailed twice weekly between the Dutch naval harbor of Hellevoetsluis and the English port of Harwich. At the Holland end, the otherwise inconsequential Hellevoetsluis was served by a coach to Brielle, from which, in turn, one could sail to Rotterdam or take a ferry to Maassluis, a terminus of the trekvaart network that gave direct access to all the cities of Holland. Maintaining the Hellevoetsluis-Harwich service were vessels of 40–50 tons in the seventeenth century and 80 tons in the early eighteenth century manned by crews of six. They could make the crossing in as little as 16 hours, but the crossing was subject to great delay and uncertainty. It often required two to three days. The eighteenth-century vessels could accommodate 26 passengers in sleeping compartments and many more on the deck.⁶⁴

Immediately apparent from a survey of the international connections maintained in the late seventeenth and eighteenth centuries is how limited international travel flows were in comparison to domestic flows. For instance, all connections with Germany together amounted to no more than a handful of coaches per week. It is probably more accurate in this case to call attention to the geographical rather than to the political barriers to travel. Cities in the eastern provinces of the Dutch Republic without access to plentiful waterborne transportation were little better served by scheduled passenger transportation services than were German destinations. On the other hand, the carrying capacity of scheduled services to the Southern Netherlands was considerable; sailing vessels departed frequently on five major routes.
CHAPTER III

ECONOMIC AND SOCIAL CHARACTERISTICS OF PASSENGER TRANSPORTATION

III. 1. PASSENGER-CARRYING CAPACITY

We have described the Dutch Republic's passenger transportation system as it existed for much of the seventeenth and eighteenth centuries. Furthermore, an attempt has been made to indicate why and how it was brought into existence. In order to connect its existence with the society and economy of the Republic we will now proceed to a consideration of several of the transportation system's most important characteristics: its capacity, speed, and cost. This reconnaissance of the economic geography of the Republic's transportation system will, in turn, help us determine who made use of this system, and why.

We have already observed the commitment of a substantial amount of capital in the development of a passenger transportation system in the mid-seventeenth-century Dutch Republic. The Dutch of those decades dug canals, built towpaths, paved a few roads, built coaches and barges, and purchased horses. Finally, they employed a considerable work force in operating an extensive network of regularly scheduled services. How great a passenger-carrying capacity did the dedication of all these resources make available?

We can estimate the capacity of the system by first calculating the vehicle-kilometers performed per day and per year by each mode of transportation in the performance of the various scheduled services. The calculation is completed by multiplying the vehicle-kilometer figures by the average passenger-carrying capacity of the barges, coaches, and sailing vessels used.

To calculate the yearly vehicle-kilometers one must know the frequency of service over every route. This information can be gleaned from the municipal ordinances governing each service and the various travel guides published in the seventeenth and eighteenth centuries. The frequencies of the major sailing vessel routes on the Zuider Zee and in the Delta region were described in the preceding chapter. Map 2.4 gives an overview of the mid-eighteenth-century coach routes and their frequencies, while an overview of trekschuit services is provided in tables 3.1, 3.2, and 3.3. These tables display 'timetables' of several of the most important trekschuit services as they functioned during the summer months in the second half of the seventeenth century. Using the summer schedule frequencies yields an exaggerated estimate of total capacity because on many routes – particularly those served by coaches or sailing
vessels—schedule frequencies were reduced in the winter months, and could often not be honored because of ice-blocked canals or impassable roads. Our estimates of yearly vehicle-kilometers incorporate adjustments for these problems.

The vehicle-kilometers run off every non-winter day in the late seventeenth century are shown, per region and per mode of transportation, in column one of table 3.4. Thanks to the abundant documentation, we can be confident of the accuracy of the trekschuit figures. The estimates for coach services suffer from a degree of uncertainty. The gradual evolution of these services and the relatively frequent schedule changes combine to make a total description of the service as it existed at a given date very difficult. The data in table 3.4 reflect the situation as it apparently existed in the last decade of the seventeenth century. By the mid-

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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buiksloot</td>
<td>19.00</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Monnikendam</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoorn</td>
<td></td>
<td></td>
<td></td>
<td>5.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoorn</td>
<td>5.00</td>
<td>8.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alkmaar</td>
<td>9.00</td>
<td>12.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoorn</td>
<td></td>
<td>6.00</td>
<td>10.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enkhuizen</td>
<td>8.00</td>
<td>12.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
eighteenth century coach services had expanded by about 30%, most of the expansion occurring in the southern and eastern provinces.

The estimates of sailing vessel-kilometers must be treated with even greater caution than the coach estimates, but for a different reason. In contrast to the coach schedules, the sailing vessel schedules are well known and were only infrequently changed. But the routes that have been included in this study are only a portion of the total beurtveer network. An unavoidably arbitrary distinction has been made to segregate the frequent, longer-distance services from the others. The estimates of sailing vessel-kilometers in table 3.4 must be understood as that portion of a much larger service that is likely to have played a significant role in the transportation of passengers.

We now have estimates of daily vehicle-kilometers per mode of trans-

to Alkmaar and Enkhuizen in the second half of the seventeenth century.

<table>
<thead>
<tr>
<th>Time</th>
<th>Alkmaar</th>
<th>Enkhuizen</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.00</td>
<td>15.00</td>
<td>16.00</td>
</tr>
<tr>
<td>15.00</td>
<td>16.00</td>
<td>17.00</td>
</tr>
<tr>
<td>16.00</td>
<td>18.00</td>
<td>19.00</td>
</tr>
<tr>
<td>17.00</td>
<td>18.00</td>
<td>19.00</td>
</tr>
<tr>
<td>18.00</td>
<td>19.00</td>
<td>20.30</td>
</tr>
</tbody>
</table>

In table 3.4:

- Rotterdam
- Delft
- Maassluis
- Delft
- The Hague
- Delft (also The Hague)
- Alkmaar
- Haarlem
- Amsterdam
- Buiksloot
- Monnikendam
- Purmerend
- Edam
- Hoorn
- Enkhuizen

Every hour a ferry
### Table 3.2. Schedule of trekschuit and coach services from Dordrecht and Rotterdam to Utrecht, Leiden, and Amsterdam in the late seventeenth century.

<table>
<thead>
<tr>
<th></th>
<th>Dordrecht</th>
<th>--</th>
<th>6.30</th>
<th>--</th>
<th>12.30</th>
<th>--</th>
<th>--</th>
<th>--</th>
<th>--</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotterdam</td>
<td>6.00</td>
<td>8.00</td>
<td>10.00</td>
<td>12.00</td>
<td>15.00</td>
<td>16.00</td>
<td>17.00</td>
<td>18.00</td>
<td>19.00</td>
</tr>
<tr>
<td>Gouda (arr.)</td>
<td>8.00</td>
<td>10.00</td>
<td>11.00</td>
<td>12.00</td>
<td>14.00</td>
<td>14.00</td>
<td>17.00</td>
<td>18.00</td>
<td>19.00</td>
</tr>
<tr>
<td>Gouda (lv.)</td>
<td>9.00</td>
<td>11.00</td>
<td>11.00</td>
<td>13.00</td>
<td>14.00</td>
<td>14.00</td>
<td>17.00</td>
<td>18.00</td>
<td>19.00</td>
</tr>
<tr>
<td>Leiden</td>
<td>16.00</td>
<td>21.00</td>
<td>21.00</td>
<td>21.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Utrecht*</td>
<td>17.00</td>
<td>20.00</td>
<td>20.00</td>
<td>20.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amsterdam</td>
<td>--</td>
<td>19.00</td>
<td>19.00</td>
<td>19.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Passengers traveling from Gouda to Utrecht boarded barges to Bodegraven, where connections were made with the barges from Leiden to Utrecht.

### Table 3.3. Schedule of trekschuit service from eastern Groningen to Harlingen, Workum, and Sneek in the seventeenth and eighteenth centuries.

<table>
<thead>
<tr>
<th></th>
<th>Nieuwe Schans</th>
<th>--</th>
<th>6.00</th>
<th>--</th>
<th>10.00</th>
<th>--</th>
<th>--</th>
<th>--</th>
<th>--</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winschoten</td>
<td>--</td>
<td>9.00</td>
<td></td>
<td></td>
<td>13.00</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Winschoten</td>
<td>5.00</td>
<td>10.00</td>
<td>14.00</td>
<td>2.00</td>
<td></td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Noordbroek</td>
<td>6.00</td>
<td></td>
<td>15.00</td>
<td></td>
<td>--</td>
<td>--</td>
<td>--</td>
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</tr>
<tr>
<td>Groningen</td>
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<td>17.30</td>
<td>19.30</td>
<td>21.30</td>
<td>9.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delfzijl</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Groningen</td>
<td>11.00</td>
<td>12.00</td>
<td>17.00</td>
<td>20.00</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Groningen</td>
<td>--</td>
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<td></td>
<td>4.00</td>
<td>9.00</td>
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<td>--</td>
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<td>--</td>
</tr>
<tr>
<td>Dokkum</td>
<td>--</td>
<td>20.00</td>
<td></td>
<td></td>
<td>11.00</td>
<td>16.00</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Dokkum</td>
<td>--</td>
<td>5.00</td>
<td>9.00</td>
<td>12.00</td>
<td>16.00</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Leeuwarden</td>
<td>--</td>
<td>8.00</td>
<td>12.00</td>
<td>15.00</td>
<td>19.00</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Leeuwarden</td>
<td>--</td>
<td>4.00</td>
<td>9.00</td>
<td>13.00</td>
<td>16.00</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Sneek</td>
<td>--</td>
<td>7.00</td>
<td>12.30</td>
<td>16.30</td>
<td>19.30</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Leeuwarden</td>
<td>--</td>
<td>4.00</td>
<td>9.00</td>
<td>13.00</td>
<td>16.00</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Bolsward</td>
<td>--</td>
<td>8.00</td>
<td>13.00</td>
<td>17.00</td>
<td>20.00</td>
<td>--</td>
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</tr>
<tr>
<td>Bolsward</td>
<td>6.00</td>
<td>9.00</td>
<td>14.00</td>
<td>18.00</td>
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<td>--</td>
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</tr>
<tr>
<td>Workum</td>
<td>8.00</td>
<td>11.00</td>
<td>16.00</td>
<td>20.00</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Leeuwarden</td>
<td>--</td>
<td>4.00</td>
<td>9.00</td>
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<td>16.00</td>
<td>20.00</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Harlingen</td>
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<td>8.00</td>
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<td>17.00</td>
<td>20.00</td>
<td>4.00</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

* Sneek to Amsterdam, daily at 9.00
b Workum to Amsterdam, daily at 9.00. In the 17th century a second boat departed at 11.00.
c Workum to Enkhuizen, daily at 12.00.
d Harlingen to Amsterdam, daily at 6.00.

The 20.00 departure is often mentioned in the 18th century. It was not in the official schedule, but the Harlingen skippers' guild (operator of the beurtsschip to Amsterdam) subsidized the trekschuit skippers to ensure that this night barge service was provided (see p. 86).
<table>
<thead>
<tr>
<th>Mode of transportation</th>
<th>Region served</th>
<th>Vehicle-km per day</th>
<th>Estimated average capacity per vehicle</th>
<th>Total capacity in passenger-km per day (in millions)</th>
<th>Percentage of total capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coach</td>
<td>Holland—Utrecht</td>
<td>1294</td>
<td>8</td>
<td>10,352</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>Friesland—Groningen</td>
<td>63</td>
<td>8</td>
<td>504</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Brabant—Limburg</td>
<td>281</td>
<td>8</td>
<td>2,248</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>Overijssel—Gelderland</td>
<td>1204</td>
<td>8</td>
<td>9,632</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>Zeeland</td>
<td>168</td>
<td>8</td>
<td>1,344</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3010</td>
<td>7.3</td>
</tr>
<tr>
<td>Sailing vessel</td>
<td>Holland—Utrecht</td>
<td>1794</td>
<td>20</td>
<td>35,900</td>
<td>10.8</td>
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<tr>
<td></td>
<td>Zuiderzee—Friesland</td>
<td>938</td>
<td>20</td>
<td>18,760</td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td>Zuiderzee—Overijssel—Gelderland</td>
<td>462</td>
<td>20</td>
<td>9,240</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>Delta</td>
<td>1645</td>
<td>20</td>
<td>32,900</td>
<td>9.9</td>
</tr>
<tr>
<td></td>
<td>Gelderland</td>
<td>200</td>
<td>20</td>
<td>4,000</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5039</td>
<td>100,800</td>
</tr>
<tr>
<td>Trekschuit</td>
<td>Holland—Utrecht</td>
<td>6102</td>
<td>30</td>
<td>183,060</td>
<td>58.7</td>
</tr>
<tr>
<td></td>
<td>Friesland—Groningen</td>
<td>2088</td>
<td>30</td>
<td>62,640</td>
<td>20.1</td>
</tr>
<tr>
<td></td>
<td>Overijssel—Gelderland</td>
<td>139</td>
<td>24</td>
<td>3,336</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8329</td>
<td>249,036</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>16378</td>
<td></td>
</tr>
</tbody>
</table>
TABLE 3.5. Geographical distribution of passenger transportation capacity (in millions of passenger-kilometers per year).

<table>
<thead>
<tr>
<th></th>
<th>Coach</th>
<th>Sailing vessel</th>
<th>Trekschuit</th>
<th>Total</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holland-Utrecht</td>
<td>3.1</td>
<td>10.8</td>
<td>58.7</td>
<td>72.6</td>
<td>61.8</td>
</tr>
<tr>
<td>Friesland-Groningen</td>
<td>0.2</td>
<td>5.6</td>
<td>20.1</td>
<td>25.9</td>
<td>22.0</td>
</tr>
<tr>
<td>Overijssel-Gelderland</td>
<td>2.9</td>
<td>4.0</td>
<td>1.1</td>
<td>8.0</td>
<td>6.8</td>
</tr>
<tr>
<td>Brabant-Limburg</td>
<td>0.7</td>
<td>--</td>
<td>0</td>
<td>0.7</td>
<td>0.6</td>
</tr>
<tr>
<td>Zeeland-Delta</td>
<td>0.4</td>
<td>9.9</td>
<td>0</td>
<td>10.3</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Portion and per region of the Republic based on the schedules of the second half of the seventeenth century. To convert these data to estimates of passenger-carrying capacity expressed in passenger-kilometers per year we need to know the capacity of the vehicles, and we must make adjustments for the less frequent service offered in the winter and the interruption of service in the winter months.

The average capacity of the vehicles, shown in column 2, is well known in the case of coaches and trekschuiten. In the case of sailing vessels we are forced, once again, to make quite arbitrary assumptions. The ordinances governing beurtveren sometimes prescribed the size and type of vessel to be used, and contemporary descriptions occasionally inform us of the number of passengers who could be accommodated on certain vessels, but these sources do not suffice to estimate accurately the average passenger-carrying capacity of sailing vessels — there were simply too many different types of vessels.

The Zuider Zee beurtschepen of the late eighteenth century generally possessed a kajuit (first class accommodation for 8), a roef (with sleeping space for 12) and a ruim, a hold in which could be crowded 100 to 130 passengers. The vessels sailing between Dordrecht and Antwerp, on the other hand, had a passenger compartment no larger than that of a trekschuit. Not only does the category 'sailing vessel' comprehend many types of vessels, but the passenger capacity of these vessels could vary with the amount of freight being carried. We will in all likelihood be making a lower-limit estimate of sailing vessel capacity by arbitrarily fixing average capacity at 20 passengers.

The conversion of the daily capacity into a yearly capacity can be made with accuracy for the trekschuit. We know from the schedules that winter capacity stood at about 90 percent of summer capacity, and we know from weather data that the trekvaarten were closed to traffic because of ice for an average of one month a year. For coach and sailing vessels we must once again content ourselves with cruder methods. From what contemporaries said of their susceptibility to unfavorable weather conditions it seems reasonable to assume that they were forced to suspend operations for a longer period than the trekschuiten. I have simply
assumed that they observed their schedules a flat 300 days per year.

The resulting estimates of the yearly passenger-carrying capacity of the Republic's passenger transportation system can be read in column 4 of table 3.4. For the trekschuiten these figures can be regarded as quite accurate, for the coaches less so, and for the sailing vessels still less. On the other hand, one would have to make radically different assumptions before the conclusions drawn from the analysis of table 3.4 could be significantly changed.

In the second half of the seventeenth century the Republic's passenger transportation system offered to the traveling public some 117.5 million passenger-kilometers of transportation capacity. Of course, not all of this capacity was actually used. Only for the trekschuiten is the 'load-factor', the percentage of capacity actually used by paying passengers, known. On the basis of estimates that will be explained below, in chapter IX, it appears that paying passengers used just under 50 percent of annual capacity in the 1660s and 1670s. Whether similar load-factors characterized the other transport modes is simply unknown. Were they to differ significantly the capacity estimates presented in table 3.4 and summarized in table 3.5 would give a distorted picture of the distribution of travel volume. Still, the capacity of the system, its division among the transport modes and among the geographical regions is not without interest in its own right. And, once again, the load-factor differences among the three modes would have to be very large before the conclusions drawn here would have to be altered.

The dominant place taken by the trekschuit in the generation of total capacity is immediately apparent in the last column of table 3.4. Its dominance would be somewhat eroded if a larger average capacity were granted to the sailing vessels, but whatever adjustment might be made here could not alter the facts that the trekschuit was the Republic's most important mode of transportation (despite the fact that it was confined to two regions of the country) and that coaches accounted for only a very small percentage of total passenger transportation.

The division of the 117.5 million passenger-kilometers of capacity of the Republic's transportation system into geographical areas uncovers another striking inequality. The Holland-Utrecht region claims the lion's share of total capacity and the adjacent Friesland-Groningen and Delta regions account for most of the remainder. The entire eastern half of the Republic was served by less than one-tenth of total capacity. It is true, the eastern half of the country was also the less densely populated half. But that fact can account only for a fraction of the discrepancy in available passenger transportation. The approximately 800,000 inhabitants of seventeenth- and eighteenth-century Drenthe, Overijssel, Gelderland, North Brabant, and eastern Utrecht had access to a passenger-carrying capacity of about 10 million passenger-kilometers while the 1,200,000 inhabitants of Groningen, Friesland, Holland, Zeeland, and
western Utrecht enjoyed access to 105 million passenger-kilometers. On a per capita basis the inhabitants of the western provinces were served by seven times the capacity of their eastern neighbors. The enormous gap separating the eastern from the western provinces of the Dutch Republic can sustain two interpretations: that the eastern provinces were very badly served by public transportation, or that the western provinces were uniquely well served. The latter interpretation is certainly the more correct. What meager evidence exists for making international comparisons shows the level of service available in the eastern provinces to be typical of much of Europe before the end of the eighteenth century. It was, then, the western provinces that were unusual, and what made them so uniquely mobile was the enormous capacity of the trekschuit network.

III.2. THE ‘TIME-FRAME’ OF THE DUTCH REPUBLIC

A geographical space can be defined by its physical dimensions – so many kilometers from A to B – or by the time required to move about in it – so many hours from A to B. The latter is commonly used today in mobile, industrialized societies where the time ‘cost’ to reach a destination often seems much more important to the traveler than the money cost or the distance itself – that is, in societies where ‘time is money’. In this context a telling fact about the seventeenth-century Dutch Republic is that they did the same thing: they reckoned distances in ‘hours’.

On account of the equal motion of the Schuits, the Dutch reckon their distances by time; for example Rotterdam to the Hague is four hours or twelve miles; from Amsterdam to Rotterdam is thirteen hours or thirty-nine miles, and this is the universal language of Holland.

The trekschuit, whose average speed of seven kilometers per hour was the standard by which distances in ‘hours’ were reckoned, surely does not impress us by its speed, but contemporaries assessed this speed – only a marginal improvement on walking – differently. Thus, Sir William Temple, the English ambassador to the Republic in the early 1670s observed that ‘by this easie way of travelling an industrious man loses no time from his business, for he writes or eats, or sleeps while he goes; whereas the time of labouring or industrious men is the greatest native commodity of any country’.

One of the time-saving features of the trekschuit that particularly impressed Temple was the night barge. These overnight services on which ‘the benches [were] turned down and covered with straw for the comfort of the passengers’, offered far from the last word in sleeping comfort. But they were a popular means of travel and could be found on nearly every important route in the Holland-Utrecht region. One could board a night barge in Amsterdam and arrive early the following morning at
Hoorn, Utrecht, Gouda, or Leiden. From Leiden one could travel overnight to Rotterdam, Utrecht, and Amsterdam. From Haarlem one could travel overnight – with what must have been an annoying 3 a.m. transfer in Leiden – to The Hague and Delft.

Within the area served by the trekschuiten, the traveler could confidently reckon distances in hours and could make efficient use of his time thanks to the frequent schedules, the comfort of travel, and the availability of night barges. Moreover, the speed of trekschuit travel did not vary appreciably with the seasons. The only difference between the seasons was a reduction of service by about ten percent. Except when ice closed the trekvaarten, the trekschuiten offered essentially the same service on a year-round basis.

Freezing temperatures, it is true, brought trekschuit operations to a standstill for an average of one month per year. But it should be emphasized that the trekvaart operators did not accept the incidence of freezing weather philosophically. On the contrary, the ordinance governing trekschuit operations rarely neglected to include provisions for the maintenance of some sort of temporary service in those periods when the barges were forced to lie idle. Typical of the emergency measures is the Haarlem-Leiden trekvaart ordinance empowering the skippers to run a wagon between the two cities when the canal was frozen. For this service they were permitted to charge 30 stuivers, $2\frac{1}{2}$ times the normal fare.

Another means of emergency transportation was provided by ice sleds, and the trekvaart administrators did not fail to include special provisions in their ordinances for the levying of tolls on such interlopers on their canals.

Finally, two routes are known where special measures were taken to prevent the ice from stopping navigation. The Amsterdam-Weesp route was of strategic importance to Amsterdam as a source of fresh water for the breweries. To keep the water boats – and hence the trekschuiten – sailing, the city had special ice breakers built. On the Rotterdam-Delft trekvaart the ordinance offered the skippers a special incentive to keep the canal open. On days when the early morning market boat could not sail because of ice the trekschuit skippers and their crews were encouraged to break up the ice and somehow get their barges through to their destinations. If they succeeded in sailing on such days, they enjoyed the right to collect 6 instead of 4 stuivers from every passenger carried.\(^7\)

Once one left the region served by the trekschuiten all of this changed: it no longer made so much sense to reckon distances in hours; the traveler could never be certain of his arrival time, and, hence, his connections, and the onset of winter completely altered the character of travel. If we think of the Netherlands as a ‘time-frame’ then it can be said to have consisted of a solid core, where communications could take place on the same basis year-round, and a surrounding region that stretched and
contracted like a concertina. In the summer coaches bounced along the almost entirely unpaved roads of the Republic at average speeds only slightly higher than the trekschuiten. The Amsterdam-Arnhem and Naarden-Groningen coaches, for instance, moved to their destinations at an average speed of between 7 and 8 kilometers per hour. The coaches from Haarlem to Alkmaar could not even attain that speed, and the Utrecht-Den Bosch coach, hobbled by the many ferry crossings on its route, could offer nothing better than an average speed of 5.2 kilometers per hour. On the other hand, the Gouda-Dordrecht coaches could, so long as the dikes were passable, move along at a 9 kilometers per hour pace. The only coach that attained a higher speed than this was the Amsterdam-The Hague postal coach. It attracted its aristocratic clientele, and justified its premium fare, by traveling at an average speed of 10.3 kilometers per hour.8

With the coming of winter even these modest attainments of the ‘outer zone’s’ transportation system had to be given up. Then many services were suspended altogether while those that remained charged higher fares, reduced scheduled frequencies, and lengthened their travel times. Table 3.6 summarizes the impact of winter on several coach and sailing vessel services in the outer zone.

In this context the long acceptability of the 7 kilometers per hour trekschuit can more easily be understood: the average speed of sailing vessels was even lower, while coaches, given the Republic’s unpaved roads and numerous water crossings, were hardly any faster until the nineteenth century. Then more paved roads were built and coach operators harnessed more horses to better-constructed coaches to achieve speeds of 10 to 12 kilometers per hour. It is noteworthy that travelers from England, where coach speeds and comfort were energetically being improved in the course of the eighteenth century, became gradually more critical of the trekschuit.9 While the praises of Sir William Temple in 1673, Maximilian Misson in 1687, and William Bromley in 1702 were unqualified, eighteenth-century travelers became progressively more critical. When Benjamin Silliman made use of the trekschuiten in 1805 he was ‘at first... delighted beyond measure with a mode of travelling so novel, so quiet and so easy but, the slowness of the motion and the perfect uniformity of all the arrangements soon made it tedious’.10 The longer he sat in the slowly moving barge the more restless he became. At one point he disembarked from the barge and marched along the towpath to demonstrate to himself and to the Dutchmen remaining on board the intolerably tardy progress of the trekschuit. Late eighteenth-century English travelers usually explained the dependable but slow pace of the trekschuit as an expression of the phlegmatic character of the Dutch. As James Mitchell put it:

This mode of travelling seems to afford a fair example of Dutch arrangements generally; it is economical of money, but expensive
Table 3.6. Winter season changes in the schedules and fares of coach and sailing vessel services.

<table>
<thead>
<tr>
<th>Route</th>
<th>Date</th>
<th>Summer service</th>
<th>Winter service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coaches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotterdam—Antwerp</td>
<td>1751</td>
<td>arrival same day</td>
<td>suspended</td>
</tr>
<tr>
<td>Rotterdam—Nijmegen</td>
<td>1791</td>
<td>arrival same day</td>
<td>arrival second day</td>
</tr>
<tr>
<td>Utrecht—Deventer</td>
<td>1778</td>
<td>arrival in 14 hours</td>
<td>arrival second day</td>
</tr>
<tr>
<td>Maassluis—Rotterdam</td>
<td>1793</td>
<td>once per day</td>
<td>suspended</td>
</tr>
<tr>
<td>Dordrecht—Gouda</td>
<td>18thc.</td>
<td>twice per day</td>
<td>'service when dikes are passable'</td>
</tr>
<tr>
<td>Nijmegen—Venlo</td>
<td>1745</td>
<td>arrival in 15 hours</td>
<td>arrival second day</td>
</tr>
<tr>
<td>Gouda—Den Bosch</td>
<td>18thc.</td>
<td>arrival same day</td>
<td>departure 3 hours earlier, arrival later</td>
</tr>
<tr>
<td>Amsterdam—Arnhem</td>
<td>17th &amp; 18thc.</td>
<td>arrival same day</td>
<td>arrival second day</td>
</tr>
<tr>
<td>Utrecht—Den Bosch</td>
<td>1780</td>
<td>arrival same day</td>
<td>service continued as long as roads are passable</td>
</tr>
<tr>
<td>Den Bosch—Maastricht</td>
<td>18thc.</td>
<td>three times per week</td>
<td>two times per week, arrival third day</td>
</tr>
<tr>
<td>Maastricht—Aachen</td>
<td>1765</td>
<td>once per day</td>
<td>three times per week</td>
</tr>
<tr>
<td>Hoorn—Medemblik</td>
<td>1776</td>
<td>twice per day</td>
<td>'service when dikes are passable'</td>
</tr>
<tr>
<td>Groningen—Lemmer</td>
<td>1731</td>
<td>arrival in 12 hours, fare: £2.16.–</td>
<td>arrival second day, fare: £3.10.–</td>
</tr>
<tr>
<td>Deventer—Arnhem</td>
<td>1760</td>
<td>scheduled to connect with trekshuit to Nijmegen</td>
<td>later arrival makes through travel to Nijmegen impossible</td>
</tr>
<tr>
<td>Groningen—Coevorden</td>
<td>1789</td>
<td>two times per week, arrival same day</td>
<td>once per week, arrival second day</td>
</tr>
<tr>
<td>Arnhem—Zwolle</td>
<td>1791</td>
<td>two times per week</td>
<td>once per week</td>
</tr>
<tr>
<td>Arnhem—Utrecht</td>
<td>1756</td>
<td>fare: £2.10.–</td>
<td>fare: £2.16.–</td>
</tr>
<tr>
<td>Arnhem—Zutphen</td>
<td>1791</td>
<td>fare: £1.5.–</td>
<td>fare: £1.10.–</td>
</tr>
<tr>
<td>Arnhem—Nijmegen</td>
<td>1786</td>
<td>fare: 15 st.</td>
<td>fare: 18 st.</td>
</tr>
<tr>
<td>Sailing vessels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotterdam—Middelburg</td>
<td>17thc.</td>
<td>two times per day</td>
<td>once per day</td>
</tr>
<tr>
<td>Dordrecht—Veere</td>
<td>17thc.</td>
<td>two times per day</td>
<td>once per day</td>
</tr>
<tr>
<td>Geertruidenberg</td>
<td>1721</td>
<td>two times per day</td>
<td>once per day</td>
</tr>
<tr>
<td>Amsterdam—Harlingen</td>
<td>1789</td>
<td>fare: 15 st.</td>
<td>fare: 18 st.</td>
</tr>
</tbody>
</table>

...of time... While a Dutchman travels three miles in an hour, an Englishman travels six or eight, and this is nearly the difference between the spirit and energy of the two nations.  

By the nineteenth century, as improved coach services began to be introduced, even Dutchmen began to turn against what mid-eighteenth-century Dutchmen had without a hint of criticism labelled the 'national transport mode'. In 1829 A. B. van Meerten Schilperoort, the author of a travel guide, recommended the trekshuit only to old, weak, or sickly...
persons. ‘As for myself’, he wrote, ‘when I am traveling I am eager to feel that I am traveling. The gliding, murmurless movement of a trek-schuit bores me; I much prefer to sit in a galloping postal coach’.12

A few years later, when railroads had been put into operation in nearby countries and their introduction in Holland seemed imminent, the trek-schuit had become an unbearable, painful symbol of national backwardness. In the Camera Obscura its author, Hildebrand, remarked, ‘As soon as one steps into the trek-schuit, and crawles through the little door, and puts on ones cap, and choses ones corner, it is as though a spirit of narrow-mindedness and triviality falls over us’. ‘Otherwise reasonable and intelligent people’, he continued, ‘find themselves capable of uttering banalities as soon as they have settled down in a trek-schuit’.13 Hildebrand’s judgement has maintained itself right up to the present day. To ‘arrive with the trek-schuit’ continues in use as a phrase meaning not only slow and hence late, but also behind the times.

But we have gotten ahead of ourselves. The trek-schuit lost its allure as a means of transportation only after it had served for a good 150 years as the centerpiece of the Dutch transportation system. During those many generations the modest time saving of (only some) coaches was more than outweighed by their several disadvantages: discomfort, high cost, and, the point at issue here, undependability.

The time-frame of the Republic consisted of two zones: one offering dependable, 7 kilometer per hour trek-schuit transportation and a second offering coach and sailing vessel transportation whose dependability, speed, frequency, and cost depended on tides, winds, rainfall, and the course of the seasons. From Amsterdam and most of the other important cities of central Holland, one could travel to almost any point in Holland and Utrecht in one day regardless of the season. In the summer, one could reach most major centers in the outlying provinces within two days if one made use of night barges and overnight sailing vessels on the Zuider Zee and in the Delta. But in the winter season trips beyond the core zone were likely to require twice their summer travel time. Suddenly, the Netherlands beyond the core zone became twice as large.

It remains to draw attention to a second way in which the core zone time-frame differed from that of the outlying regions. Not only could one travel to one’s destination confident of the cost and arrival time, but from any major city one had direct one-day accessibility to very nearly the entire zone. This is another way of stating what was established in chapter II, that the trekvaart network in the Holland-Utrecht region was characterized by a high degree of connectivity.

Despite Amsterdam’s great size and enormous importance, the trekvaart network was not entirely focused on that city. The other important cities had access to the whole region directly, and not only via Amsterdam. This fact is of particular importance in a pre-telegraphic age, because it implies not only the equalization of physical accessibility, but also the
equalization of accessibility to information. This characteristic of the network endowed Holland’s numerous cities with a measure of resistance to the powerful forces making them dependent upon and subordinate to Amsterdam. With direct accessibility to the whole region each city could hope to compete with the others and carve out an important role for itself. In short, the trekvaart system contributed to the organization of Holland’s cities into an urban system.

A crude measure of the accessibility enjoyed by the various cities is the summation of the urban population which one could reach within one day’s travel from a given city. Table 3.7 shows the accessible population (using 1660 population estimates) of four selected cities. The figure in the first row represents the population of the accessible cities, the second row presents the population of the city in question, which was, of course, also accessible.

The similar totals for these cities do not mean that each city offered roughly equal opportunities to business enterprise. Obviously, for many activities having 200,000 people at one’s doorstep offered advantages over having 200,000 people ten hours away. But the direct accessibility to people and to information enjoyed by all the cities of Holland was nonetheless of great value in the development of an urban system. Dutch cities beyond the core region were forced, by the nature of their transport system, to be either much more autonomous or more dependent on another, larger city, as part of a well-defined urban hierarchy. They had no opportunity to take their place in an urban system.

The connectivity of the trekvaart network is not the only expression of the cities of Holland’s struggle to preserve direct accessibility to people and information. This policy is also illustrated by the political wrangles surrounding the operation of the postal service between the Republic and England. Why, one might ask, did the packet boats from England dock at the insignificant and rather eccentrically situated little port of Hellevoetssluis? Had, say, Rotterdam or Dordrecht served as the Dutch terminus the merchants of those cities would have enjoyed a time advantage over merchants in the rest of the country with regard to information from England. In Hellevoetssluis lived no one who could profit

<table>
<thead>
<tr>
<th>Table 3.7. Urban population accessible within one day's travel from four selected cities (population estimates of c. 1660; in thousands).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Total population of other accessible cities</td>
</tr>
<tr>
<td>Population of city in question</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
from such a strategic advantage. Nonetheless, a glance at the map will show that Rotterdam and the other cities of southern Holland would still get their information a bit sooner than would Amsterdam if the English mail were distributed from Hellevoetsluis. To avoid even this inequality, the mail was sent, unsorted, to the village of Waddinxveen, in central Holland, whence it was sorted and distributed to the various cities. This arrangement, established in 1661, was altered several times in the following decades, but the principle of equalizing accessibility to information always played a role in the choice of a new distribution center.¹⁶

III.3. TRAVEL COSTS

What did it cost to travel via the various modes of transportation available in the seventeenth- and eighteenth-century Dutch Republic? Trekschuit tariffs in the 1660s stretched across a rather broad range, from 3.6 p. per km to 7.0 p. per km, but the great bulk were clustered between 4.2 p. and 5.6 p. per km. It is noteworthy that the exceptionally low fare of 3.6 p. was charged on the Delft-The Hague route. This was by far the shortest route — only 9 kilometers long — of the entire network and probably felt, more than other routes, the need to compete with the alternative of traveling on foot. The average fare of all routes in the Holland-Utrecht region was 4.8 p. per km. In the Friesland-Groningen region a narrower range of fares prevailed, stretching from 5.0 to 6.3 p. per km. Here the average of all routes for which information is available came to 5.7 p. per km. The Flemish trekschuiten were more costly still; there the range was 5.5 to 7.3 p., and the average fare 6.3 p.¹⁷

The costs of coach travel varied more greatly than did the trekschuit tariffs. The coach routes which supplemented the trekvaart network, and which enjoyed certain efficiencies in operation because of their large travel volume, charged between 10.0 and 11.4 p. per km. Coaches that served the eastern provinces levied quite varied tariffs that ranged from 11 to 18 p. per km. Finally, the Amsterdam-The Hague postal coach, serving an exclusive clientele with what passed for a high-speed service, charged 21.4 p. per km. Even higher was the tariff of the one-day Rotterdam-Antwerp coach service inaugurated in the mid-eighteenth century. It cost an unprecedented 31.5 p. per km.¹⁸

The third mode of transportation, sailing vessels, levied tariffs that also varied a great deal, but were nearly always cheaper than the trekschuiten. The basic fare for Zuider Zee crossings — 15 stuivers in summer, 18 stuivers in winter — amounted to no more than 2.0 p. per km. In the Delta region the routes to Zeeland and Antwerp cost 2.8 and 2.4 p. per km, respectively. These tariffs are for passage only. Special accommodation was extra. Thus, to the 15 stuiver fare for passage from Amsterdam to Harlingen, the passenger wanting a sleeping compartment with linen
in the kooi had to pay an extra 12 stuivers.\textsuperscript{19}

Other sailing vessel routes – particularly those covering shorter distances and sailing over inland waterways – charged up to twice the per-kilometer tariffs of the routes just mentioned. Table 3.8 gives an overview of the various beurtveer tariffs. These fares, ranging from 2.2 to over 5.0 p. per km, were, in almost all cases, cheaper than the trekschuiten.

The fare structure as it existed in the 1660s underwent virtually no changes until the second half of the eighteenth century, and then the increases were quite modest. For over a century, then, one could travel by beurtveer for between 2.5 and 4.0 p. per km, by trekschuit for between 4.5 and 6.5 p. per km, and by coach for between 10 and 18 p. per km. Those few coaches offering more speed or comfort than the ordinary slow and unsprung Dutch coaches cost over 20 p. per km. It should be noted that included in the trekschuit fares – but not the beurtveer fares – was a provincial tax, the passagiegeld, which, in Holland, amounted to 0.85 p. per km.\textsuperscript{20}

The trekschuit tariffs were rarely changed. On many routes the fares established at their inception continued to be charged at the end of the eighteenth century, and in Friesland and Groningen, in particular, the petrification of tariffs is striking. After the Groningen-Dokkum tariff was raised in 1657, a year after the inauguration of service on this route, no evidence for fare increases has been found until the Leeuwarden-Bolsward route imposed a 10 percent increase in 1792.\textsuperscript{21} In Holland and Utrecht fare adjustments were more frequent. Table 3.9 provides an overview of the changes. The cost of traveling by trekschuit from Amsterdam to Rotterdam via Haarlem, Leiden, and Delft, amounted to 29 st. 12 p. in the 1660s. One and one-half centuries later the cost had risen by 10 percent. The unweighted average of the fares levied on 12 routes for which complete fare information has been assembled shows a somewhat greater increase, of 16 percent. The divergence between the two averages was almost entirely concentrated in the decades after 1770, when fare increases were most frequent.

When these tariffs are compared to other prices as summarized by the cost-of-living index based on Leiden prices compiled by N. W. Posthumus, two facts that will prove of importance later in this study (in chapter IX) come to light. The first is that in the 1660–1690 period trekschuit travel – and travel via other modes as well – became more expensive relative to the prices of the consumer necessities included in the cost-of-living index. Thereafter the trends of the two indices move in the same general upward direction, but by the end of the eighteenth century the more rapid rise of the cost-of-living index had the effect of making trekschuit travel relatively cheaper.

Trekschuit tariffs continued to increase in the nineteenth century. By the eve of the railway age, in the 1830s, they averaged about 7.5 p.
**Table 3.8. Beurtveer fares.**

<table>
<thead>
<tr>
<th>Route</th>
<th>Date</th>
<th>Fare (in stuivers)</th>
<th>Fare per km (in penningen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam–Harlingen</td>
<td>1789</td>
<td>15</td>
<td>2.2</td>
</tr>
<tr>
<td>Amsterdam–Lemmer</td>
<td>1815</td>
<td>18</td>
<td>3.6</td>
</tr>
<tr>
<td>Amsterdam–Staveren</td>
<td>1633</td>
<td>10</td>
<td>2.2</td>
</tr>
<tr>
<td>Enkhuizen–Staveren</td>
<td>1633</td>
<td>6</td>
<td>4.4</td>
</tr>
<tr>
<td>Enkhuizen–Workum</td>
<td>1682</td>
<td>9*</td>
<td>4.2</td>
</tr>
<tr>
<td>Enkhuizen–Lemmer</td>
<td>1806</td>
<td>7.5</td>
<td>3.6</td>
</tr>
<tr>
<td>Enkhuizen–Amsterdam</td>
<td>1630, 156</td>
<td>10*</td>
<td>3.0</td>
</tr>
<tr>
<td>Enkhuizen–Amsterdam</td>
<td>1806</td>
<td>11*</td>
<td>3.3</td>
</tr>
<tr>
<td>Beets–Amsterdam</td>
<td>1658, 1696</td>
<td>6</td>
<td>4.2</td>
</tr>
<tr>
<td>Beverwijk–Amsterdam</td>
<td>1756</td>
<td>10</td>
<td>5.7</td>
</tr>
<tr>
<td>Beverwijk–Alkmaar</td>
<td>17thc.</td>
<td>3</td>
<td>2.2</td>
</tr>
<tr>
<td>Rotterdam–Utrecht</td>
<td>1663</td>
<td>18</td>
<td>5.6</td>
</tr>
<tr>
<td>Rotterdam–Brielle</td>
<td>before 1749</td>
<td>4</td>
<td>2.7</td>
</tr>
<tr>
<td>Rotterdam–Dordrecht</td>
<td>1749–63</td>
<td>6</td>
<td>4.0</td>
</tr>
<tr>
<td>Rotterdam–Dordrecht</td>
<td>1763</td>
<td>8</td>
<td>5.3</td>
</tr>
<tr>
<td>Rotterdam–Middelburg</td>
<td>1721</td>
<td>15</td>
<td>2.4</td>
</tr>
<tr>
<td>Dordrecht–Gorinchem</td>
<td>1721</td>
<td>4</td>
<td>2.9</td>
</tr>
<tr>
<td>Dordrecht–Willemsbad</td>
<td>1755</td>
<td>6</td>
<td>3.7</td>
</tr>
<tr>
<td>Dordrecht–Geertruidenberg</td>
<td>1721</td>
<td>6</td>
<td>3.2</td>
</tr>
<tr>
<td>Dordrecht–Antwerp</td>
<td>1693</td>
<td>18</td>
<td>2.8</td>
</tr>
<tr>
<td>Nijmegen–Zaltbommel</td>
<td>18thc.</td>
<td>10</td>
<td>3.2</td>
</tr>
<tr>
<td>Leeuwarden–Staveren</td>
<td>1636</td>
<td>12</td>
<td>5.6</td>
</tr>
<tr>
<td>Leeuwarden–Grouw</td>
<td>1644, 1740</td>
<td>2</td>
<td>2.3</td>
</tr>
<tr>
<td>Leeuwarden–Warga</td>
<td>1696</td>
<td>1.5</td>
<td>3.4</td>
</tr>
<tr>
<td>Sneek–Grouw</td>
<td>1740</td>
<td>2.5</td>
<td>2.9</td>
</tr>
</tbody>
</table>

* Summer fare.
* Winter fare.

**Table 3.9. Trekschuit tariffs in the Holland–Utrecht region, 1660–1830 (in stuivers and penningen).**

<table>
<thead>
<tr>
<th>Route</th>
<th>1660s</th>
<th>1700s</th>
<th>1740s</th>
<th>1770s</th>
<th>1800s</th>
<th>1830s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam–Rotterdam via</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haarlem, Leiden, Delft</td>
<td>29.12</td>
<td>29.12</td>
<td>30.8</td>
<td>31.8</td>
<td>32.12</td>
<td>39.0</td>
</tr>
<tr>
<td>Index</td>
<td>100</td>
<td>100</td>
<td>103</td>
<td>106</td>
<td>110</td>
<td>131</td>
</tr>
<tr>
<td>Total of 12 routes</td>
<td>113.12</td>
<td>113.12</td>
<td>119.1</td>
<td>121.8</td>
<td>131.0</td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td>100</td>
<td>100</td>
<td>105</td>
<td>107</td>
<td>116</td>
<td></td>
</tr>
</tbody>
</table>
per km, 30 percent more than in the 1660s. Coach fares, however, had risen even more. The more extensive coach network of the early nineteenth century, using somewhat faster and more comfortable vehicles, offered in several respects a different and better service than had the coaches of the seventeenth and eighteenth centuries. Nonetheless, the fares now tended to fall in the 23 to 28 p. per km range, from three to nearly four times the cost of the trekschuit.22

The expense of traveling in the Netherlands was less than in neighboring countries. This was obviously the case when the traveler made use of trekschuiten and sailing vessels. But it was also true for the users of coaches. As we have seen, fares were lowest on those coach routes that complemented the trekvaart network or that competed with sailing vessels (such as Rotterdam-Dordrecht or Haarlem-Alkmaar). But even where such price-depressing competition did not exist, Dutch coach fares seem to have stood a bit below those of neighboring countries. Around 1800 Dutch fares (on only those routes without direct water competition) averaged 19 to 20 p. per km compared to 22 p. in Belgium and a range of 25 to 30 p. per km in England. In the 1830s the English rates were still in this same range, the intense competition of the coaching age keeping fares at their mid-eighteenth-century levels. In France fares were higher than in England – 32 p. per km was a typical rate. In Holland fares had risen to an average of 24 p.23 Since, as we have already observed, Dutch coaches did not win the immediate approval of most foreign visitors, it is not impossible that quality differences can explain all or most of the observed differences in tariff levels. But, for those willing to put up with a coaching system that probably suffered from under-investment, travel expenses in the Netherlands were less than in other countries.

Interestingly enough, the same was not true for the upper class travelers who were accustomed to ‘posting’ – hiring horses to travel in one’s private, or hired, coach. Eighteenth-century travel guides discouraged their readers from posting in the Republic. For travelers from northern Germany a chain of posting stops made it possible to exchange horses periodically all the way to Naarden. But a guide book added, ‘posting costs more in the Republic than elsewhere, since at each post duties and tolls must be paid’. The traveler from France and Belgium found that post horses ceased to be available north of Breda. From there ‘one travels with carriers [coaches] and by water’, although, for those prepared to pay the exorbitant price, it was possible to negotiate the rental of horses to Utrecht.24

Was travel expensive or cheap? This question can, of course, be answered only in a relative way. We have seen that trekschuit travel, which in the seventeenth and eighteenth centuries was only marginally slower than coach travel, cost only one-half to one-third as much. In this context the almost total absence of coaches in the areas served by trekschuiten is not hard to explain. Moreover the relatively inexpensive
waterborne transportation seems to have influenced the rates charged by coaches. We have already noted the low fares charged by coach routes that provided connecting links in the trekvaart network. The same phenomenon can be observed in Belgium, where coach travel assumed a much larger role than it did in the low-lying portions of the Republic. In 1800, Belgian coach fares on routes that faced waterborne competition (such as Antwerp-Brussels, Antwerp-Leuven, and Antwerp-Mechelin) were only twice the then prevailing trekschuit fares, while other coach routes charged at least three times the trekschuit rate.

The final and most telling indication of the relative cheapness of travel in the Dutch Republic is provided at the beginning of this chapter in table 3.4, where estimates of the passenger transportation capacity of the various modes are made. Despite the trekschuit's restricted area of service, its carrying capacity in the late seventeenth century was fully ten times that of the coaches. (A similar comparison for the mid-eighteenth century, when the coach system had expanded further, only reduces the advantage of the trekschuit to nine times coach capacity.) Correspondingly, in areas not well served by waterborne transportation, per capita transport capacity — and presumably per capita travel — was only about one-seventh of what it was elsewhere.

The apparently massive differences in demand faced by these two modes of transportation, with their sharply differing prices, is a telling indication of the sensitivity with which contemporaries reacted to the cost of travel. Apparently, they found the trekschuit to be a ‘bargain’ in comparison to the alternatives and responded by traveling more than they otherwise would have done. This characterization of consumer behavior raises an issue of great importance to the history of the trekvaart industry to which we will return again several times in later chapters.

III.4. WHO TRAVELED ON THE TREKSCHUITEN AND WHY?

Three of the most significant characteristics of the Dutch Republic’s passenger transportation system have now been described: its capacity, its speed, and its cost. The task remains of bringing life to this system by filling its vehicles with people. The questions associated with this task include the following: what sorts of people made use of this capacity and what motivated them to take the time and pay the money to move about the Republic as much as they did? Answers to these questions are of the greatest importance — and most difficult to provide — in the case of the trekschuit passengers. The handful of passengers on the expensive coaches did not weigh heavily in the total Dutch transportation system. Moreover, these travelers were no unique phenomenon; beginning in the mid-seventeenth century coach travel on a roughly similar scale existed all over Europe. It is the trekschuit, with its enormous capacity, that by its
uniqueness presents a challenging problem to historical explanation. We can approach the questions posed above by first asking who did not use the trekschuiten. The people about whose daily lives we are best informed are, needless to say, the very richest and politically most prominent people. We rarely ever read of them traveling by trekschuit. Probably the only public transportation services regularly graced by the presence of members of regent and aristocratic families were the premium-fare postal coaches between Amsterdam and The Hague—whose schedule was geared to the court calendar—and the eighteenth-century coaches that crossed the Veluwe en route to Deventer and Zutphen and that went out of their way to call at Het Loo, the Stadholder’s palace. In general, the very rich had little need to use public transportation: most of them maintained their own private coaches and horses.

The very rich also owned, or had access to, private yachts. One of the perquisites of the high municipal and provincial government offices habitually filled by members of the richest families was access to the stads- and statenjachten. Almost every city and province maintained such vessels—the executive jets of their day—for the official, and needless to add, unofficial travels of their officeholders. The isolation from the public transportation system that these private vehicles afforded the governing class is illustrated by an episode in the administrative history of one of the trekvaarten. In 1744 when disputes among the skippers of the Leiden-Delft trekvaart forced the burgemeesters of Leiden to consider the assumption of a more direct control over the skippers’ affairs, a municipal official advised their high mightinesses against such a step with the following frank observation:

Who among the magistrates travels with the schuiten enough to be capable of establishing the justice of their [the skippers’] requests and complaints? The magistrates, after all, travel either with their own or rented coaches or with Stadsjagten and therefore know very little about the [number of] passengers using the schuiten.26 City regents, high officials of the Staten Generaal and the provincial Staten, and the very wealthiest merchants were highly unlikely to be found sitting in the trekschuiten or even in the postal coaches. How far must one descend the social hierarchy to encounter trekschuit patrons? No firm answer can be given, but the fact that the ownership of more than one horse or of a carriage was only very thinly spread among mid-eighteenth-century households below the very high annual taxable income of f 10,000 indicates that the non-trekschuit users at the upper end of the income scale formed a numerically very small group.27

More important than the handful of people too rich to use the trekschuit were surely those who were too poor. Travel by trekschuit was, as we have seen, far cheaper than travel by coach. Still, the 5 to 6 p. per kilometer fare was no negligible amount. A skilled urban worker, who, when employed, could expect to be paid about 25 stuivers per day would
have had to part with five days’ wages in order to travel with his wife from Amsterdam to Rotterdam and back. When one considers how little of one’s wages in the pre-industrial economy was left as discretionary income after the purchase of necessities, the expense of trekschuit travel is put in a different light from when it is compared to coach fares in foreign countries. It would seem that the fares were sufficiently high to have prevented that great majority of the population that did not even earn 25 stuivers a day, or did not do so on a regular basis, from ever setting foot in a trekschuit. This would seem to be the case, but what happened in fact? Who was too poor to travel by trekschuit?

A point that bears on this question is the availability of cheaper alternatives to the trekschuit. The presumably free alternative to the trekschuit, walking, was not, in fact, always free. The toll barriers that were densely scattered across the Dutch landscape along roads and at bridges and ferries were capable of imposing a considerable financial burden on the pedestrian. For example, the use of the road from Haarlem to Amsterdam cost the pedestrian 2 stuivers while the trekschuit passenger paid 5 stuivers. In the early nineteenth century, when two scions of prominent families spent a summer walking through the entire, then Kingdom of the Netherlands, they often encountered toll barriers. When they got to Friesland one of them, Jacob van Lennep, complained in his diary that ‘the tolls here are numerous and crazy. At some of them pedestrians must pay 12 duiten [1 1/2 stuivers] and therefore prefers to travel by schuit’. Van Lennep’s observations notwithstanding, walking was surely cheaper than taking the trekschuit. But walking was by no means free, and once the costs of extra time away from home and of human energy expenditure are included, the gap, particularly for long trips, may not have been all that large.

The municipal ordinances governing trekvaart operations and the correspondence of the city officials who oversaw those operations reveal some interesting facts about the clientele of the trekschuiten. The poor, those apparently numerous but almost totally unknown people who lived on the margins of settled peasant and urban society in every pre-industrial society in Europe, were no strangers to the trekschuit. Nowhere was the free transportation of the ‘scamelle lui’ flatly forbidden. Rather, the municipal authorities established guidelines to deal with what was obviously a sensitive problem. Official policies may have been formulated at an earlier date, but the first mention of this problem I have been able to find in the trekvaart archives dates from the 1670s. In 1674 the Leiden skippers on the Leiden-Delft route reported that they were heavily burdened by the provision of free transportation to ‘soldiers and other persons without income, since the number of such persons has so increased that it has often been impossible to accommodate them all, which consequently became the cause of many complaints’. In 1688 the same skippers complained that they carried ‘ten sailors [bootgezellen], poor
persons, and soldiers [oorlogsgasten] for every three carried by the Delft skippers. The skippers' complaints leave one no alternative to believing that the free transportation of such persons was insisted upon by the municipal authorities.

These same problems arose on other routes, particularly in Holland, and gave rise to explicit municipal policies governing the transportation of the indigent. In 1685 Haarlem forbade its skippers on the Haarlem-Amsterdam route from transporting beggars to Haarlem. They could, however, take aboard beggars 'who want to go from here [Haarlem] to there [Amsterdam]'. A more reasonable approach was taken nine years later when Haarlem's regulations governing the commissioner of the Haarlem-Amsterdam trekvaart forbade the transport of beggars — in either direction — but empowered the commissioner to 'discretely' permit the free transport of beggars, sailors, and soldiers when conditions made this advisable.

In the eighteenth century the problem of transportation for the poor came increasingly to be handled through charitable subvention. The 1730 regulations governing the Rotterdam-Delft trekvaart required the poor to apply to a Rotterdam charitable institution for a passant-briefje (a letter of passage). When the skippers later returned these coupons to the granting institutions, they were reimbursed for the services they had performed. The Leiden-Delft and Leiden-Utrecht trekvaarten also came to operate in this way, except here the coupons were distributed directly by the city governments.

In the north it became the custom to extend half-fare privileges to the poor, a fare otherwise reserved for children between 4 and 12 years of age. On the Dokkum-Groningen route the commissioner of the trekvaart could on his own authority grant half-fare rights to anyone he deemed to be too poor to pay the full tariff. The 1791 ordinance of the Groningen-Winschoten trekvaart was more specific. It empowered the commissioner to sell half-fare tickets to — and only to — laborers, sailors, servants, and common soldiers who specifically requested this special tariff and who agreed to sit in the frontmost part of the barge. There were, of course, beggars and poor people who could not pay even half-fare. They could be carried only if they had first acquired a briefje from the diaconen (the church deacons). Curiously, Groningen's regulations on this route did permit the skippers to give free passage to poor persons encountered while en route, but only if they were destined for the city of Groningen.

These official measures are interesting for several reasons. The repeated grouping together of sailors and soldiers with beggars tells us something about who 'the poor' were. We see in the instructions to the commissioners an effort to use the trekschuiten as an instrument for maintaining public order; depending on conditions, the barges could be used to get some of het grauw — the rabble — out of town. Finally, and, for our immediate purposes, most importantly, these measures permit us to draw the con-
clusion that trekschuit use extended far down the social hierarchy, down even to the poorest people. It would seem unreasonable to believe that charitable institutions and city governments would have systematically subsidized the use of the trekschuiten by the very poor if the self-supporting poor, one rung higher up the social ladder, did not make use of them. There must certainly have existed large differences in the frequency with which different income groups traveled and the distances they traveled. But apparently the overseers of charitable institutions did not invariably feel it extravagant to pay the costs of a trekschuit fare so that a recipient of charity could avoid having to walk to his destination.

If we now turn our question around and ask who did use the trekschuit, then our answer has to be very nearly everyone. The top one percent or so of income earners had little need to use public transportation of any kind while the much larger group of charity recipients at the other end of the income scale boarded trekschuiten only when the just described regulations permitted. But once these border groups are noted we have to conclude that the trekschuit was a means of transportation in which one could find a cross section of the Republic's population.

We do not have to rely exclusively on our deductive approach in drawing the conclusion that nearly all classes made some use of the trekschuit. Foreign visitors who wrote accounts of their travels through the Republic rarely failed to draw attention to the fact that, as a French traveler put it, 'dans toute la République il n'y a [vait] rien de si républican qu'une barque'. A young French gentleman, Le Cointre, who traveled in the Republic in 1681, likened the trekschuit to 'une espèce d'Arche de Noe, on il y avait des femmes, des filles, des nonces, des matelots, des vivandières, des gens de toute sorte de calibre'.

The operators of the trekschuiten were no less aware of the wide range of social classes to be found aboard their vessels. Correspondingly, the ordinances governing the operation of the barges paid attention to the conduct of not only the skipper and his crew, but of the passengers as well. On the Groningen-Winschoten route a supplement to the ordinance was drafted in 1800 to deal with the maintenance of decorum. This was judged to be necessary, as the preface to the ordinance read, because the trekschuiten 'bring together so many people of contrasting character and morals'.

These trekschuiten played an integral role in the creation of the unique social texture that has since so often been celebrated by historians of the Dutch Republic. As we shall see in greater detail later, every year hundreds of thousands of travelers used the trekschuiten to travel tens of millions of kilometers. In the 1660s and 1670s the trekschuiten alone produced a volume of paid travel sufficient to allow every man, woman, and child in the four provinces served by the trekvaart network to spend some 6 hours in a barge. Besides churches, taverns, and marketplaces, what other public institutions commanded so much of Dutch society's collective
time? These vehicles offered Dutch society not only a unique mobility, but also a unique social 'space'. Assessments of the value and desirability of the trekschuit as a social institution tended to vary. Someone who boarded the trekschuit as much for the social experience as for the transportation service was the mid-eighteenth-century naturalist Le Francq van Berkhey, the author of *Natuurlyke Historie van Holland*. ‘One meets’, he wrote with playful enthusiasm,

Every sort of person, and seldom does one make a trip without falling into pleasant conversation, or listening to someone; whether it be over woman-talk, serious declamation, or farming: everyone has the opportunity to attach himself to someone with his sensibilities to pass the time. Our trekschuiten are, indeed, noteworthy as free places where everyone can, with modesty, freely say his peace. This is why authors who set out to covertly tell of some or another matter, yes, even matters of state, often title their works with the name *schuitenpraatjes* [barge discussions].

Le Francq van Berkhey goes on to warn, however, that people of substance should exercise caution in their discussions. This advice he directed with particular emphasis to men of the cloth, ‘whose imprudent pronouncements sometimes make them the objects of ridicule from an impetuous sailor [dartelen matroos] or a light-headed girl [ligtmis], who here speaks with the freedom of a teacher at the lecturn’.¹¹

These conditions did not appeal to everyone; in fact, they sometimes outraged foreign visitors. The English traveler Joseph Marshall could barely control his disgust after his first trip in a trekschuit:

> What can be expected from a conveyance that carries one at the rate of about a penny a mile; if traveling is very cheap very low, and vulgar people [whom he also describes as ‘people who were born to use their feet’] will travel... But, however, to do justice to these boats, I shall readily allow, that if the fare was sixpence a mile, they would be a most agreeable method of travelling.³²

Marshall was not charmed at having to sit among ‘a dozen Dutch boors who setting at nought the cleanliness of their country, will spit close at your feet, whatever be your rank’. He conceded that ‘men of education, genius, science, and so forth are sometimes poor’. But he preferred not to take chances. ‘Am I to be pesterd’, he asked rhetorically, ‘with the company of half a score of Dutch boors, because it is probable that a man of genius may now and then honor it with his presence’.³³

In fairness to Marshall, it must be added that after two weeks of traveling by trekschuit, he modified his snobbish attitude. He then reported, after traveling to Edam,

I am quite reconciled to this mode of travelling; at first it was disagreeable through a want of custom, and it certainly would be constantly so in England; but among foreigners, it is much better.³⁴

Marshall obviously was not alone in his preference for social segregation,
for we have already observed that during the first half of the eighteenth century many routes introduced new trekschuiten with two classes: the *ruim* for ordinary folk, and the *roe* for those whom Le Francq van Berkhey simply called 'special persons'. The statistical records kept on one route, the Leiden-Haarlem trekvaart, inform us of the number of people traveling in each of the two classes in the late eighteenth and early nineteenth centuries. A quite constant 25 percent of the travelers regarded themselves as sufficiently special to pay the 50 percent higher fare required to take a place in the *roe*.48

The sheer passenger-carrying capacity of the trekschuit system, the enormous discrepancy between the per capita volume of travel in areas served by trekshuiten and areas not so served, and the testimony of contemporaries all offer compelling evidence that the nearly five million guilders invested by the Dutch cities in the construction of the trekvaart network succeeded in creating a true mass transportation system. Nearly every social class made use of the trekshuit.

We have filled the trekshuiten with people – people of every description. This brings us to the final, and most difficult question: for what purposes did all of these people travel? Unless we have some idea of the economic and social functions served by trekshuit transportation it will not prove possible to assess the significance of trends and fluctuations in the demand for this service; neither will the place of this unique innovation in the context of the Dutch economy and society be fully explicable. The fact that ordinary, quite poor, people were willing to part with a sizeable portion of their incomes to make trekshuit trips is evidence enough that the travel motives of trekshuit passengers were compelling. But what were they specifically?

We can, once again, approach this question by first determining those travel functions *not* served by the trekshuit. They did not serve market-bound farmers with goods to sell. For this purpose farmers either used their own boats or wagons, or they used the finely meshed network of market boats. These sailing vessels, with schedules geared to the market dates of the cities they served, offered sufficient space for the farmer's produce. In addition, the skippers of these vessels functioned as deliverers of goods destined for market. They brought them to brokers in the market towns and thus saved the farmers a trip. The trekshuiten offered a very limited baggage space, and the skippers acquired a reputation for ex-torting illegally high fees for the transport of 'excess baggage'.46 Consequently, we can be confident that the trekshuiten were not swarming with chickens and pigs, and laden with baskets of produce. For this function there existed a separate transportation network.

Rural to urban travel in general was not an important function of the trekshuit. A characteristic of the trekvaart network is that nearly all routes linked together cities and were financed and operated by city
governments. The routes passed through villages, of course, but Joseph Marshall’s complaint about having to travel in the company of ‘boors’ notwithstanding, the intercity trekschuiten did not attract a large portion of their customers from their intermediate stops. The market boats and beurtveren served this type of travel. This is confirmed by the detailed records of travel to intermediate points kept on the Amsterdam-Gouda trekvaart. Despite the fact that this is a lengthy route and passes through several large villages, the number of passengers to and from these places was of trivial importance. Thus, in 1681–82, to choose a year at random, 12,663 passengers were carried between Amsterdam and Gouda by the Gouda skippers (the Amsterdam skippers carried a more or less equal number). From Gouda to Goudasluis (Alphen aan den Rijn) 306 were carried, while from Goudasluis to Amsterdam the total was 271. From Gouda to Nieuwveen we find only 72 passengers recorded, while 77 passengers traveled from Nieuwveen to Amsterdam. The records for the intermediate stops should be taken with a grain of salt. While the number of passengers boarding and disembarking at the end points could be – and was supposed to be – checked by the commissioners of the trekvaart, the accuracy of the records for intermediate points depended in large measure on the honesty of the skippers. Failure to record such passengers and failure to turn over the resulting revenue, apparently formed a source of fraudulent income for the skippers. This suspicion is strengthened by the complex duplicate record keeping procedures imposed by several eighteenth-century ordinances in an effort to control this abuse.

Even when the accuracy of these figures is amply discounted, the volume of rural-urban travel using the intercity trekschuiten on the Amsterdam-Gouda route remains extremely small. There is no reason to expect it was any greater on the other routes of the Holland-Utrecht network. In Friesland and Groningen a different situation prevailed. There, rural passengers were important on nearly every route. In the province of Groningen this was obviously true since the only cities besides Groningen itself were little more than large villages. Many of the passengers on the Groningen trekschuiten must have been drawn from the countryside. The relative importance of the rural-urban versus inter-urban traffic can accurately be gauged from the evidence presented about the Groningen-Dokkum route in a complex dispute between the skippers of the two cities about the equitable division of their receipts. Figure 3.1 displays, in line A, the number of passengers who traveled to or from Groningen and all other points on the Groningen-Dokkum route in May, 1658. Line B displays the number of passengers who traveled between all points on this route and Dokkum, its western terminus. For the entire year 1658, complete data are available for the trekvaart passengers leaving Groningen in the direction of Dokkum. In that year 16,300 left this provincial capital, but only 7,300 of these travelers were left in the
FIGURE 3.1. Travel to and from intermediate stops on the Groningen–Dokkum trekvaart, May, 1658.

A + B All passengers boarding or disembarking at either Groningen or Dokkum.
A Passengers boarding or disembarking at Groningen who are in the trekschuiten upon arrival at or departing from each village on the route to Dokkum.
B Passengers boarding or disembarking at Dokkum who are in the trekschuiten upon arrival at or departing from each village on the route to Groningen.

Source: G.A. Groningen, no. 742r, 'Questie met de Stadt Dokkum over de trekweg'.
barges when they arrived in Dokkum. Most of these were, presumably, not actually destined for the small city of Dokkum itself, but continued their trip to Leeuwarden, the capital of Friesland. On this route, connecting the two largest cities of the northern provinces, the majority of passengers boarded or disembarked in villages. But this approach exaggerates the importance of rural-urban travel to the trekvaart. The intercity travelers, despite their small number, accounted, because of the greater length of their trips, for three-quarters of the passenger-kilometers and revenues produced by this trekvaart. If intercity travelers generated 75 percent of the total trekschuit travel in a particularly rural portion of the Republic, it is not hard to accept that they completely dominated trekschuit travel in the highly urbanized Holland-Utrecht region.

For what purposes did the Dutch travel from one city to another in the seventeenth and eighteenth centuries? The cities that invested capital in the trekvaarten and the provincial governments that granted octrooi to permit construction, believed, as was shown in chapter I, that they were stimulating economic life. Not only would existing business travelers using other modes of transportation find the trekschuit a superior, economically advantageous, innovation, but new transport-intensive economic activities would be created while others would change their location in response to the new, cheap, and dependable mode of transportation. (The 1640 petition of the Leiden merchants provides the clearest expression of contemporary belief in the dynamic effects of transport improvement.)

In the early years of the trekvaart era, the business demand for trekschuit transportation could thus be expected to grow faster than population and income would suggest because of the introduction into the production system of an attractive substitute for other factors of production. The regions of the Republic served by trekschuiten now offered unique advantages to economic activities requiring frequent travel and face-to-face contacts. Moreover, such activities, which in the absence of trekschuiten would have had to be concentrated in one large city (to economize on costly, undependable transportation) could now be efficiently located at several points.

All of these expected economic adjustments to the introduction of a new mode of transportation should have gradually increased the business demand for trekschuit service. Unfortunately, it is difficult to give concrete examples of this adjustment process at work. Which sectors of the preindustrial economy were communications intensive? What sorts of occupational groups made particularly intensive use of the trekschuiten? What kind of an economy was it that apparently compelled Amsterdam’s businessmen to leave the comfort of their homes several thousand times per year to board trekschuiten for overnight trips to Leiden (to cite but one example)?

Besides business travel, official travel must have made a substantial
contribution to the aggregate demand for trekschuit service. It is not hard to believe that the decentralized, multiple-layered structure of Dutch government and administration must have been highly transport intensive. A central government in which the legislators were regarded as ambassadorial representatives of their provincial governments rather than as direct representatives generated great demand for communications back and forth between The Hague and the provincial seats, and further, between the provincial seats and the cities in which authority ultimately rested. While the highest dignitaries could expect to travel in the luxury of statenjachten and other official vehicles, there existed many lesser officials who must have used the trekschuiten.

With the structure of government in the confederated Republic we have only begun to identify the sources of official demand for passenger transportation. An impression of the numerous official institutions that contributed to that demand can be gained from a letter written in 1817 by the cities of Hoorn and Enkhuizen addressed to the king of the Netherlands.

In former days [Hoorn and Enkhuizen] were fortunate to possess within their walls various establishments, such as, in the case of Hoorn, the East and West India Companies, the [West Friesian] Admiralty, together with its wharves, the College of Gecommitteerde Raden in Westfriesland en het Noorder quartier [an organ of provincial government], a national arsenal, and (every third year) in conjunction with Enkhuizen and Medemblik, the West Friesian mint. After producing a similar list of institutions formerly established in Enkhuizen, the cities observed that through the existence of these establishments numerous correspondences took place not only between the two just mentioned cities, but also with Amsterdam and the Zuiderquartier [Holland south of the IJ].

Since the purpose of the letter was to request assistance in the maintenance of the paved road connecting the two cities, the removal or destruction of the official institutions during the era of French rule after 1795 provided a convenient justification for royal support. Nonetheless, the fact remains that the scattering of such official organs all over the Republic had generated considerable demand for travel. The division of the Dutch East India Company into five separate chambers obliged the directors and administrators of the company to be prepared to travel constantly in order to deal with the equipage of outbound fleets, the recruiting of crews, the disposition of arriving cargoes, etc.

The intercity passenger travel described thus far was a service input into the Dutch Republic’s economy. The volume of such travel can be regarded as a derived demand that depended on the transport intensiveness of the economic and administrative structure and the level of business activity. We are unable to go beyond this general statement to
identify specifically the most important economic and official generators of this derived demand.

Passenger travel functions not only as an input—an element in the production process; it is also in demand as a consumption good—a final output of the economy. We know this to be true today. But how important could 'leisure travel' have been in a pre-industrial society? It is generally thought that leisure travel for ordinary folk was a creation of the mid-nineteenth century, when industrialization and the railways combined to permit industrious, financially prudent families to make short holiday outings to the seashore and the like. But the reader of diaries and novels of eighteenth-century Dutch life comes often enough across references to what we would call holiday outings. Amsterdammers took the barge to Haarlem to walk in the woods round about the city or to walk through the dunes to the seashore. A stranded whale or shipwreck was sure to attract crowds from the cities—then as now. In 1762 a stranded whale on the beach near Zandvoort attracted such large crowds that an enterprising fellow made prints of the curious scene for sale at the site as souveniers.

A major destination of seventeenth- and eighteenth-century holiday makers was the kermis and the other annual markets. These events lasted for many days and did not lack a practical, economic purpose. But they were also occasions for merry-making, and since each city's kermis fell at a different time, the major kermises were able to attract visitors from other cities. When James Mitchell approached The Hague in a trekschuit he was puzzled to see passing him in the other direction 'a party of the lower orders of both sexes in their holiday clothing, singing and making and entertainment in a trekschuyt on the canal'. Later he passed 'a second party engaged in a similar manner'. The explanation for this curious sight is that the merry-makers were visitors to The Hague kermis traveling back to Delft or Leiden.

The busiest periods on the various trekschuit routes often coincided with the dates of local kermises. The city fathers of Leiden and The Hague anticipated as much in 1638, for they stipulated in the ordinance governing trekschuit service in that first year of operation that no private party could hire a barge (and thus reduce the transport capacity available to the public at large) during the kermises of Leiden or The Hague or during the annual Valkenburg fair and horse market. Through the centuries kermis time remained a period of intense demand for trekschuit transportation, for the 1805 ordinance of the Leiden-The Hague trek­schuiten established a fare for the rental of the roef—the first class com­artment—that was 16 stuivers throughout the year except during the kermis periods of the two cities, when the fare was doubled.

On the Amsterdam-Haarlem trekvaart the introduction of roeven in 1752 was the occasion for new regulations governing both the charter of whole barges and the reservation of the roef for private parties or
individuals. A list of the periods when both of these capacity-reducing forms of travel were forbidden gives an interesting picture of the occasions that generated the greatest demand for travel between these cities. These periods were:

- The Saturday before Pinkster (Whit Sunday)
- The Sunday, Monday, and Tuesday of Pinkster week
- The Saturday before Haarlem Kermis
- The Monday, Tuesday, and Saturday of the first week of Haarlem kermis
- The Sunday, Monday, and Tuesday of the second week of Haarlem kermis
- Hartjesdag, and the Saturday and Sunday before and after Hartjesdag
- The Saturday before Amsterdam kermis
- The Sunday, Monday, and Tuesday of the first week of Amsterdam kermis.
The intensity of the demand for space on the trekshuiten during kermis time can be seen in figure 3.2, where the weekly number of passengers carried by the Leiden skippers on the Leiden-The Hague trekshuiten can be read. The Hague kermis began on the first Sunday in May, and lasted eight days; in that week twice as many passengers were carried than in the surrounding weeks.

The Hague kermis was a bigger event than most kermises, but even so the contribution of a single week of kermis visitors to the total annual volume of trekshuit travel was limited. It can account for only a small portion of the total travel volume. Surely most leisure time travel in this period must have occurred within the context of family life – visits to close relatives. In order to assess the potential importance of this travel motive we would need to have some idea of the average geographical dispersion of families. How likely was a family domiciled in, say, Gouda, to have in-laws, grown children, parents, or uncles and aunts, in say, Rotterdam, Utrecht, or Amsterdam? The degree to which marriage patterns were exogenous and the internal migration patterns of the population could, in this way, have had an impact on the level of demand for trekshuit travel. Various types of evidence support the view that marriage was highly exogenous and mobility rates high, but, once again, we cannot fill in this theoretical discussion with concrete data.56

The cities of the Dutch Republic had the needs of business and official travelers in mind when they set out to build and operate a vast network of trekvaarten, and there is every reason to believe that the trekshuiten played an important role as an input in the Dutch economy. But it appears that the large passenger-carrying capacity of the trekshuiten and the relatively low fares combined with unique characteristics of Dutch society to make leisure travel a second important element in the determination of the aggregate demand for trekshuit travel. However, neither the relative importance of travel as a production good and as a consumption good, nor long-term trends in the relationship between these types of travel is known.
PART TWO

A PRE-INDUSTRIAL BIG BUSINESS?
CHAPTER IV

THE CONSTRUCTION AND OPERATION OF THE TREKVAARTEN

The network of trekvaarten dug in the mid-seventeenth century and the extensive schedule of trekschuiten that plied these waterways for almost two centuries, has been introduced in Part I as a transportation innovation. The technical and geographical characteristics of this innovation have been presented, and an attempt was made to place the innovation in the economic and social context in which it functioned. Here, in Part II, the trekvaart network will be analyzed as a business enterprise. This is of interest for various reasons, not the least of which is the fact that the trekvaart network had some of the characteristics of a 'big business'. It stands out in the context of the pre-industrial economy by its large requirement for fixed capital investment, its need for a large, relatively specialized labor force, its need to supervise and coordinate activities which were spread over a large geographical area, and its production and sale of a service that depended on a mass market. How did a 'capitalist', but 'pre-industrial' society deal with these matters? We will try to answer these questions by studying the organizations used to manage the trekvaart system and by uncovering the economic impact that these organizations had on the Dutch economy during the trekschuit era.

IV.1. CAPITAL INVESTMENT

Once the cities agreed with each other to build a trekvaart, and once they received octrooi from the provincial government empowering them to do so, the business history of these activities can be said to have begun. For then the capital had to be raised, the physical assets created, and organizational forms established to administer the capital and labor that cooperated to provide the end product — transportation service. These first steps were, in every case, taken directly by the municipal governments that had taken the initiative to clear the path of legal and political obstacles. With the reports of the surveyors in hand, municipal officials set about letting contracts for the necessary construction.

How much did it cost to dig and equip a trekvaart? In the case of those canals which were mainly or entirely newly dug, the costs ranged between f 10,000 and f 14,000 per kilometer. The breakdown of these costs is most clearly presented in the construction cost accounts of the Haarlem-Leiden trekvaart. For the approximately fifteen kilometers of this route built by the city of Haarlem, the city treasurer presented the summary displayed in table 4.1.
Table 4.1: Construction expenses of the Haarlem-Leiden trekvaart (Haarlem Accounts), 1657–58.

<table>
<thead>
<tr>
<th>Receipts</th>
<th>gl.st.p.</th>
</tr>
</thead>
<tbody>
<tr>
<td>From the treasury</td>
<td>222,000. - -</td>
</tr>
<tr>
<td>From sale of two parcels of land</td>
<td>39. - -</td>
</tr>
<tr>
<td>From various sources</td>
<td>19,876. 4. 6</td>
</tr>
<tr>
<td><strong>Total receipts</strong></td>
<td><strong>241,915. 4. 6</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expenditures</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor expenses in the dunes</td>
<td>16,118. 0. 8</td>
</tr>
<tr>
<td>Purchase of mills (i.e., pumps) and pumping costs</td>
<td>4,479.14. -</td>
</tr>
<tr>
<td>Transport of sand from the dunes</td>
<td>18,072.16. -</td>
</tr>
<tr>
<td>Transport costs at the digging sites</td>
<td>64,560.17. -</td>
</tr>
<tr>
<td>Cost of lumber and associated labor costs</td>
<td>9,647.11. 8</td>
</tr>
<tr>
<td>Cost of lime and stone</td>
<td>7,591.18. -</td>
</tr>
<tr>
<td>Cost of nails and ironwares</td>
<td>2,218.16. -</td>
</tr>
<tr>
<td>Land acquisition costs for parcels paid for in one installment</td>
<td>15,703.11. -</td>
</tr>
<tr>
<td>Land acquisition costs for parcels exceeding 300 guilders, paid in three installments</td>
<td>40,342. 2.12</td>
</tr>
<tr>
<td>Miscellaneous expenses</td>
<td>17,943.17. -</td>
</tr>
<tr>
<td>Further expenses at the close of the account on 17 June 1658</td>
<td>43,080.11. 4</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>391. - -</td>
</tr>
<tr>
<td><strong>Total expenditures</strong></td>
<td><strong>245,700.15. -</strong></td>
</tr>
</tbody>
</table>

Source: G.A. Haarlem, kast 24, no. 29 (1079).

By far the largest expense was for labor. Approximately £100,000 of Haarlem's expenses are identified as, chiefly, labor expenses. The daily rates paid these workers are not known, but the prevailing rates for such tasks as ditch digging, the loading and unloading of sand, etc. hovered around one guilder (20 stuivers) per day. We can conclude, therefore, that something like 100,000 man-days of labor were needed to build 15 kilometers of new trekvaart. Since construction began on 25 April, and the first trekschuiten sailed on 1 November 1657, it appears that most of this labor was hired in the intervening six month period. In other words, the city of Haarlem set at least 770 laborers to work during the spring and summer of 1657; in those same months Leiden presumably employed a similar number in order to build its half of the trekvaart.1

This large number of workers employed at one time is typical of most trekvaart construction and is the result of the widespread policy of dividing the planned work into numerous small sections. The entire project could be finished with dispatch by accepting the bids of many contractors whose construction teams worked, literally, side by side. This decentralization of the construction project was possible because the tasks were relatively simple, requiring little costly machinery or scarce
skills. It succeeded because there apparently existed an abundance of readily available labor.\(^2\)

The costs of construction materials — lumber, nails, iron, brick, and mortar — were modest in comparison to the labor costs. Land acquisition was the second most important expense, amounting to f 56,000. (These figures very well may be considerably short of the mark since an unitemized f 43,080 was also spent. Haarlem's total costs amounted to f 245,701.)

As was shown in chapter II, land-acquisition costs formed a smaller expense on routes where existing waterways were transformed into trekvaarten than on entirely new routes. But on routes of the latter category such costs were not altogether absent, and their varying importance is one of the reasons why the per kilometer cost of constructing such trekvaarten varied enormously. Most such routes cost between f 2000 and f 6000 per kilometer.

Although the construction costs of all trekvaarten are not known, the existing data — summarized in table 4.2 — are sufficient to make a reliable estimate of the total capital investment and its distribution between the two chief periods of trekvaart construction. In the first wave of construction, stretching from 1628 to 1648, 266 kilometers were built. Since the known routes cost f 970,360 or f 6,027 per kilometer, the whole of the distance probably required about 1.6 million guilders. In the second construction wave of 1656-65, the costs of creating 230 kilometers of trekvaart are known. The f 1,964,000, or f 8,540 per kilometer, is consistent with an estimate of 3.0 million guilders for the total investment in this period. Thus, the entire network represented a fixed capital investment of 4.6 million guilders, most of it committed in a period of ten years.

This figure can be put in perspective when we compare it to other major investments. We know, for instance, that the initial capital invested in the Dutch East India Company, the largest single enterprise of its time, amounted to 6.1 million guilders. The major land reclamation projects of the first half of the seventeenth century provide another point of comparison. The largest such project, the Beemster lake drainage, required an investment of 1.5 million guilders. All the major seventeenth-century North Holland drainage projects together probably absorbed 10 million. These examples of large-scale investment are not perfectly comparable.\(^3\) Nevertheless, when all the differences are noted, the impression is left that the capital invested in the trekvaarten represented a major commitment of resources and imposed on the organization that managed this capital investment rather novel entrepreneurial and administrative tasks. But before going on to consider the organizational form that managed the trekvaarten, we should pause to consider one more important question about the 4.6 million guilder investment: how was the capital raised?

The capital was, in every case, raised by the municipal governments. No private or autonomous agencies raising capital on their own authority
played any role. But the methods used by the cities to raise the capital took several forms. When Amsterdam and Utrecht set out to convert sections of the Vecht to a trekvaart in 1628, Utrecht issued bonds (paying 8% interest) to finance its share. Two years later, when Utrecht sought to improve the river Vecht northward to Hinderdam, it found that bonds could be sold bearing only 5% interest. The Reformed Church of Utrecht bought the bulk of the issue. In 1640 the Friesian city of Harlingen also issued bonds to finance its share of the trekvaart to Leeuwarden. Local citizens purchased some of these 6% interest bonds, but most were bought by residents and the Reformed Church of Molquerque (a seafaring village in southwest Friesland) and residents of Amsterdam and Hoorn.

In 1656 Gouda raised most of its share of the capital for the trekvaart to Amsterdam by issuing lijfrenten, a form of annuity on which interest is paid only during the lifetime of the purchaser. Every year the city paid...
the owner of the *lijfrenten* the ‘twelfth penny’ of the purchase price (i.e. an interest rate of 8.33%). This was double the prevailing interest rate, but gave the city the advantage of never having to worry about repaying the principal, which would be written off with the death of the *lijfrent* purchasers.⁸

This is the only known case of financing trekvaart construction through the sale of *lijfrenten*. Of the ordinary bond issues that other cities relied on to raise the needed capital very few were specified as an obligation of the projected trekvaart itself. The Friesian city of Dokkum sold *trekweg obligaties*, whose promised 5% interest was to be paid from the revenues of the trekvaart.⁷ But far more common was the issuance of ordinary municipal bonds. These were direct obligations of the city treasuries; the financial success of the trekvaart had no bearing on the security of the bonds.

Among the issuers of these municipal bonds we find Gorinchem, which borrowed from a large number of private and institutional lenders at 4% interest, Hoorn, which financed its one-fifth share in the f 794,000 Amsterdam–Hoorn trekvaart with the sale of bonds bearing 3.5% interest, and Alkmaar, which sold 3.5% interest bonds to 40 separate parties, mainly residents of Alkmaar, Hoorn, and Amsterdam.⁸

The coziest financial arrangements were those in which the municipal officials responsible for raising the capital needed to build the trekvaarten were able to persuade their fellow officials, the custodians of municipal charitable institutions, to invest their endowments in very low interest trekvaart bonds. The oligarchic character of Dutch municipal government made it possible that these two functions might have been united in the same individual, or in close relatives. Whatever the precise reason, this probable abuse by the guardians of the endowed charitable institutions was the source of trekvaart capital for a number of smaller cities whose ambitious trekvaart projects exceeded their own financial resources. Both Muiden and Naarden raised their f 70,000 shares of the trekvaart to Amsterdam by borrowing from their *burgerweeshuizen* — citizens’ orphanages. The regents who had custody of the orphanage sold off a large portion of the endowment — consisting of land and bonds — and invested the proceeds in 3.4% trekvaart bonds. Much the same thing occurred in the Friesian city of Sneek, where the regents of the *burgerweeshuis* were persuaded to buy 2% interest bonds.⁹

In the financial records of several of the largest trekvaart projects the income accounts say, only that the capital is a grant from the city treasurer (*thesourier*). Where the city treasuries got the money generally remains unclear. Gouda’s treasury raised the funds to build the paved road to Rotterdam by selling city property and by issuing a bill of exchange on Gouda’s municipal lending bank.¹⁰ It seems likely that current city revenues were drawn upon in the case of several small grants. But how are we to understand the f 222,000 city treasury grant that financed
Haarlem’s share of the Haarlem-Leiden trekvaart, to cite but one example? Presumably these large grants were the product of municipal borrowing, but no interest rate or repayment schedule is ever mentioned in connection with them. This practice raises some questions about seventeenth-century attitudes toward ‘capital’ that will be pursued further in the following chapter.

IV.2. The Management

Once the trekvaart was ready to be put into service, the cities were faced with the need to establish a permanent organization to manage the operation of the new artery on a day-to-day basis. For this purpose the cities appointed commissarissen (commissioners) and it is the often minutial records of these officials, preserved in the municipal archives, which form by far the most important source of data for this study. The commissioners were not high-ranking city officials with vast independent authority. Above them were placed dignitaries, drawn from the ruling families and appointed by the burgemeesters, who gave their approval to the yearly financial statements and, in correspondence with their counterparts in the other participating city or cities, formulated policy and resolved disputes. But it was the commissioners who held the daily operations of the trekvaart in hand, and on whom the Heren relied for most of their information.

The functions of the commissioner, usually outlined in a municipal ordinance, were numerous. He supervised the skippers who operated the trekschuiten, seeing to it that the skippers fulfilled the requirements of the municipal ordinance that governed their activities and enforcing those requirements with the imposition of fines. The commissioner supervised the collection of municipal revenues from the trekvaart. For this he had collectors stationed wherever the users of the canal and towpath were required to pay tolls, while he, himself, usually was stationed at the terminus of the canal where he oversaw the sale of tickets to passengers (and regulated the free transport of the poor) and collected that portion of the fare accruing to the city. In addition he made periodic inspections of the skippers’ barges and horses. Finally he played a role in supervising the repair and maintenance work on the trekvaart, and, together with the bookkeeper, provided the higher officials with periodic financial reports. In return for the performance of these numerous functions, the commissioner was usually provided with a dwelling at the terminus of the canal and was paid a salary, a fee for each departing trekschuit, or a combination of the two.

The municipal organization in which the commissioner played the central role was responsible for the maintenance of the canal and the enforcement of the ordinance that governed both the collection of tolls,
or user-fees, and the trekschuit service. That is, it was responsible for everything except the operation of the trekschuiten themselves. For this there existed a separate organization, a skippers’ guild. At the heart of the commissioner’s job was the maintenance of the fixed capital asset in his custody and the drawing of revenue from the use of that asset. The nature of his work and the measure of his success can best be seen by examining his sources of revenue, his expenditures, and, finally, the profitability of the assets under his care.

IV.3. Revenues

The chief source of revenue on all the trekvaarten was the passenger toll, or *gabelle*, included in the trekschuit fare. For instance, of the 5 stuivers paid by travelers between Amsterdam and Haarlem, the commissioner collected 2 stuivers. The remainder of the fare went to the province of Holland, (which levied a tax, called *passagiegeld*, on all trekschuit travel in the province) and to the skippers. On the Haarlem-Leiden route the fare of 12 st. 10 p. which prevailed until 1741, was composed of a 5 stuiver *gabelle* destined for the commissioner, 1 st. 10 d. *passagiegeld*, and 6 stuivers kept by the skippers. The Leiden-Delft/The Hague routes levied a fare of 7 st. 2 d.: 1 st. 2 d. was *passagiegeld*, 4 st. was kept by the skipper, and 2 st. went to the commissioner. Of this amount 1 st. 8 d. was the *gabelle* proper, while 8 d. was dedicated as a reimbursement to the cities for the cost of the barges used by the skippers.

The commissioners’ records of the receipts of these *gabellen* are what enables us to know the number of passengers traveling on almost all of the trekvaart routes. Luckily, the accuracy of the commissioners’ record keeping not only is important to us, but was important to the cities which had built the trekvaarten as well, for these sums formed the lion’s share of trekvaart revenues. To insure accuracy the burgemeesters typically required the commissioner to be present for the arrival and departure of all barges and to count the passengers, while the skippers were required to deposit their receipts and their own record keeping with the commissioner at the end of every day, or at the latest, the following morning. The hundreds upon hundreds of bundles filled with the scrawled notations of the number of passengers on every barge, every day, every year, for nearly two centuries, that have been preserved most completely in the municipal archives of Leiden, form an imposing monument to the conscientiousness of the commissioners and to the municipal administration’s ingrained distrust of undocumented financial statements.

The second largest revenue source for nearly every trekvaart was formed by other toll receipts. Despite the severe restrictions imposed on the use of some trekvaarten they were rarely used *exclusively* by trekschuiten. Most waterways also saw other vessels such as market-boats, various
freight vessels, and private and pleasure yachts. This was obviously true of trekvaarten whose waterways had existed before the construction of the towpath. To the extent that vessels on such waterways made use of the towpath (and thus did not navigate under sail), they were subject to user fees levied at strategically located toll gates. The towpaths themselves formed an even greater source of toll revenue. These paths not only served the barges on the canals; they served as important roads for every sort of wheeled traffic as well as for people on foot and on horseback. All of this traffic, of course, was required to pay tolls for the right to use the towpath. Whereas the gabelle levied on the trekschuit passengers records the volume of traffic using public transportation, these toll receipts can be regarded as a reflection of the volume of private transportation that flowed along a given route.

We use the word 'reflected' advisedly. Unlike the gabelle on passengers, the towpath toll receipts were an aggregation of several types of traffic, each subject to a different fee. Moreover, the work of the commissioner was frequently lightened by leasing the toll booths to private parties. In the apparent belief that the difficulties of supervising isolated toll collectors invited fraud, many cities simply leased the collection rights, often for several years at a time, to the highest bidder.

The third, and final, source of revenue for the commissioners was of minor importance, but is nevertheless of considerable interest as an indication of the intensity with which all resources were utilized. The value of the fish in the canals, of the grass growing on the towpath embankments, and of the reeds sprouting at the edges of the canal was not allowed to be lost to the cities that owned the trekvaarten. The difficulties of enforcement notwithstanding, the commissioners were instructed to lease the fishing, grazing, and reed-gathering rights. They were further obliged to insure that horses making use of the towpath not graze on the embankment grass. The contributions to total revenue made by these sources of income were trivial, but seventeenth- and eighteenth-century administrators were not prepared to let the value of any of their resources escape as externalities. On at least one route they even felt it worth their while to plant trees along the embankment opposite the towpath so that a once-per-generation harvest might add a bit of revenue to the general accounts. After harvesting their little forest in 1759, the Leiden commissioners of the Leiden-Delft trekvaart invested 272 man-days of labor in the replanting of 3000 poplar trees.

The external diseconomies of the trekvaarten were also turned to account. The digging of the trekvaarten not only introduced new transport arteries, it introduced new barriers as well. But instead of the cities’ compensating the disadvantaged people who now had to find a way across the new obstacle, they levied fees at the bridges and ferries (schouws) that they operated to cater to such traffic.
IV.4. EXPENDITURES

Administration (mainly revenue collection) and trekvaart maintenance formed the two chief categories of expenditure for the commissioners, with the second being by far the more important. Constant attention was required to preserve the canals and towpaths in a usable condition, although, as can be seen in table 4.3, the per-kilometer maintenance costs varied considerably from route to route. If we accept the f353 per kilometer average for the routes listed in table 4.3 as typical for the trekvaart system as a whole, then we can conclude that the annual maintenance and administration costs totaled some f232,000. This expenditure level was surprisingly constant through the period 1660–1800. Only in the second half of the eighteenth century is a slight tendency toward higher costs discernible. Since the capital invested in the trekvaarten came to a system-wide average of f7000 per kilometer, the annual maintenance costs can also be expressed as 5% of the initial construction costs.

How was this money spent? The answer to this question is to be found in the annual accounts of the various trekvaart administrations, where every payment is recorded. In the accounts of the Amsterdam-Haarlem

<table>
<thead>
<tr>
<th>Route</th>
<th>Period for which data are available</th>
<th>Average annual total f.</th>
<th>Expenditures per kilometer f.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam–Haarlem</td>
<td>1685–1800</td>
<td>16,124</td>
<td>849</td>
</tr>
<tr>
<td>Haarlem–Leiden</td>
<td>1680–1745</td>
<td>7,743</td>
<td>267</td>
</tr>
<tr>
<td>Leiden–Leidschendam</td>
<td>1680–1800</td>
<td>4,015</td>
<td>365</td>
</tr>
<tr>
<td>Delft–Maassluis</td>
<td>1645–1665</td>
<td>1,778</td>
<td>118</td>
</tr>
<tr>
<td>Amsterdam–Naarden</td>
<td>1750–1800</td>
<td>6,701</td>
<td>394</td>
</tr>
<tr>
<td>Nieuwersluis–Hinderdam</td>
<td>1635–1665</td>
<td>5,423</td>
<td>387</td>
</tr>
<tr>
<td>Amsterdam–Gouda</td>
<td>1660–1800</td>
<td>7,850</td>
<td>171</td>
</tr>
<tr>
<td>Amsterdam–Hoorn</td>
<td>1680–1790</td>
<td>12,734</td>
<td>227</td>
</tr>
<tr>
<td>Total for 205 km of route</td>
<td></td>
<td>72,368</td>
<td>353</td>
</tr>
</tbody>
</table>

Average annual paved road maintenance expenditures

<table>
<thead>
<tr>
<th>Route</th>
<th>Period for which data are available</th>
<th>Average annual total f.</th>
<th>Expenditures per kilometer f.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gouda–Rotterdam</td>
<td>1680–1800</td>
<td>3,474</td>
<td>165</td>
</tr>
<tr>
<td>Enkhuisen–Hoorn</td>
<td>1707–1743</td>
<td>5,500</td>
<td>289</td>
</tr>
</tbody>
</table>

A trekvaart, to give an example, the expenditures are grouped under eight separate headings. Table 4.4 gives a summary of the Amsterdam commissioner’s payments. Over 20% of the expenditures were devoted to the purchase and transportation of sand and rubble, necessary elements in the maintenance of the embankments. Every year many hundreds of boatloads of sand were dug from the dunes that stretch along the western coast of Holland (where sand-covered land was systematically being reclaimed for cultivation) and brought by boatmen to the desired point along the trekvaart.

Categories 3 and 4, lumber and ironwares, together account for 11% of Amsterdam’s expenditures. The purchases of ironware were strikingly

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<tr>
<td>1685</td>
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<td>2678</td>
<td>845</td>
<td>249</td>
<td>444</td>
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<tr>
<td>1695</td>
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<td>222</td>
<td>247</td>
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<td>1700</td>
<td>1363</td>
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<td>397</td>
<td>240</td>
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<tr>
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<td>2695</td>
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<td>170</td>
<td>482</td>
<td>335</td>
<td>279</td>
<td>1141</td>
<td>6764</td>
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<td>1715</td>
<td>1047</td>
<td>2139</td>
<td>856</td>
<td>184</td>
<td>875</td>
<td>1070</td>
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<td>762</td>
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<td>230</td>
<td>1179</td>
<td>7064</td>
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<tr>
<td>1725</td>
<td>3837</td>
<td>3088</td>
<td>844</td>
<td>227</td>
<td>1117</td>
<td>999</td>
<td>228</td>
<td>1180</td>
<td>11520</td>
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<tr>
<td>1730</td>
<td>3834</td>
<td>3191</td>
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<td>507</td>
<td>484</td>
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<tr>
<td>1735</td>
<td>3060</td>
<td>2703</td>
<td>207</td>
<td>178</td>
<td>509</td>
<td>493</td>
<td>239</td>
<td>1228</td>
<td>8617</td>
</tr>
<tr>
<td>1740</td>
<td>1897</td>
<td>3018</td>
<td>817</td>
<td>117</td>
<td>1135</td>
<td>1016</td>
<td>227</td>
<td>1208</td>
<td>9435</td>
</tr>
<tr>
<td>1745</td>
<td>1638</td>
<td>3385</td>
<td>528</td>
<td>114</td>
<td>1056</td>
<td>773</td>
<td>224</td>
<td>1213</td>
<td>8931</td>
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<tr>
<td>1750</td>
<td>2114</td>
<td>3188</td>
<td>300</td>
<td>106</td>
<td>694</td>
<td>631</td>
<td>224</td>
<td>1214</td>
<td>8471</td>
</tr>
<tr>
<td>1755</td>
<td>1716</td>
<td>2971</td>
<td>300</td>
<td>87</td>
<td>317</td>
<td>310</td>
<td>224</td>
<td>1233</td>
<td>7158</td>
</tr>
<tr>
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<td>3024</td>
<td>3198</td>
<td>593</td>
<td>442</td>
<td>1290</td>
<td>1393</td>
<td>224</td>
<td>1774</td>
<td>11938</td>
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<tr>
<td>1765</td>
<td>34963</td>
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<td>83</td>
<td>190</td>
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<td>224</td>
<td>695</td>
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<td>2732</td>
<td>549</td>
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<td>330</td>
<td>2262</td>
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<td>551</td>
<td>649</td>
<td>240</td>
<td>699</td>
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<tr>
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<td>537</td>
<td>2785</td>
<td>734</td>
<td>106</td>
<td>1864</td>
<td>733</td>
<td>245</td>
<td>709</td>
<td>7713</td>
</tr>
<tr>
<td>1790</td>
<td>1097</td>
<td>2845</td>
<td>743</td>
<td>342</td>
<td>1704</td>
<td>835</td>
<td>252</td>
<td>541</td>
<td>8379</td>
</tr>
<tr>
<td>1795</td>
<td>336</td>
<td>2963</td>
<td>72</td>
<td>206</td>
<td>212</td>
<td>1085</td>
<td>239</td>
<td>566</td>
<td>5681</td>
</tr>
<tr>
<td>1800</td>
<td>168</td>
<td>2882</td>
<td>0</td>
<td>246</td>
<td>0</td>
<td>2432</td>
<td>229</td>
<td>1249</td>
<td>7206</td>
</tr>
</tbody>
</table>

Total* 38956 63068 13529 4746 16309 19975 5283 24981 186847

% 21 34 7 3 9 11 3 13 100

Key
2. Labor costs 5. Carpentry 8. Administration

* The expenditures of 1765 have been excluded from the total and percentage figures.

modest and consisted chiefly of nails. The nails were purchased because of the large need for lumber on the trekvaarten. Not only were the bridges and sluices made of wood, but the banks of most canals were lined along their entire length with wooden retaining walls. This *verschoeijing*, literally shoeing, was essential to prevent the collapse of the embankments and was a major cause of maintenance expense. Working with the lumber were carpenters, and working with the sand and rubble, often waist-deep in water and mud, were the common laborers who maintained the embankments, dredged the canals, and cut away the reeds. Categories 2 and 5 display the wage payments made to these workers.

Category 8, administration costs, is also primarily composed of labor costs, but of a different sort. Here we find the yearly salaries paid to the commissioners, toll collectors, and bookkeepers. To complete this survey of trekvaart expenditure, we can note the provincial land taxes, recorded in category 7, which were no great burden, and the catchall category 6, diverse expenses. Here one often finds not readily identifiable payments which are presumably administrative in character, but maintenance materials not classifiable elsewhere — such as brick — are also recorded here.

To confirm the representativeness of these expenditures we can examine the accounts of other trekvaarten, but comparisons are rendered difficult by the unfortunately unique and often overly general bookkeeping practices of the various trekvaart administrations. The breakdown of expenditures of the five cities that operated the Amsterdam-Hoorn trekvaart and of Leiden’s share of the expenses on the Leiden-Utrecht trekvaart do not appear to contradict the more detailed Amsterdam records. On the basis of these expenditure patterns (see table 4.5) the annual f 232,000 of trekvaart expenditures can be divided as follows:

<table>
<thead>
<tr>
<th>Table 4.5. Distribution of expenditures on three trekvaarten.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Route</strong></td>
</tr>
<tr>
<td>Amsterdam–Hoorn</td>
</tr>
<tr>
<td>Leiden–Utrecht</td>
</tr>
<tr>
<td>Amsterdam–Haarlem</td>
</tr>
</tbody>
</table>

a Included under materials and labor.
b Chiefly expenses listed by other routes under materials and labor and sand.

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Taxes</td>
<td>3-4%</td>
</tr>
<tr>
<td>Sand and Gravel</td>
<td>20</td>
</tr>
<tr>
<td>Materials and labor</td>
<td>60</td>
</tr>
<tr>
<td>Salaries</td>
<td>6-7%</td>
</tr>
<tr>
<td>'Other'</td>
<td>10</td>
</tr>
<tr>
<td>Maintenance</td>
<td>80</td>
</tr>
<tr>
<td>Administrative</td>
<td>16</td>
</tr>
</tbody>
</table>

These expenditures can also be divided another way. About half of the cost of sand and gravel can actually be assigned to shipping charges which were mainly the boatmen’s wages. Labor costs represent two-thirds of the materials and labor category and, of course, the entire administrative salaries category. All told at least 60% of total payments took the form of direct payments to labor.

An essential question to ask of an industry, particularly one interjected into the economy as an innovation, is what are its backward linkages? That is, what impact does its needs for inputs have on the rest of economy. In the case of the trekvaarten we have been able to determine that an initial investment of nearly 5 million guilders elicited a stream of expenditures averaging over 230,000 guilders per year throughout the period 1660-1800. But however innovative the services provided by the trekvaarten were, the same cannot be said for the backward linkage impact of trekvaart expenditures. On the contrary, the most striking characteristic of these expenditures is how little stimulation they gave to the suppliers of what we might call ‘modern’ goods and what little need they had for a labor force with ‘modern’ skills. The construction of the trekvaarten required skilled surveyors and hydraulic engineers, and the more important trekvaarten generated a varied array of administrative tasks that called for what must then have been a high level of middle-management and executive ability. Here is a demand whose satisfactory fulfilment we must later examine. But for the rest, the trekvaarten made use of readily available material inputs and labor skills. Dike maintenance, land reclamation and drainage, harbor dredging, and river navigation improvement—all important activities in the seventeenth- and eighteenth-century Dutch Republic—made much the same kinds of demands on the economy. The construction and maintenance of trekvaarten simply added to this already existing demand for already existing skills and materials.

The trekvaarten imposed few novel demands on the economy, but that does not mean that the annual expenditures were without importance. The maintenance of an extensive, expensive fixed capital plant offered few opportunities for postponement. In contrast to many economic activities before the rise of modern industry, trekvaart maintenance expenditures had to proceed through good times and bad. Administrators who deferred maintenance in bad years to avoid running deficits ran an
enormous risk of making the trekvaart unusable and of facing very high restoration costs. Thus, trekvaart expenditures were quite constant in an economy where the minor role of fixed capital equipment induced a characteristic instability and volatility in the annual levels of investment and employment. Of particular interest in this regard is the employment impact of trekvaart expenditures, 60 percent of which took the form of direct outlays for labor.

Despite the importance of the trekvaart administration’s wage bill, and despite what has been said about the relative steadiness of the flow of trekvaart expenditures, very few people served as permanent employees. On many routes only the commissioner, his toll collectors, and perhaps a bookkeeper were regularly employed. On some of the larger operations we find one or two carpenters and common laborers employed on a year-round basis, but this is exceptional. Street pavers on the paved roads between Enkhuizen and Hoorn and between Gouda and Rotterdam are the only manual workers who regularly enjoyed a monthly or annual salary rather than a daily wage. The common laborers, whose functions were defined as sloghten, buugelen, uitbaggeren, and schoeijen, and the craftsmen, mainly carpenters, ships’ carpenters, and masons, were always paid on the basis of daily wage rates, which could be divided into quarters of days.

The accounts sometimes show that the same workers were repeatedly hired, so that they might be considered to be regular employees of the trekvaart. But their monthly earnings were very irregular, and few names are found in the expenditure accounts for more than a few consecutive years. Thus, two workers named simply Foppe and Jacob worked for the city of Edam almost every month in 1667 and 1668. But the number of days of employment fluctuated between 15 and 24. Their wages, on the other hand, were fixed: 22 st. per day in the summer, 20 st. in November and 16 st. in December and January.14 Canal maintenance on the Amsterdam-Hoorn trekvaart in the vicinity of Buiksloot was regularly performed by successive generations of the same family. Amsterdam’s accounts for 1775 lists the names of the men employed, the wage rates paid, and the number of days they worked. Twenty-seven years later members of the Bosschieter family can still be found in these accounts. Members of this family were regularly available, it is clear, but they were not regularly employed.15 But even this casual use of a small number of regularly available workers does not account for most labor expenditures. The administrators preferred to maintain the trekvaarten in the same way that they were built — by temporarily setting to work a large crew of workers. Neither the threat of temporary labor shortages nor the need or desire to train a labor pool with specific skills was felt strongly enough to induce the trekvaart administration to hire in any but the most casual way.

Since most trekvaart labor was hired by the day rather than on the
basis of long-term contracts, the wage rates paid can be regarded as an accurate reflection of labor market conditions. The subject of wage rates and their evolution over time is, of course, enormous and cannot be treated here in depth. But a few observations can be made on the basis of the hundreds of wage-rate quotations available in the trekvaart financial accounts. Full documentation will have to be made available in another place. In the first place, wage rates between c. 1650 and 1800 were stable in the long run, but occasionally subject to small short-term adjustments. Thus, the salaried commissioner of the Neksluis, a toll collection point on the Leiden-Delft/The Hague trekvaart earned 16 st. per day (except on days when the canal was closed by ice; when he earned 8 st.) from before 1677 (when the first sources are available) to after 1790 (when the documentation ceases). The road maintenance expenditures of the city of Enkhuizen are available for the period 1711–1798. From at least 1711 to 1787 the permanently employed street paver earned f 45.16 per month. (In 1787 his salary was converted to a yearly off 500 – in effect, a nine percent reduction.) Daily wages showed much the same stability. The Leiden commissioner of the Leiden-Delft trekvaart paid journeyman carpenters 29 st. and hod carriers (opperman) 16 st. per day from at least 1680 until at least 1749. Day wages were occasionally adjusted, however. Weesp paid 24 st. per day for beugelen, canal dredging, in 1709 and again in 1745. But the following year the rate fell to 20 st., while in 1751 it rose to 22 st. Likewise, the journeyman ships' carpenters employed by Leiden usually earned 25 st. per day. But, in the course of the eighteenth century the quotations ranged from 24 to 27 st.

One cause of these fluctuations may have been the differing skill levels of workers. The employment policies of the trekvaart administrators show no concern for developing the specific skills needed for trekvaart maintenance, but that does not mean that they treated their work force as an undifferentiated mass. It was not unheard of that the members of a work gang each be paid a different wage. The six workers employed in 1780 to renovate a sluice on the Leiden-Delft/The Hague trekvaart were paid four separate wage rates ranging from 30 to 20 st. When in 1669 Edam hired a labor gang to perform maintenance tasks, two men earned 24 st. per day, most of the others earned 22 st., two earned 18 st., and one 16 st. In 1680 the daily wages of the men employed in the repair of a bridge were 30 st. for the baas, 28, 26, and 22 st. for other undescribed workers, and for Claes de Jonge, an apprentice, 8 st.

Most labor was hired outside the winter months, but such winter wage quotations as exist almost always show, when compared to quotations for the same work performed from March to October, a discount of from 10 to 30%, with 17% as an average. The skilled workers seem to have suffered less of a winter wage reduction than the common laborers, whose productivity probably was more sensitively affected by the short,
cold, and wet winter days than that of the carpenters, bricklayers, and street pavers.23

Finally, the spatial dimension of a transportation enterprise causes regional wage differences to play a role in determining the overall level of expenditures. Wages for the same sort of work varied considerably between Holland-Utrecht and the rest of the country. In the mid-seventeenth century common laborers engaged in trekvaart maintenance earned between 24 and 18 st. in most of Holland (see table 4.6). Around Muiden and Weesp common laborers received 16 st., and in Dordrecht some laborers earned only 15 st. Even less was paid on the trekvaarten in Overijssel and Gelderland. The city of Kampen paid 14 to 12 st., while Arnhem paid a consistent 12 st. per day to day laborers from 1620 until at least 1652.

The observable geographical pattern of wages a century later is rather more motley. Friesian wages were far below those in Holland, and most Groningen wages were at the Friesian level. But within Holland some unexpected but interesting contrasts appear. The Amsterdam commissioners for the Amsterdam-Hoorn trekvaart, who paid craftsmen higher wages than anyone else, paid their common laborers a surprisingly low 18 st. per day. But further to the north in such economically depressed places as Hoorn and Enkhuizen common labor frequently received 22 st.

Curiously, though substantial inter-provincial wage differentials existed, and persisted throughout the seventeenth and eighteenth centuries, rural-urban wage differentials did not. Laborers hired in villages along the canals seem to have been paid wages equal to those prevailing in the cities.

A great deal remains to be known about the labor market in pre-industrial economies. But for the purpose of this study, the conclusions can be drawn that the trekvaart administrations did not face significantly rising, or falling, labor costs in the period 1660-1800 and that trekvaart maintenance, which was labor intensive, was as much as 40 percent cheaper in Friesland, Groningen, and the eastern provinces than in Holland.

It remains to estimate the average annual direct employment generated by trekvaart administration and maintenance. If the average daily wage throughout the system is set at 20 stuivers, or 1 guilder, and the wage bill is estimated at 60% of total average expenditure (7232,000), then the maintenance and administration of the trekvaarten required 139,000 man-days of labor. Assuming 300 work-days per year, the demand for labor can be expressed as 464 man-years. But we have seen that the bulk of trekvaart laborers were employed on a casual basis for short periods, usually outside the winter months. It is not improbable that 800 to 900 workers depended on trekvaart maintenance for the bulk of their annual employment from the mid-seventeenth until well into the nineteenth century. They were, of course, scattered over a large area; trekvaart
Table 4.6. Daily summer wage rates of common outdoor labor (in stuivers).

<table>
<thead>
<tr>
<th>Location</th>
<th>Year Range</th>
<th>Wage Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holland</td>
<td>1641</td>
<td>15 (30% of laborers)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 (70% of laborers)</td>
</tr>
<tr>
<td>Dordrecht</td>
<td>1694–1720</td>
<td>20,18</td>
</tr>
<tr>
<td></td>
<td>1722–37</td>
<td>23,22</td>
</tr>
<tr>
<td>Nieuw Beijerland</td>
<td>1674–77</td>
<td>15</td>
</tr>
<tr>
<td>The Hague</td>
<td>1670–71</td>
<td>1730–59</td>
</tr>
<tr>
<td></td>
<td>1780</td>
<td>22,20</td>
</tr>
<tr>
<td>Delft</td>
<td>1638</td>
<td>22</td>
</tr>
<tr>
<td>Leiden</td>
<td>1637–38</td>
<td>24,26,24</td>
</tr>
<tr>
<td></td>
<td>1639–44</td>
<td>25,24</td>
</tr>
<tr>
<td></td>
<td>1729–30</td>
<td>24,18,20</td>
</tr>
<tr>
<td>Weesp</td>
<td>1690–71</td>
<td>22,20</td>
</tr>
<tr>
<td>Muiden</td>
<td>1750–51</td>
<td>16</td>
</tr>
<tr>
<td>Haarlemmerliede</td>
<td>1674–75</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Buiksloot</td>
<td></td>
<td>1775–812</td>
</tr>
<tr>
<td>Purmerend</td>
<td>1751–55</td>
<td>18</td>
</tr>
<tr>
<td>Edam</td>
<td>1667–69</td>
<td>22</td>
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<tr>
<td></td>
<td>1677–78</td>
<td>24</td>
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<tr>
<td>Hoorn–Alkmaar</td>
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<td></td>
<td>1675–88</td>
<td>20,18,16</td>
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<td>Enkhuizen</td>
<td>1784–97</td>
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<tr>
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<td>1796–97</td>
<td>22</td>
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<tr>
<td></td>
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<td>18</td>
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<tr>
<td>Province</td>
<td>Year Ranges</td>
<td>Notes</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------</td>
<td>-------</td>
</tr>
<tr>
<td>Montfoort (Utrecht)</td>
<td>1793</td>
<td>14</td>
</tr>
<tr>
<td>Sneek (Friesland)</td>
<td>1760–74</td>
<td>14</td>
</tr>
<tr>
<td>Drachten (Friesland)</td>
<td>1773–81</td>
<td>1793</td>
</tr>
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<td>1793</td>
<td>1801–10</td>
</tr>
<tr>
<td>Groningen (Groningen)</td>
<td>1635</td>
<td>1690</td>
</tr>
<tr>
<td>Groningen (Groningen)</td>
<td>1730</td>
<td>1750</td>
</tr>
<tr>
<td>Groningen (Groningen)</td>
<td>1810</td>
<td>14</td>
</tr>
<tr>
<td>Arnhem (Gelderland)</td>
<td>1629–52</td>
<td>16</td>
</tr>
<tr>
<td>Arnhem (Gelderland)</td>
<td>1810</td>
<td>14</td>
</tr>
<tr>
<td>Kampen (Overijssel)</td>
<td>1663–</td>
<td>14</td>
</tr>
<tr>
<td>Kampen (Overijssel)</td>
<td>1780–1800</td>
<td>14–10</td>
</tr>
</tbody>
</table>

Sources: See note 23a.
employment by itself could have had no significant impact on the labor market of any given place.

Once the trekvaart network assumed its ultimate form, in 1665, the various trekvaart administrations saw their task in static terms; the maintenance of the then existing waterway seems to have been the only definition of their mission that was entertained. In the engineering and design specifications for the restoration or replacement of sluices, bridges, embankments, etc. that fill the archives of the trekvaart administrations, there may have been included some improvements or alterations that effectively increased the capital value of the trekvaart. But apart from this possibility there occurred only two acts of further capital investment in the trekvaart network: the paving of the Delft-The Hague towpath in 1692 and the paving of the Amsterdam-Haarlem towpath in 1762–67. This latter project was, for reasons difficult to understand, exceedingly time-consuming and costly: it took five years and cost the two cities £370,000 – far more than the construction of the entire trekvaart (including land purchase) had cost in 1631–32. Interestingly enough the discernible effect of this investment on towpath revenues was very small indeed. (For further analysis of this investment see chapter IX.) With these exceptions the trekvaart administrations settled down to lives of maintenance and essentially static administration once the initial construction has been completed.

Still, one should not underestimate the task of maintenance, for as we have noted earlier, deferral of maintenance for only a short time could have lasting effects on the usability of the trekvaart, and storms and floods could wash away great sections of towpath and silt up long stretches of canal. The preservation of the trekvaarten in a usable condition was no automatic process and could occasionally impose large extraordinary expenditures. The canal dug across the Betuwe to connect Arnhem and Nijmegen became notorious for the maintenance problems with which it confronted its owners. The investment by the two cities of £309,000 in excess of toll receipts to build the canal and maintain it for its first seven years (with Nijmegen contributing three-fourths) did nothing to diminish the costliness of this important transport artery in future years. In 1682 the cities went so far as to issue a new ordinance which required the trekschuit skippers to suspend their work every July in order to assist in the herculean task of keeping the canal navigable. Ultimately, the Province of Gelderland assumed ownership of the costly canal from the two cities, and in the late eighteenth century one no longer reads of continued trekschuit service on this route.24 The Vianen-Gorinchem trekvaart also suffered from high maintenance costs. Insufficient funds compounded by a long-lasting squabble between the two cities over their respective responsibilities caused it frequently to become un-navigable. Finally in 1745 a new beginning was made. The relations between the two cities were put on a peaceful footing, very small barges
were put into service, and a modest service was maintained for the rest of the century.\textsuperscript{25}

Even when the administrators could not be accused of neglect, accidents and floods could wreak havoc with the trekvaarten. In 1702 the rupture of a dike along the Utrecht-Amsterdam route assumed such proportions that the schedule had to be reduced from three to two barges per day while an emergency supplement of 2 stuivers was added to the fare to help defray the repair costs.\textsuperscript{26}

In the north complaints of inadequate maintenance sprang up around the middle of the eighteenth century. In 1755 a resolution of the Workum city government observed that the trekvaart from there to Bolsward, and on to Leeuwarden, had 'for some time (been) so dry as to be almost unusable, to the prejudice of our commerce'. Grants from the cities of Workum and Bolsward plus from the adjacent rural districts permitted the commissioners to proceed with a costly slatting (dredging) of the entire trekvaart.\textsuperscript{27} In Groningen the towpath along the trekvaart to Dokkum was in such a state in 1752 that all horses and vehicles were banned from it except for the postal coaches to Lemmer. That was apparently not the only problem on the Groningen-Dokkum trekvaart, for when Joseph Marshall made use of it in 1768 he complained that the trip 'took us the whole day from interruptions of many sluices some of which were out of order'. The Groningen to Delfzijl trekvaart also posed maintenance problems: the inadequacy of piecemeal efforts to shore up its chronically weak banks led in 1791–92 to a complete renovation, which cost f 162,000.\textsuperscript{28}

The task of trekvaart maintenance did not exactly require dazzling entrepreneurial leadership, but it did require conscientious and diligent attention to detail, and the systematic expenditure of considerable sums of money to prevent the destruction of the value of a costly physical asset.\textsuperscript{29}

IV.5. THE ACCOUNTS

The commissioner and various toll collectors on a trekvaart periodically handed their records and collected revenues over to a bookkeeper (sometimes the commissioner acted as bookkeeper) who prepared the annual rekening, or account. This was then presented to the ranking city officials who, united in a college, held ultimate responsibility for the trekvaart operations. But before the books for a given year could be closed one more step had to be taken. Nearly every trekvaart was in fact built and exploited by from two to five separate cities. They did not form one administration to operate the enterprise. Instead, each appointed officials to oversee and exploit its share. For this purpose the trekvaart route was usually divided into sections, each of which was the responsibility of a single city. Thus, on both the Amsterdam-Haarlem
and Haarlem-Leiden trekvaarten one found a settlement midway along the route called Halfweg, which marked the boundary of each city's responsibility. The Leiden-Utrecht trekvaart, exploited by the three cities of Leiden, Woerden, and Utrecht was divided into three sections. Each city collected tolls and performed maintenance tasks only on its section. But this division of responsibility notwithstanding, the cities had shared equally, or according to some formula, in the capital investment, and they expected to share in the income and expenses of the trekvaart as a whole on the same basis. For this purpose, the trekvaart overseers from each city had to come together to compare and approve each other's accounts, and to unite the separate accounts into one for the purpose of an equitable division of the profits or losses. In addition, this annual meeting became the forum in which financial and policy matters were discussed, disputes settled, and the activities of the separate administrations coordinated. It was also, on most trekvaarten, a festive occasion.

In correspondence of the Leiden-Delft trekvaart, there appears every year an exchange of letters between the two cities to set the date of the annual meeting for which the following, written in 1746, is typical:

Wij verzoeken hier op een lettertje tot rescriptie, ende ingevalle den voorsz. dage urđe Groot Achtb'ouden zoude mogen aggregēren, zullen wij na onder gewoonde de bezorging van de wijn op ons nemen ende die van de spijs urđe gr. Achtb: aan bevolen laten.

We request a little letter of confirmation, concerning the proposed date and in case the above mentioned day suits your high mightinesses we shall, according to old custom, assume responsibility for the provision of the wine and leave to your mightinesses the provision of the food.

The refreshment expenditures for these annual meetings were not a trivial portion of the 'miscellaneous expenditures' of the trekvaart administrations. This was partly because of the large number of people who found a reason to attend. When the three cities responsible for the Leiden-Utrecht trekvaart held their meeting in 1683, the bookkeeper noted the presence of 12 heren (gentlemen of the city governments), and 14 knechts, bodens, en schippers (servants, messengers, and trekschuit skippers). The midday meal provided for this assemblage, which featured turkey as the main dish, cost 46 guilders. The Rhenish and French wines (for the gentlemen) cost an additional 40 guilders, but the beer (for the lesser folk) cost no more than 3 guilders. There were further expenses for the lodgings of these administrators, and, of course, their travel expenses had to be reimbursed. In years when disputes between the cities or among the trekschuit skippers were to be aired and, it was hoped, settled, the number of people present at such a meeting could assume impressive dimensions. When the annual meeting of the Haarlem-Leiden trekvaart assembled (at Halfwegen) in 1729, a clerk took attendance: there were
22 heren, 5 bodens, 4 schippers of the Leiden and Haarlem guilds, 9 knechts and jagers, 2 commissarissen, 14 knechts van de heren (servants of the gentlemen), 4 dienstmeiden (servant girls), 4 commissaris vrouw en kind (wives and children of the commissioners), and 2 stalknechts (stable boys). All together the clerk counted 66 people in attendance. Then he corrected himself, for he had failed to record himself and a second clerk, present to record the reports and decisions of the meeting.

The 1729 meeting of the Haarlem-Leiden trekvaart administrators was a tense, probably unpleasant event, but most of the time the city officials could insure that the agenda was routine, and that nothing would stand in the way of a full enjoyment of the wine and food. The city officials of Amsterdam and Gouda with responsibility for the trekvaart connecting their cities saw to it that the tollhouse at the midpoint of the route was appropriately equipped for the annual meetings. It was their custom to spend the night at this hideaway after consuming a dinner provided by an Amsterdam caterer. The costs of these events regularly exceeded f400 (i.e. in excess of the annual salary of a skilled worker). In fairness to the gluttonous officials, it must be added that they did nothing to hide their self-indulgent expenditures behind euphemistic or misleading descriptions.

The accounts of the Amsterdam-Haarlem trekvaart clearly identify the wine expenditures, which averaged for Amsterdam alone f130 per year, or 1.6% of total expenditures between 1690 and 1795. Presumably Haarlem spent an equal amount on wine. After 1795 we see no more wine expenditures, nor do we find expensive catered dinners in the Amsterdam-Gouda records. The new French-dominated government insisted on reforms – or at least discretion.

The annual account books of many of the trekvaarten have survived intact to this day, permitting one to survey the incomes and expenditures from the inauguration of a trekvaart until the nineteenth century. The extent to which routine and tradition came to dominate the operation of this economic enterprise is the first and most immediate message which a reading of these account books conveys. Five generations separated the commissioners and bookkeepers of 1800 from those of 1650, but every aspect of their work that is reflected in the account books remained unchanged. The formal preambles to the accounts, the categories of income, the categories of expense, the method of reckoning each city's share of the profit or loss remained exactly the same in all trekvaart accounts. The only visible change is a switch from Roman to Arabic numerals, which usually took place by the middle of the seventeenth century.

The reduction of trekvaart administration to routine, which is so clearly expressed in these accounts, was possible not only because of the absence of entrepreneurial initiatives on the part of the cities that owned the trekvaarten, it was also facilitated by the remarkable constancy of the legal and institutional structures of the Dutch Republic. One would expect
in this regard that the fall of the Republic in 1795 and its replacement by a French-dominated Batavian Republic would be reflected in the organization of these records, as account was taken of new taxing policies and new forms of municipal organizations. In fact, most of the accounts proceed on their old footing. As far as the trekvaarten are concerned, no revolution occurs until 1806-07, when the Kingdom of Holland is proclaimed. Then we see new categories, reorganized record keeping, the use of the French language, or no account books at all. The latter was, unfortunately, very frequent. Our ability to follow the affairs of the trekvaarten in the last 40 years of their life as important transport arteries for passengers is sharply reduced by changes in municipal government that seem to take effect when the Dutch provinces are reorganized into the Napoleonic Kingdom and, in 1810, are incorporated into the French Empire.

Although most nineteenth-century records are unavailable, the financial results of several trekvaarten can, nonetheless, be charted uninteruptedly for over 150 years. Moreover, the interpretation of those results is unimpeded by major changes in either financial structure or price level.

What, then, were the financial results of the mid-seventeenth-century investment of 4.6 million guilders in a network of trekvaarten? At this point it will be useful to recall the description given above of the revenues and expenditures of the trekvaart commissioners. The chief revenues on all the trekvaarten took the form of a toll on all trekschuit passengers and a toll on all private transportation making use of the towpath. In short, the revenues depended directly on the volume of travel. The expenditures were dominated by maintenance costs. Such costs could fluctuate considerably in the short run; they could, for instance, shoot upward in a flood year. But they tended in the longer run to be constant. Maintenance could be deferred for more than a year or two only at the risk of letting the trekvaart become unnavigable.

The total surplus or deficit generated as a consequence of the interplay of these two factors is shown for nine routes in table 4.7. These figures are based on the data presented to the annual meetings of the municipal overseers and regarded by them as the financial results of the operation of their trekvaart. We have avoided using the word 'profit' in connection with these data because of a noteworthy, indeed telling, omission in the annual accounts of virtually every trekvaart administration. No capital accounts were kept, no distinctions were made between current expenditures and capital investment, and no interest or amortization payments were included as expenditures of the trekvaarten.

As we have seen, much of the capital invested in the trekvaarten came in the form of grants from the city treasurers. No interest rate was ever mentioned in connection with these grants. But much of the capital was raised – usually via the city treasurers – by the issue of bonds. Yet,
Table 4.7. Surplus of trekvaart revenues over current expenses, expressed as a percentage of invested capital, per ten-year period.

<table>
<thead>
<tr>
<th>Period</th>
<th>Amsterdam− Haarlem</th>
<th>Haarlem− Leiden</th>
<th>Leiden− Leidschendam</th>
<th>Delft− Maassluis</th>
<th>Amsterdam− Naarden</th>
<th>Amsterdam− Gouda</th>
<th>Leiden− Utrecht</th>
<th>Amsterdam− Hoorn</th>
<th>Gouda− Rotterdam</th>
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<tbody>
<tr>
<td>1634−39</td>
<td>6.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1640−49</td>
<td>7.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1650−59</td>
<td>7.9</td>
<td></td>
<td>27.3</td>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1660−69</td>
<td>8.9</td>
<td>5.8</td>
<td>29.8</td>
<td>1.6</td>
<td>4.3</td>
<td>2.9</td>
<td>-0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1670−79</td>
<td>6.8</td>
<td>5.5</td>
<td>30.9</td>
<td>1.7</td>
<td>4.2</td>
<td>2.3</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1680−89</td>
<td>7.4</td>
<td>4.5</td>
<td>26.1</td>
<td></td>
<td>4.9</td>
<td>2.0</td>
<td>0.1</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>1690−99</td>
<td>6.9</td>
<td>3.8</td>
<td>23.8</td>
<td></td>
<td>6.9</td>
<td>1.4</td>
<td>0.0</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>1700−09</td>
<td>5.9</td>
<td>2.9</td>
<td>22.1</td>
<td></td>
<td>5.9</td>
<td>1.7</td>
<td>0.2</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>1710−19</td>
<td>3.4</td>
<td>3.0</td>
<td>17.7</td>
<td></td>
<td>3.3</td>
<td>0.7</td>
<td>-0.1</td>
<td>3.0</td>
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<tr>
<td>1720−29</td>
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<td>14.0</td>
<td></td>
<td>3.1</td>
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<td>-0.2</td>
<td>0.6</td>
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<tr>
<td>1730−39</td>
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<td>2.5</td>
<td>11.2</td>
<td></td>
<td>5.3</td>
<td>0.3</td>
<td>0.0</td>
<td>-0.2</td>
<td></td>
</tr>
<tr>
<td>1740−49</td>
<td>2.3</td>
<td>2.1</td>
<td>8.4</td>
<td></td>
<td>5.4</td>
<td>-0.2</td>
<td>-0.2</td>
<td>2.8</td>
<td></td>
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<tr>
<td>1750−59</td>
<td>2.0</td>
<td>2.2</td>
<td>8.1</td>
<td>1.1</td>
<td>4.3</td>
<td>0.0</td>
<td>-0.4</td>
<td>3.1</td>
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<tr>
<td>1760−69</td>
<td>4.1</td>
<td>1.7</td>
<td>7.7</td>
<td>0.8</td>
<td>3.0</td>
<td>0.3</td>
<td>-0.7</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>1770−79</td>
<td>5.8</td>
<td>2.4</td>
<td>8.0</td>
<td>1.0</td>
<td>3.3</td>
<td>0.1</td>
<td>-0.8</td>
<td>-3.0</td>
<td></td>
</tr>
<tr>
<td>1780−89</td>
<td>4.4</td>
<td>1.7</td>
<td>6.6</td>
<td>0.2</td>
<td>4.5</td>
<td>0.2</td>
<td>-1.4</td>
<td>2.1</td>
<td></td>
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<tr>
<td>1790−99</td>
<td>5.1</td>
<td>2.5</td>
<td>7.6</td>
<td>2.0</td>
<td>4.3</td>
<td>0.4</td>
<td>-1.6</td>
<td>1.6</td>
<td></td>
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</table>

Sources: see table 4.3; also G.A. Utrecht, secretarie archief, no. 1076; G.A. Leiden, Trekvaarten en jaagpaden, no. 279. Leiden−Utrecht rekeningen.
the annual expense of interest payments is included in the accounts of only one trekvaart, the problem-plagued Gorinchem-Vianen route – and there only for the first decade of its operation.\textsuperscript{33}

The available annual surplus data are presented in table 4.7 as a percentage of the initial capital investment. These widely varying rates must be reduced by from three to six percent – the cost of interest payments – in order to arrive at a true profit figure.

Were the trekvaarten a profitable investment? This is a question that the investing municipalities seem never to have asked themselves in so many words. At any rate, they never arranged their extensive statistical information in a form designed to answer this question. Nearly every municipality dealt with its trekvaart enterprises as follows: the annual surplus was entered as income in the general municipal accounts (the \textit{stadsrekening}). The capital costs of the trekvaarten were imbedded in the municipal bond issue; the interest payments on these bonds were expenses in the general municipal accounts. These two specific trekvaart entries were never directly compared. They did not serve as either a signal for further investment in trekvaarten or a warning sign to disinvest. The latter was forced upon some cities only when enormous trekvaart deficits threatened the entire municipal budget with bankruptcy.

This does not mean that the commissioners and municipal officials were oblivious to the financial condition of their trekvaarten. The long-term decline of the surplus that is observable for most routes in table 4.7 did not go undetected by contemporaries, and corrective measures were proposed to improve the financial results. The history of the measures taken to stem this decline forms the focus of chapter VII. For now we can note that the form that these initiatives took was partly dictated by the fact – apparent from the bookkeeping practices – that the trekvaarten were regarded as a kind of municipal utility and not as a business enterprise subject to the rules of profit-maximization.

These municipal administrations in which the commissioners functioned as the central figures were not the only institutions that figure in the operation of the trekvaarten. Their administration of the canals and towpaths stopped short of operating the barges which provided the actual passenger transportation service. On every route this service was governed by municipal ordinances which the commissioners were charged with enforcing. But the business of transporting the passengers (plus mail and parcels) was put in the hands of skippers who were united in guilds which functioned as a sort of business enterprise. It is to these skippers and their guilds that we now turn.
CHAPTER V

THE OPERATION OF THE TREKSCHUITEN

V.1. THE SKIPPERS

The skipper was appointed to his position by the burgemeesters of his city. To be eligible for appointment, the skipper had to be a burger of the city, a status that all but the sons of burgers had to purchase. To become a skipper, one was usually required to swear an oath of loyalty to the municipal government, pay a deposit to guarantee one’s honest conduct, and sometimes, pay a recognition fee to one or other municipal institution. The municipality in the person of the commissioner further bound the skipper to perform his duties in strict accordance with the relevant municipal ordinances, lists of regulations which could be very lengthy. Failure to honor the requirements of the ordinances to the commissioner’s satisfaction subjected the skipper to fines, suspension, and even removal from his post. In return to subjecting himself to all these controls, the skipper was granted a monopoly: he, together with a specific number of other skippers united in a guild, exercised the exclusive right to provide passenger transportation over a specified route.

To gain entry to the guild, the new skipper not only had to satisfy the above mentioned requirements of the municipality but also had to provide his portion of the capital needed to perform the guild’s economic functions. On some routes the skipper had to maintain his own trekschuit, own the horses he needed to pull the barge, and personally hire the helper and jockey who formed his crew. On most routes the assets were held in common by the skippers’ guild. But in either case, once the trekschuit service had begun to function, a new skipper was required to buy the assets, or his share of the guild as a whole, from the widow or heirs of the skipper whose death had made place for the new appointee. Two or more ‘disinterested’ experts were usually consulted to determine the value of the assets to be taken over by the new skipper. On the Amsterdam-Haarlem trekvaart this decision was made by no less than five men: the three overlieden (supervising members) of the guild, an appointee of the widow, and an appointee of the new skipper.

When the Amsterdam-Haarlem trekvaart began its operations each of the 40 appointed skippers (20 in each city) deposited f2000 as his share of the joint capital. Later appointees also bought their shares for f2000 until 1699. In that year the number of skipper’s positions was reduced. This was accomplished through attrition, by not appointing replacements upon the death of a skipper. But what became of the widows and heirs? Since no successor existed to buy the share of the deceased skipper, the guild contracted a loan for the amount that would have
been paid and used it to compensate the survivors. This policy had the effect of increasing the entry price for later appointees. The new skippers after 1699 had to pay £2560 and after 1763, when the number of skippers was once again reduced, the entry price rose further still. Including recognition fees payable to the city government (for the honor of being appointed), the late-eighteenth-century skipper paid £3100. In the 1820s the entry price alone exceeded £3000.\(^3\)

The entry price did not reflect the expected value of the rights and assets to be acquired. Thus, it cannot be compared to the price of taxi medallions in New York City or seats on the New York Stock Exchange. On the contrary, the experts called in to determine the entry price always sought to set it at a level that would cover the replacement cost of the guild’s physical assets (barges, horses, buildings, etc.). But, since the entry price also served as a sort of pension for the widow of the deceased skipper, the total ‘value’ of the guild’s assets could not be reduced when, in the course of the eighteenth century, the number of skippers was reduced through attrition. As we have seen in the case of the Amsterdam-Haarlem trekvaart, the entry price came to represent not only the assets but also the accumulated ‘pension’ debts of the guild. Since this debt rose as the decline of the business forced the reduction of the number of skippers, the curious situation was created where the cost of a skipper’s post rose as its profitability fell.

The skippers were clearly not ordinary laboring men. The capital needed to become a skipper varied from route to route – not all were as costly as the Amsterdam-Haarlem route – but invariably posed a formidable obstacle. We might borrow the label attached to American railway engineers in the nineteenth century and describe the skippers as ‘aristocrats of labor’. Their capital and nearly universal literacy distinguished them from the mass of manual workers, but did not make them ‘capitalists’ either.

The skipper was a curious hybrid of private entrepreneur and municipal functionary. Men with navigational skills and enough capital or credit to buy and hire a crew had the opportunity to function as private skippers, relatively unencumbered by municipal fees and regulations. Those who sought appointment as trekschuit skippers (or beurtveer skipper, where much the same entry procedures obtained) presumably believed that within the context of the conditions laid down by the municipality and the guild they could earn a superior return on their capital (human and physical). Here we must again underscore the all embracing character of the ordinances that governed the conduct of the skippers.

How little discretionary power remained in the hands of the skipper can best be understood if we examine a typical ordinance, one issued in 1654, and remaining in effect until 1730, by the burgemeesters of Delft and Rotterdam to apply to the trekvaart connecting their cities. The required conduct of the skippers is spelled out in no less than 40
articles. The first article refers to an earlier ordinance that stipulated the sort of barges to be used. The second specifies the fare to be charged to adults, children, and infants. There follows a specification of the rates that apply to parties of varying sizes that wish to charter the barges. The trekschuit schedule is spelled out in the following 14 articles. Trekschuiten were to depart from each city every hour on the hour from a specified morning hour that varied with the seasons until 7 p.m. From 1 March until 30 October a final barge departed at 7:30 p.m., and a separate article emphasizes that the last barge must depart, charging no more than the ordinary tariff, even if only one or two passengers present themselves. People wishing to travel between the two cities after the departure of the last barge are accommodated in article 19, that sets the cost of a chartered barge after 7 or 7:30 p.m.

The municipalities strove to ensure that the ‘traveling man’ would never be frustrated by the unavailability of barges, or by full barges. To guard against these inconveniences a series of articles required the skippers at all times to have two barges available, with horses and ropes ready for departure. The first barge was the one scheduled for departure within the hour; the second was a back-up barge, which could be chartered, or which could become the scheduled departure itself if the commissioner ordered the first barge to depart early. This he could do if 20 passengers presented themselves within 30 minutes of the previous departure (art. 25), or if 30 passengers showed up at any time before the scheduled departure. The next scheduled departure had to be observed even if there were only one or two passengers (art. 26).

The ordinance also stipulated three places where the barges could stop en route to board passengers. Several articles threatened fines for excessive delay en route— which seems to have been caused primarily by the tavern at the village of Overschie. The departure of the barges was to be governed by the clock on the city gates next to the docking places, and to enforce prompt arrival at the other end of the route (the distance was to be covered in a maximum of 1 hour and 45 minutes) it was decided in 1673 to install an hourglass in each barge.4

The commissioners were empowered to inspect the barges, horses, and jockeys twice per year and whenever else they felt it necessary. The skippers were required to make any repairs or improvements dictated by the commissioners. The inspection of the jockeys, the riders of the horses, was felt necessary to prevent the employment by the skipper of boys too young and inexperienced. The ordinance stipulated that the jockeys be at least eight years old (art. 28).

The last ten articles regard conduct. Fines and suspension faced the skipper if he was drunk either when he departed or when he arrived at his destination, if he mistreated or abused the passengers, quarrelled with the other skippers and employees, overcharged the passengers, did not personally perform his functions, failed to light the interior of his barge
with candles in the evening, swore, smoked, or permitted passengers to smoke. In the light of contemporaries’ descriptions, which invariably describe the cabin of the trekschuit as filled by a thick cloud of smoke, the ubiquitous prohibitions on smoking found in the ordinances in both the seventeenth and eighteenth centuries are curious. In the ordinance being described here the emphasis was placed on how intolerable tobacco smoke was to female passengers. Because they in particular could not stand it, tobacco smoking was forbidden to everyone, young and old, on penalty of 12 st. to be shared equally by the commissioner and the skipper.

Finally the ordinance forbade ‘women or others not directly concerned’ from attending the daily settlement of accounts between the skippers and the commissioner. Clearly, the skippers were left very little leeway in the operation of their business. The service to be offered, the fares charged, and the behavior of the skippers and his men were either stipulated by the ordinance or left for the commissioner to decide, whose interest in the observance of the ordinances was quickened by the provision that he could pocket most of the fines.

Where decision-making powers were left to the skipper, they had to be carried out in the context of the skippers’ guild. These guilds, with only few and temporary exceptions, required all proceeds to be deposited and all payment to be made from a common fund from which equal distributions were made to each skipper. Whatever superior results a skipper could achieve by his own diligence or economy (likely to be modest, given the all-embracing regulations) were thus sure to be distributed among all his brother skippers.

Given the service requirements laid down by the municipal ordinances it is difficult to see how any other organization of the skippers could have been possible. The requirements to observe the schedule in turns, to depart promptly, and to provide extra departures when demand warranted would surely have generated endless quarrels among the skippers if they each operated for their own account. This logic, which was convincing to the city governments, interested as they were in dispute-free transportation service, was not always convincing to the skippers. Quarrels frequently broke out among the skippers which induced some of them to propose to the magistrates the abolition of the guild’s communal sharing of income and expenditures. Thus, the ordinance governing the Rotterdam-Delft trekvaart, which we have just described, was amended in 1730 to permit the Rotterdam skippers to work on their own account. As independent businessmen the skippers could uphold the requirement to honor the schedule regardless of the number of passengers, and to depart early and more frequently when travel demand was high only by entering into complex negotiations with each other. The skipper whose barge filled up before departure time,
and who was required by the commissioner to set out immediately, had
to compensate directly the reserve skipper who now had to observe the
regular schedule even if he carried but one passenger. Still, their dis­
agreements with and distrust of each other were apparently such that
this cumbersome time-consuming approach seemed preferable to com­
munal operation. On the vast majority of routes, the communal character
of the guilds was maintained; here the guild rather than the individual
skipper was the unit of business enterprise that operated the trekschuiten,
and it is this typical form of organization that will be examined here.

One should not naively assume that the communal character of the
guilds expressed a 'natural' fraternal tendency among seventeenth-
century workers or that cooperation came easily to the guild members.
On the contrary, a great deal of tension existed in the dealings among
the skippers, as the abandonment of communal operations in Rotterdam
demonstrates. Ironically, evidence of this tension is most clearly apparent
to us in the efforts made by municipal officials to impose on the guilds a
mandatory fraternalism. The 1633 ordinance of the skippers' guild of
Staveren stipulated that the brothers hold on each St. Stevensday a jolly
evening (vrolycke avondt) in which they put aside their differences and
drink a ton of beer together (for which they each had to contribute no
more than 30 stuivers). The serious nature of their differences is hinted
at in a later article of the ordinance where we read of the fines that were
to be imposed on any guild brother 'who in anger or with ill will attempts
to harm a fellow brother with a knife or boathook or any other weapon'.

The guild brothers in Bolsward were required by their ordinance to
gather with their wives once per year on Copper Monday. At this
social event they were to 'treat each other with respect and friendship
and without difficulty, fighting, throwing each other into the water,
hurling verbal abuse, nor with the use of any string music (snarenspel) or by carrying a weapon'.

V.2. THE BUSINESS OF THE SKIPPERS' GUILD

The guild as a whole exercised the monopoly right to provide passenger
transportation on a given trekvaart route. Within the context of the
strictly defined rules-of-the-game established by the municipalities, the
guild was free to maximize its profits, which were distributed equally
to the skippers, who, in turn, had each contributed equally to the guild's
capital stock.

The skippers were the only investors in the 'business', and thus the
only recipients of its profit, but they were by no means the only workers
involved in the production of the transportation service. The operation
of a trekschuit required, as was described in chapter II, three men: the
skipper, who navigated the barge from the rudder at the stern; the
helper, who, when the barge was in motion, was stationed forward near the mast, where he handled the line; and the jockey, who rode the horse pulling the barge and announced the barge’s arrival on his horn. The horses, of course, had to be cared for, and for this purpose the skippers owned stables and hired the stable keepers and other laborers needed to feed and maintain the horses. Finally, the barges themselves needed to be maintained and periodically replaced. This too required the skippers’ guild to hire labor, although rarely on a permanent basis. The maintenance of barges and horses, the management of labor, and the keeping of guild accounts usually could not be performed by the skippers collectively. The larger guilds hired or drew from their midsts a business manager called a *vinder*.

If we continue to think of the guild as a business, it consisted of a fixed number of owner-skippers and a larger number of employees, consisting of helpers, jockeys (who were often young boys), and, depending on the size of the guild, a number of stable keepers. Coordinating the guild’s activities as a business enterprise was the *vinder*.

This description of the guild as a business enterprise knew one variation. On several routes there were no helpers. Instead, the number of skippers was doubled, and they alternately acted as skipper one day and helper the next. For example, the Amsterdam guild of skippers serving the Amsterdam-Haarlem route consisted of 20 skippers, no helpers (since the skippers alternately served as helpers), 12 jockeys, and several stable keepers and ship’s carpenters. The guild owned collectively 23 horses, an equal number of barges, a stable, and several parcels of land along the route which were used to feed the horses. The Haarlem guild was of equal size. On the Haarlem-Leiden trekvaart the two guilds each consisted of 6 skippers, 6 helpers, approximately as many jockeys, 12 to 15 horses, and 2 or 3 stable keepers.¹⁰

In guilds where the skippers did not themselves perform the functions of the helper, helpers were usually employed by the guild as a whole rather than by an individual skipper. However, they were employees of an unusual kind. Their number and their pay was often determined not by the skippers’ guild which employed them but by the municipal government in its ordinances.¹⁸ Correspondingly, the helpers formed a sort of miniguind and, just as the skippers, directed themselves to the municipal government for redress of their grievances. Their pay took the form of a fixed payment per trip. Since both the number of helpers and the frequency of trekschuit departures were fixed by municipal ordinance, the average annual income of *knechts* can readily be determined. The *knechts* could try to increase their incomes by asking the city to permit a reduction in their number. Since they could not very well request that one of their number be dismissed from service, their request – and similar requests from the skippers – asked that their number be allowed to ‘die out’ to the desired, smaller number. But, whether because of the strength of
the collegial spirit or because of the long period before such a policy of attrition could have any effect, even this sort of request is infrequently encountered. Instead, the helpers sought the assistance of the city in their struggle with the skippers to maintain the service levels stipulated in the ordinances. The skippers sought to reduce their costs by eliminating lightly patronized runs; for this they needed municipal permission, of course, and when such requests were submitted, a petition from the helpers opposing the request and exposing the bad management or evil intentions of the skippers was sure to follow. On routes where the skippers did not themselves perform the helpers' function, there was no love lost between the skippers and their helpers.

The jockeys who rode the horses rarely appear in the official records. The ordinances did not stipulate their number, and in only one known instance was their pay fixed by ordinance. The maintenance and working of the horses was the only major cost of operation over which the skippers exercised direct control. This situation seems to have exposed the jockeys to the full cost-reducing zeal of the skippers. To economize on labor, boys as young as eight years of age were hired, and their pay was so low that travelers took pity on them. We read in travelers' descriptions that it was customary among the better off passengers to give the jockey a small tip at the end of his relay. The ordinances sometimes take cognizance of this custom, condoning it only so long as the jockeys (and other crew members) do not try to extort tips by making their payment a condition of prompt arrival at the destination.

The skippers, helpers, and jockeys were all 'operating personnel'. To keep them in operation the guild employed maintenance and managerial personnel on both a permanent and temporary basis. Employed year-round we find one or more stable keepers to care for the horses and, in the larger guilds the vinder, who bought and sold horses, bought feed, supervised temporary employees such as the bookkeeper, and contracted with craftsmen and suppliers. The vinder, who might have been drawn from among the skippers, was likely to combine this work with other sources of employment. His pay took the form of commissions on his contracts and per diem payments for business trips to horse markets, etc.

To summarize, the skippers' guilds were regulated monopolies dedicated to the provision of passenger transportation service. They were not simply loose associations of masters; they can be regarded as 'production units', or, if you will, firms, albeit of a peculiar sort. We are therefore justified in asking the kinds of questions of them that we would ask of a modern business enterprise.
V.3. REVENUES

The revenues of the skippers depended primarily on the number of paying passengers carried. Our first task, therefore, is to acquire an idea of the annual volume of passenger travel. In chapter III estimates were made of the passenger-carrying capacity of the trekschuiten, but we can go further than that. The trekvaart archives often yield very exact information on the number of passengers carried per route. On several routes this information is available on an annual, monthly, or sometimes even on a daily basis from the introduction of service in the mid-seventeenth century until the nineteenth century. On others, only shorter series have been preserved. Much of the available annual data is presented in figures 9.1 through 9.6.

The length of the time series and the number of separate series combine to make these data highly unusual and of great value. At different levels of aggregation they can form the basis for answering a wide variety of questions. They are informative about the trekvaart as an industry, about the relations of the numerous Dutch cities with each other, and about the economic and social history of the Dutch nation as a whole. In later chapters attempts will be made to use these data for all of these purposes. Here we will confine our attention to the first, the analysis of the trekvaarten from the perspective of their business history.

We observed earlier that the fares paid by trekschuit passengers were a summation of the provincial tax, the trekvaart toll, and the skippers' fare. The skippers collected the full fare and turned over at the end of each day or week those portions of the receipts destined for the city and province. The skippers' portion, a fixed amount per passenger, then went into the common pot (gemene beurs) of the guild. Thus, the Amsterdam-Haarlem skippers received 3 st. per passenger in the six summer months and 4 st. in the six winter months. The Haarlem-Leiden skippers, on the other hand, kept a constant 6 st. of the 12 st. 10 p. fare. These portions of the fares, multiplied times the number of passengers, form the most important source of revenue for the skippers.

But, there existed three other sources. The skippers supplemented their regular passenger revenues with the revenues from chartered barges. This was usually a very minor source of revenue. A more important source of revenue was provided by the transport (and sometimes delivery) of small parcels and mail. The barges provided very little room for baggage and freight. So limited was this space that passengers with accompanying baggage exceeding that which could be stored under one's seat often faced quite steep extra charges. Nonetheless, the transport of small parcels and mail was sufficiently important to receive separate attention in the ordinances. The goods that were sent by trekshuit rather than with the beurtschippers were those for which speed was of great importance. Short-distance mail (most mail was carried by special
horsebacked couriers) and money transfers were sent by trekschuit as were small parcels requiring prompt delivery. On the Rotterdam-Delft trekvaart oysters and lobster regularly were sent to Delft by trekschuit in the eighteenth century, and the Amsterdam to Utrecht trekschuiten sometimes paused — to the annoyance of the passengers — to deliver exotic commodities from Amsterdam shops to the inhabitants of the country houses that lined the river Vecht.\textsuperscript{12}

The most remarkable parcel business of the trekschuiten involved dirty linens. In the course of the seventeenth century the problem of water pollution in Amsterdam seems to have gotten progressively worse. In the citizens’ efforts to deal with this problem they sometimes made use of the trekvaarten. We have already noted that the Amsterdam brewers depended on the trekvaart to Weesp to secure a suitable fresh water supply for their breweries; specially constructed ‘water barges’ sailed this trekvaart with water from the River Vecht. The inhabitants of Amsterdam also began to use the trekschuiten to have their dirty linens sent to Gouda and Haarlem for cleaning. The Amsterdam-Gouda trekvaart published a detailed tariff regulating the charges applicable on letters, money transfers, and dirty linens (\textit{wasgoed} or \textit{vuile wasch}) and, for the first time in 1703, the Amsterdam-Haarlem trekvaart did the same thing.\textsuperscript{13} Apparently this business assumed a considerable importance, for in 1757 it attracted the attention of the provincial \textit{Staten}. In that year they sought to protect the bleachers of the province from ‘foreign’ competition by forbidding the shipment of dirty linens outside the province.\textsuperscript{14}

The third and most important of the supplementary revenue sources was formed by the sale of space in the first class compartment, the \textit{roef}. As noted above, the division of the barges into two classes was not begun until after the mid-eighteenth century. Contrary to the skippers’ pessimistic expectations that the \textit{roeven} would generate more extra expenses than extra revenue, the supplementary payments levied on \textit{roef} passengers became of great — sometimes crucial — importance to the skippers. The social structure and status concepts of eighteenth-century Holland were such that a large proportion of trekschuit passengers (about 25 percent on the Haarlem-Leiden route) felt themselves obliged to spend an average of 50 percent more than the ordinary fare so that they might take a seat in the \textit{roef}.\textsuperscript{16}

If 25 percent of all passengers used the new \textit{roef} service, for which a 50 percent higher fare is charged, total revenue — all other things remaining equal — would rise by 12.5 percent. But, since this supplement, unlike the basic tariff — was not divided between the skippers and the cities, but was the skippers’ to keep, it had a much larger impact on the skippers’ revenues than appears at first glance. The skippers’ share of the total basic tariff usually stood at about 60 percent. Under these conditions the \textit{roef} supplement, which increased total revenue by 12.5 percent, increased the skippers’ revenue by 20.8 percent.
The total revenue of the skippers can be approximated by multiplying the number of passengers times the skippers’ portion of the total fare (an amount which remained very nearly fixed on most routes until the late eighteenth century) and multiplying the resulting amount by 20 percent (probably less on the Friesian and Groningen routes) once the roeden are introduced. Finally, to complete our calculation of skippers’ revenues, an amount to represent the parcel and mail business of the skippers must be added. Since this revenue source may not have been strictly proportional to the number of passengers carried and may not have followed the same trend over time, the possibility of error is very great. But since this revenue source did not weigh heavily in the total revenues of most routes, it is unlikely that such errors will greatly distort our picture of the skippers’ financial position.

V.4. EXPENDITURES

The skippers’ expenditures were directly related to the production of the service stipulated by the ordinances under which they functioned. Once their production capacity had been set by the municipal ordinances, the skippers set about assembling the resources needed to produce at the required level. The skippers’ costs of production depended on their production function, that is, the relationship between the quantities of inputs used and the maximum output that could be produced per unit of time. This production function, corresponding to the technology described in chapter II above, was characterized by fixed factor proportions. The skippers had virtually no ability to substitute one factor of production for another in the operation of their business. A barge needed a crew of three and a horse. And the maintenance of barges and horses required inputs that increased proportionally with their number. The only exception to this rule was that scale economies could be realized by the larger skippers’ guilds through the more efficient utilization of labor. This was the result of the more frequent schedules on high-volume routes which reduced the waiting time of the skippers.

Figures 5.1 and 5.2 are intended to characterize the production characteristics of trekschuit service. Figure 5.1 indicates the output levels attainable when the inputs (labor and horses) are combined in the fixed proportion indicated by the slopes of rays I and II. When schedule frequency attained a sufficiently high level, the skippers could switch to the production function indicated by ray II. The more frequent schedules allowed the crews to complete more trips per day. This had the effect of rendering labor more productive by the utilization of more horses and barges per crew. Figure 5.2 displays the output attainable as successively larger inputs of labor were utilized. Within the fixed technology available to the skippers, they could combine their factors of
production only in fixed proportions. But above a certain schedule frequency it became possible for the skippers to achieve higher labor productivity. Their new production function continued to be one of fixed factor proportions, but the proportions were different; the movement from ray I to ray II increased the marginal productivity of labor.

How much labor, capital, and other inputs were actually needed? Table 5.1 gives an overview of the available information. On this basis we can make estimates of the total inputs required for the entire network to function at its late seventeenth-century capacity. These are recorded on the bottom line of the table. The high-capacity routes stretching from Amsterdam to Rotterdam via Haarlem, Leiden, and Delft are separated from the others in table 5.1 in order to confirm the difference in factor proportions between these and the remaining routes that was sketched out in figures 5.1 and 5.2.

The skippers' guilds also employed besides the operating personnel mentioned in table 5.1 labor to maintain the horses and the barges. The two guilds operating the Haarlem-Leiden trekvaarten each hired three stable keepers. In addition, each of these guilds paid smiths and saddlemakers an average of £350 to £400 per year. Such a sum probably represented a total of about one man-year of labor. Ignoring the labor hired in the course of maintaining the barges, we can conservatively estimate the 'maintenance' labor force required by the Haarlem-Leiden trekvaart at eight full-time employees, four for each guild. On the Amsterdam-
**Table 5.1.** Labor and physical assets employed in the production of trekschuit service.

<table>
<thead>
<tr>
<th>Route number*</th>
<th>Barge-km scheduled per day</th>
<th>Number of three-man crews</th>
<th>Number of horses</th>
<th>Number of barges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>608</td>
<td>20</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>2</td>
<td>522</td>
<td>14</td>
<td>24–30</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>702</td>
<td>18</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>486</td>
<td>18</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>480</td>
<td>20</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>180</td>
<td>12</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>252</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>8</td>
<td>140</td>
<td>6</td>
<td></td>
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<tr>
<td>9</td>
<td>276</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>348</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>122</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>70</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>13</td>
<td>342</td>
<td>12</td>
<td></td>
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<td>14</td>
<td>220</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>138</td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>16–20</td>
<td>912</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>21</td>
<td>192</td>
<td>10</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>112</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>208</td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>216</td>
<td>10</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>25</td>
<td>88</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>176</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27–28</td>
<td>460</td>
<td>24</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>29–31</td>
<td>280</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>366</td>
<td>15</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>33</td>
<td>52</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>240</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>117</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>68</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

**Daily barge-kilometers per:**

<table>
<thead>
<tr>
<th></th>
<th>crew</th>
<th>horse</th>
<th>barge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–5</td>
<td>2798</td>
<td>31.1</td>
<td>15.0</td>
</tr>
<tr>
<td>6–37</td>
<td>5531</td>
<td>21.2</td>
<td>17.5</td>
</tr>
<tr>
<td>total</td>
<td>8329</td>
<td>24.0</td>
<td>16.3</td>
</tr>
</tbody>
</table>

**Estimated total numbers of:**

<table>
<thead>
<tr>
<th></th>
<th>crews</th>
<th>horses</th>
<th>barges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–5</td>
<td>88</td>
<td>188</td>
<td>135</td>
</tr>
<tr>
<td>6–37</td>
<td>261</td>
<td>316</td>
<td>229</td>
</tr>
<tr>
<td>total</td>
<td>349</td>
<td>504</td>
<td>364</td>
</tr>
</tbody>
</table>

* For the identification of route numbers, see Appendix.
dam-Haarlem route the Haarlem guild reported in 1751 the full-time employment of six men in the maintenance of their 23 to 24 horses. Thus, the guild operating the trekschuiten to Leiden employed one man for each 3.75 horses while the guild operating the trekschuiten to Amsterdam employed one per 3.8 to 4.0 horses. If the higher rate holds for all routes and maintenance employment can be set at 128. All together, then, the late seventeenth-century trekvaart system probably gave full-time employment to 349 skippers, 349 helpers, 349 jockeys, and to the equivalent of 128 maintenance workers.

With this knowledge of the labor and physical assets needed to operate the trekschuit system, we can proceed to estimate the expenses incurred by the skippers in the exploitation of their business. Among the expenses, labor costs took a prominent place, and we shall begin there. The jockeys were usually boys, and their pay was very low. Only one source, the ordinances of the Haarlem-Leiden trekvaart, specifies the pay of the jockeys: 10 st. per round trip. Since each jockey could hope to make no more than 230 round trips per year on this relatively long route, the annual wage income of a jockey could not have exceeded 115 guilders.

Both the skippers and helpers were paid in the form of a fixed sum per trip. As a consequence, the bulk of all labor costs was a direct function of the number of trips made. The pay received by the helpers on several routes in South Holland is summarized in table 5.2. With the exception of the Leiden-The Hague helpers, whose pay was raised to conform with that of their close comrades on the Leiden-Delft route, these pay rates seem to have remained fixed throughout the seventeenth and eighteenth centuries.

The skippers drew a per-trip wage in addition to receiving the profit of the guild enterprise. Table 5.2 displays examples of their pay for each completed round trip. Clearly, if these skippers received no guild profits to supplement their wages, their incomes could not always be distinguished from those of their helpers.

On one other trekvaart, the Amsterdam-Haarlem route, we do not know the per-trip payments made to each of the crew members, but do know the total sum which was divided among the three (skipper, helper and jockey). In the summer months they divided 37 stuivers per round trip (38 km); in the winter months that amount was raised by 2 stuivers. In total the labor costs on this busy route amounted to 0.97 to 1.03 st. per barge-kilometer. On the Haarlem-Leiden route, the total labor expense also came to 1.03 st. per barge-kilometer, while on the Leiden-Utrecht and Leiden-Delft routes these expenses (in these cases excluding the jockeys' payments) came to 0.86 (.95 in winter) and 1.19 st. per barge-kilometer, respectively. Total labor costs on the major routes were not exactly the same, but were not so different as to have caused the operating costs of the various routes to diverge significantly one from another.
TABLE 5.2. Skippers' and helpers' (knechts) pay on six South Holland trekvaarten.

<table>
<thead>
<tr>
<th>Route</th>
<th>Year or period</th>
<th>Pay per round-trip</th>
<th>Stuivers per km</th>
<th>Approximate annual income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leiden-Delft</td>
<td>1674-1805</td>
<td>20 st.</td>
<td>.48</td>
<td>£300</td>
</tr>
<tr>
<td>Leiden-The Hague</td>
<td>1674-1679</td>
<td>16</td>
<td>.44</td>
<td></td>
</tr>
<tr>
<td>Leiden-The Hague</td>
<td>1745-1805</td>
<td>20</td>
<td>.56</td>
<td></td>
</tr>
<tr>
<td>Leiden-Haarlem</td>
<td>1657-1800</td>
<td>20</td>
<td>.35</td>
<td>£230</td>
</tr>
<tr>
<td>Leiden-Utrecht</td>
<td>1687</td>
<td>60 (summer)</td>
<td>.52</td>
<td>£255</td>
</tr>
<tr>
<td>Leiden-Utrecht</td>
<td>1687</td>
<td>50 (winter)</td>
<td>.48</td>
<td></td>
</tr>
<tr>
<td>Delft-Rotterdam</td>
<td>1757</td>
<td>16</td>
<td>.43</td>
<td></td>
</tr>
<tr>
<td>Gorinchem-Vianen</td>
<td>1664</td>
<td>20</td>
<td>.43</td>
<td></td>
</tr>
</tbody>
</table>

Skippers' pay

<table>
<thead>
<tr>
<th>Route</th>
<th>Year or period</th>
<th>Pay per round-trip</th>
<th>Stuivers per km</th>
<th>Approximate annual income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leiden-Delft</td>
<td>1674-1805</td>
<td>30 st.</td>
<td>.71</td>
<td>£450</td>
</tr>
<tr>
<td>Leiden-The Hague</td>
<td>1674-1805</td>
<td>30</td>
<td>.83</td>
<td></td>
</tr>
<tr>
<td>Leiden-Haarlem</td>
<td>1657-1800</td>
<td>30</td>
<td>.52</td>
<td>£345</td>
</tr>
<tr>
<td>Leiden-Utrecht</td>
<td>1687</td>
<td>50</td>
<td>.43</td>
<td>£225</td>
</tr>
<tr>
<td>Gorinchem-Vianen</td>
<td>1664</td>
<td>25</td>
<td>.65</td>
<td></td>
</tr>
</tbody>
</table>

Sources: G.A. Leiden, Trekvaarten en jaagpaden, no. 1, Leiden-Delft / The Hague register, 6 September 1674; 'Ordonnantie op het schuitenveer', 1805; no. 70, losse stukken, c.1745; no. 242; G.A. Haarlem, kast 24, no. 45 (1097), 'Rekening... die de vinders en schippers van de trekschuyten van Haarlem op Leiden...'; G.A. Delft, 1e afdeling, no. 1060, 'Memorie van de schippers op de Rotterdamse jaagschuyten tot redres van het veer', 1757; G.A. Gorinchem, O.A., no. 2178.

The labor costs of the non-operating personnel remain to be considered. The permanently employed stable keepers on the Haarlem-Leiden route earned £22 per month (£264 per year) in 1723-30, and £26 per month (£308 per year) in 1759. In 1780, when the records are once again available, the Haarlem skippers paid one stable keeper £22 and another £20 per month. These salaries remained unchanged through 1818, the last year for which records are available.20 On the Amsterdam-Haarlem route stable keepers received £26 per month plus a rent-free dwelling and reimbursement for their lighting expenses.21 Little is known about the labor costs of the craftsmen engaged temporarily to shoe horses, repair saddles and ropes, etc., except that the yearly totals of these fees paid by the Haarlem skippers on the Haarlem-Leiden route were relatively stable. These maintenance costs were not a direct function of the number of trips made by the skipper. But, since the wage costs showed such little change in the course of the seventeenth and eighteenth centuries, these costs assumed the character of a fixed charge whose size varied with the number of horses owned by the guild.

This brings us to the other major category of expense for the skippers' guild: horsepower. This category of expenses — which takes the place of the energy costs of a modern mode of transportation — was of key im-
portance to the skippers' guilds. Not only did it account for at least half of their total costs, it was the only major cost over which they exercised real control. In the maintenance and utilization of their horses the guilds performed an independent managerial function. For this purpose the skippers hired the just discussed stable keepers while the larger guilds hired, in addition, the vinder.

A horse was a costly capital good. The annual ownership and maintenance costs of a horse suitable for work on the trekvaart equaled the cost of a man-year of labor. This fact and other aspects of horsepower expenses can be followed in unusual detail thanks to the partial preservation of the bookkeeping records of the skippers' guilds on the Haarlem-Leiden trekvaart. Table 5.3 specifies the horsepower expenses of the Leiden skippers for 1723–30 and the Haarlem skippers for 1759 and 1780–1818.

The largest single expense was for horse feed. The 12 horses maintained by the Haarlem skippers after 1780 were each fed about 2 lasts of oats and \( \frac{1}{2} \) last of beans per year.22 In addition, the horses received unspecified quantities of hay and straw. The costs of this relatively constant volume of feed showed pronounced fluctuations and a tendency to rise in the late eighteenth century. The costs of oats, beans, hay, and straw did not exhaust the horse-feeding expenses of the skippers. They also rented pastures and meadows, the costs of which are listed under column 4.

The next most important expense, which was also capable of sharp yearly fluctuation, was the purchase of horses. In order to maintain a stable of 12 horses, the skippers were obliged to replace an average of 4.3 per year. In this number I have excluded 'trade ins', the sale of older, but not yet valueless horses for new ones. Thus the true 'depreciation rate' of towpath horses was considerably in excess of 33% per year. It is not certain that the standards maintained on this route applied everywhere. The skippers on the Friesian route connecting Bolsward and Leeuwarden expressed the opinion in 1757 that a horse needed to be replaced only after six years of service – twice as long as the Haarlem-Leiden horses were kept in use.23

Not only did the number of horses purchased each year vary (delay in replacing horses seems to have been a favorite means of economizing in years of low revenue), but so did the prices paid for the horses. Figure 5.3 shows the prices paid by the vinders of the Haarlem skippers. Presumably the intra-year differences in the price of horses reflect the differing ages and qualities of the beasts. Despite the wide dispersions of price quotations, a clear cyclical pattern is evident. The mid-1790s and the mid-1810s, both periods of high military demand for horses, saw prices reach very high levels.

The remaining horse-related expenses – the stable keepers’ salaries, land taxes, the services of saddlemakers and smiths – were quite stable from year to year.

To calculate the total expense incurred by the Haarlem and Leiden
### Table 5.3. Annual horsepower expenditures of the Haarlem and Leiden skippers' guilds, 1721–1818 (in guilders).

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Key:
1. Stable keepers' expenses.
2. Saddlemakers and smiths.
3. Purchase of horses (and taxes on horses).
4. Rental of stables and land.
5. Oats and beans.
6. Hay and straw.
7. Direct taxes.
8. Income from horses.
9. Net expenditures (the sum of 1. through 7. minus 8.).

**Figure 5.3.** Purchase prices of horses acquired by the Haarlem skippers' guild of the Haarlem–Leiden trekvaart, 1780–1818.

Source: G.A. Haarlem, kaart 24, no. 45 (1097).
skippers in maintaining a stable of 12 horses, we must deduct certain revenues that accrued to them in the course of the year. The sale of horses retired from trek schuit service (the prices were always a small fraction of the cost of a new horse), the sale of horse manure, the sublease of a portion of the skippers’ pasture and meadow land, and finally, the income derived from the use of the horses in pulling other vessels all together added up to a tidy sum. The true cost of the horsepower is, thus, the net cost, and since the annual number of trips made is known, this cost can be expressed as a cost per barge-kilometer.

In the 1720s the horsepower costs, with the wages of the stable keepers and the jockeys included, came to 1.36 st. per barge-kilometer. Was this expense typical for the other trekvaart routes? In 1745 Leiden skippers on the route to The Hague presented a summary of their costs in which the horsepower-related expenses made up just over half. Expressed as a cost per barge-kilometer, it was almost exactly the same as on the Leiden-Haarlem route: 1.42 st. In 1757 the Delft skippers to Rotterdam presented a summary of their operating costs to the city government. The costs, expressed as an average cost per round-trip, were provided in a summary form that does not inspire complete confidence, but the cost of horse and jockey was put at 30 st. or 1.00 st. per barge-kilometer. More than a century earlier, in 1628, the horsepower costs on the Amsterdam-Utrecht route also amounted to exactly 1.00 st. per barge-kilometer. The city officials who organized this trekvaart divided it into three sections and had stables built at the two relay points, Nieuwersluis and Voetangel. The jockeys were then empowered to charge the skippers a total of 46 st. for pulling a trekschuit over the 46 km. route. The considerable rise of both grain and horse prices in the decades immediately following 1628 forces increases in these charges. It is not known when the charges were increased, but in 1744 the cost stood at 60 st., or 1.30 st. per barge-km. Finally, on the Gorinchem-Vianen trekvaart, the cost of horse and jockey came to 25 st. per trip in 1664, or 1.09 st. per barge-km.

In the northern provinces horsepower costs appear to have been lower than in Holland and Utrecht. The Bolsward skippers to Leeuwarden reckoned their total annual costs for the maintenance of eight horses at £1,400 in 1783. These horses were used less intensively than those in Holland, which may explain why the skippers set their useful life at six years. The cost of horses was also significantly less. The horsepower cost per barge-kilometer came to 0.8 st. Once the wages of the jockey are added, the cost probably approached 1.00 st. per barge-kilometer.

The estimates of horsepower costs range from 1.0 st. to just over 1.4 st. per barge-kilometer. It does not therefore seem unreasonable to accept the most detailed records describing horsepower costs, those of the Haarlem-Leiden trekvaart, as representative for the Holland-Utrecht network. These records show horsepower costs to have fluctuated around
1.4 st. in the 1720s, 1759, and the 1780s. But they go on to record a sharp inflation in energy costs after the 1780s. By 1815 they had reached 1.9 st. per barge-kilometer.

The total cost of supplying the trekschuiten with a source of power can be reckoned on the basis of a fact presented in table 5.1. There we find that the horses were run an average of 16.3 kilometers per day. At an average cost of 1.4 st. per kilometer, each horse cost 416 guilders per year (1.4/20 x 16.3 x 365). After subtracting an amount to represent the jockeys’ wages from that amount, it seems reasonable to set the average annual maintenance costs per horse, in the mid-eighteenth century, at about 300 guilders — equal to the annual earnings of a fully-employed laborer. The estimated 504 horses used by all the trekschuit skippers would then have accounted for over f150,000 in annual expense. This cost rose in the second half of the eighteenth century (to f250,000 in 1815) and was probably also higher in the mid-seventeenth century as well.

Another skippers’ expense, but of much less importance than labor and horsepower, was the construction and maintenance of the estimated 364 barges used to carry the passengers. Considerable ambiguity adheres to the actual cost of a new trekschuit. Two documents dating from the first years of the trekvaarten speak of new barges each costing about f500. But it could be that this sum excludes the relatively costly fittings and interior furnishings, for when the skippers complained of the costs of remodelling their barges to include roeven much larger sums were mentioned. Moreover, the value attached to trekschuiten on the Amsterdam-Haarlem route in the early nineteenth century varied from f1400 to f2000. If we take f1000 as an (uncertain) average cost, then it follows that the trekschuit fleet represented an investment of some f364,000. If we accept the statement in an official report that the barges were replaced every 20 years, then the annual replacement cost can be reckoned at 18,200 (1/20 of the f364,000 acquisition cost of 364 barges). To that sum one must add maintenance costs that might double or triple that sum. But even under the most extreme assumptions, these costs are very small in relation to labor and horsepower costs.

These labor, horsepower, and trekschuit costs together form the bulk of the variable costs — the costs that are directly related to the transportation capacity made available by the skippers. The other expenses — fees paid to the bookkeeper, the commissioner, the vinder — assume the nature of overhead expenses. While they were not utterly fixed, they were at any rate not particularly sensitive to the size of the skippers’ operations.

What were the skippers’ total costs in operating the trekschuiten? The estimates of total costs presented by several skippers’ guilds in mid-eighteenth-century petitions for financial relief are the first source which we must consider. While their purpose makes these estimates suspect, their mutual consistency gives us reason to trust them. On the Leiden-The Hague route, the Leiden skippers estimated the cost of operating one
roundtrip per day for an entire year at f 1712, or 2.4 st. per barge-kilometer. Ten years later the Delft skippers to Rotterdam estimated the component costs differently, but ended up with a figure that is equivalent to 2.3 st. per barge-kilometer. On the Gorinchem-Vianen route, the Gorinchem officials reckoned the costs (excluding depreciation of the barge and fees) at 2.2 st. per barge-km. In Friesland, the Bolsward skippers to Leeuwarden asserted that their total costs in 1757 had been f 2200, excluding their own wages. This sum is equivalent to 1.3 st. per barge-kilometer. If we set the incomes of the eight skippers at the f 250 per year that the skippers themselves held to be reasonable in another portion of their correspondence with the municipal government, then the total per barge-kilometer cost rises to 2.3 st.

Finally we have the detailed records of the skippers on the Leiden-Haarlem trekvaart. Because these records consist of the skippers' own bookkeeping rather than figures presented as part of requests for subsidies or fare increases, we can consider them to be trustworthy. And here too we find the average per barge-kilometer cost of operation in 1723–30 to be 2.4 st.

On the basis of these remarkably consistent estimates, we can confidently conclude that the average cost of providing trekschuit service in the early and mid-eighteenth century stood very close to 2.4 st. per barge-kilometer. In addition we can accept the records of the Leiden-Haarlem skippers as representative for the system as a whole. Because the complete records of the Leiden skippers are available for the period 1723–30 and those of the Haarlem skippers are available for the period 1780–1818, we can study the course of trekschuit operating costs on an annual basis.

Figure 5.4 shows the skippers' guilds' annual expenses grouped into three categories: horsepower, labor, and overhead and maintenance. Immediately apparent is the short-term fluctuations that occur despite the stability of the capacity offered by the skippers' guild. Also apparent is the source of these fluctuations — horsepower costs. The role of horsepower costs is even more apparent in figure 5.5, where the two major categories of trekschuit operating costs are expressed as a cost per barge-kilometer. All costs, including those for stable keepers and jockeys, have been included under the labor category. Throughout the eighteenth and early nineteenth century labor costs remained virtually fixed at 1.2 st. per barge-kilometer. Horsepower costs, on the other hand, fluctuated in the short run and rose considerably in the longer run. This expense, itself dominated by feed costs, was responsible for the cost fluctuations seen in figure 5.4 and for the 33% rise in average total operating costs between the 1720s and the first decade of the nineteenth century.

We now have a rather complete picture of trekschuit operating costs. From the beginning of the trekvaart era into the nineteenth century
Source: G.A. Haarlem, kast 24, no. 45 (1097).

FIGURE 5.5. Major operating expenses per barge-kilometer on the Haarlem–Leiden trekvaart, 1729–1730 and 1780–1818.
Sources: G.A. Leiden, Trekvaarten en jaagpaden, no. 108; G.A. Haarlem, kast 24, no. 45 (1097).
the technology remained unaltered. That technology was held to require a production function of fixed factor proportions. Skippers and helpers with an average daily physical productivity of 24 barge-kilometers combined with horses with a productivity of 16.3 barge-kilometers and barges with a physical productivity of 22.5 kilometers to produce the trekschuit service. The costs of these factors of production were almost entirely variable. That is, they varied with the level of service being offered. The costs seem to have risen very nearly proportionally with the level of service. The higher labor utilization of the highest volume routes (see routes 1–5, table 5.1) represents the only apparent scale economy.

The cost of production per barge-kilometer, standing in the mid-eighteenth century at 2.4 stuivers, was thus nearly constant over the entire range of output. Its level varied both in the short run and in the long run primarily as a result of changing horse feed costs and, to a lesser extent, horse prices. Other costs were either constant or of minor importance throughout the seventeenth and eighteenth centuries.

V.5. SKIPPERS’ INCOMES

We have now examined the sources of revenue and the categories of expenditure that confronted the skippers. The bulk of their revenue was a direct linear function of the volume of passengers handled; expenses were overwhelmingly attributable to the cost of operating the barges. These costs were quite stable in the long run and were influenced by only very minor scale economies. With this information we can proceed to the task of identifying the income of the skippers.

On most routes the skippers’ incomes had two component parts: wages and profits. The skippers received, just as their helpers and jockeys, a fixed payment per trip worked. For instance, the Utrecht-Leiden skippers paid themselves 50 st. per roundtrip, while the Leiden-Haarlem skippers paid themselves 30 st. per round-trip. On other routes these payments were combined with the equivalent of a fixed yearly wage. The Bolsward-Leeuwarden skippers paid themselves a flat 50 st. per week plus 10 st. ‘travel costs’ for every one-way trip.87

These payments were drawn from the treasury of the skippers’ guild and were regarded as a regular expense of trekschuit operations. At the end of the year a balance sheet was drawn up and the funds remaining in the treasury were divided equally among the skippers. All the remaining funds were disbursed with two possible exceptions. First a sum was left to provide the working cash for the following year. In principle, this sum equaled the amount left in the treasury at the beginning of the previous year. It was intended only to provide cash in short periods when incoming receipts would be inadequate to pay unpostponable expenses. It was not large enough to act as a financial reserve to make good annual
deficits. For this latter purpose some guilds withheld from disbursement in good years a portion of their annual surplus to be invested, usually in negotiable paper.

The skippers' accounts share with the accounts of the municipal trekvaart administrations the complete absence of capital accounts. All expenses, including those that increased the values of the guilds' assets, were run through the current accounts. The skippers did not understand their business to be capable of benefitting from capital investment. Expansion, given the fixed-factor production function, would invariably require, it seemed to them, the addition of new skippers, who themselves would be required to supply the needed additions to the capital stock. In theory, the skippers could have enlarged their capital stock through the reinvestment of the guild's surplus, and could simply have hired more employees to operate the enlarged enterprise. But such a development, whereby the skippers would have become true capitalists, was explicitly prohibited by the municipal ordinances. These regulations rarely failed to place great emphasis on the requirement that the barges always be operated under the personal command of a skipper. He could not appoint others to perform the actual work in his stead. Under these conditions, the guild surplus had only two possible destinations: investment in negotiable paper (to serve as a financial reserve) or - and this was by far the more important - distribution to the skippers.

In summary, the skippers' incomes consisted of their wage plus their share of the hoped for annual guild distribution. The available references show the skippers' annual wages to hover between f350 and 250. These amounts are not appreciably more than the annual earnings of their helpers, or, for that matter, of manual workers employed in trekvaart maintenance (assuming full-employment). If the skippers were to receive a return on their substantial capital investment, and if they were to be financially and socially distinguishable from the mass of manual workers, they had to see to it that their guilds generated a substantial surplus for distribution. By how much did these distributions supplement the skippers' wage incomes, and how stable was this socially crucial income source?

The descriptions of revenues and expenditures presented above provide a basis from which we can attempt to answer this question. By sketching this evolution we can broadly identify the trends of the skippers' surplus. Since our most extensive and dependable expenditure data were drawn from trekschuit operations in Holland, and there is reason to believe that several important costs in the more rural northern provinces were lower than in Holland, the following calculations, summarized in table 5.4, will be confined to the Holland-Utrecht network.

The total expenditure can be estimated by multiplying the number of barge-kilometers per day (see table 5.1) times the average cost per barge-kilometer (as identified in the preceding section) times the average
### Table 5.4. Estimated total expenditures and revenues of the Holland–Utrecht trekschuit skippers, 1650–1800.

<table>
<thead>
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<td>2864</td>
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<td>300,000</td>
<td>38,000</td>
<td>30,000</td>
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<tr>
<td>1700</td>
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<td>238,000</td>
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<tr>
<td>1750</td>
<td>2.4</td>
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<td>222,000</td>
<td>13.5</td>
<td>148,000</td>
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<td>15,000</td>
<td>172,000</td>
<td>-50,000</td>
<td>15,500</td>
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<tr>
<td>1780</td>
<td>2.4</td>
<td>5550</td>
<td>222,000</td>
<td>15.0</td>
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<td>222,000</td>
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<td>1800</td>
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<td>5550</td>
<td>272,000</td>
<td>16.0</td>
<td>180,000</td>
<td>27,000</td>
<td>36,000</td>
<td>243,000</td>
<td>-29,000</td>
<td>21,000</td>
<td>-8,000</td>
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Key:
1. Average cost per barge-km (in stuivers).
2. Daily barge-km.
3. Annual expenditures (in guilders).
4. Approximate annual passenger volume (in millions of pass.-km).
5. Annual revenue at original fares (in guilders).
6. Additional revenue from fare increases (in guilders).
7. Ref revenue (in guilders).
8. Total passenger revenue (Σ Col. 5–7).
9. Surplus or loss (Col. 8–Col. 3).
10. Estimated non-passenger revenue ([Col. 5 + Col. 6] × .1).
11. Total surplus or loss (Col. 9 + Col. 10).
number of days per year that the trekschuiten operated, 330. The average eighteenth-century cost of 2.4 st. per barge-kilometer must be raised for the mid-seventeenth century, when feed and horse prices were above their mid-eighteenth-century level, and again for the end of the eighteenth century, when we know that increased feed and horse prices increased total costs by at least a quarter. The assumptions behind the estimates of total expenditures found in column 1 of table 5.4 are presented in the footnotes.

To estimate revenues we must first know the volume of passengers, expressed in passenger-kilometers, carried by the Holland-Utrecht skippers. In chapter IX several aggregate measures of passenger volume are presented. The most comprehensive of these aggregate series shows that passenger volume on eight routes stood at 20 million passenger-kilometers in 1670, 15 million in 1700, and 10 million in 1750. By the end of the eighteenth century passenger volume stood about 10% above the mid-century level. This aggregate series does not include all routes. Around 1670 the total volume of the Holland-Utrecht routes probably stood at about 27 million passenger-kilometers. The estimates of total passenger volume in column 4 of table 5.4 assumes that the long-term evolution of the missing 7 million passenger-kilometers of 1670 followed the same course as the aggregate series. The 1650 estimate is directly based on the available data from the eight routes then in operation in the Holland-Utrecht region.

The fares which prevailed from the mid-seventeenth century until the mid-eighteenth century provided the skippers with an average revenue of 3.5 p. per passenger-kilometer (or 1 guilder per 90 passenger-kilometers). This average skipper’s portion times the number of passenger-kilometers gives us the estimate of total revenue presented in column 5. But in the second half of the eighteenth century fares were increased. In chapter III we found that early nineteenth-century fares stood above the seventeenth-century level by an average of 16%. Since the passenger tolls levied by the trekvaart administrations were rarely increased, the lion’s share of this income went to the skippers; their revenues were therefore raised by much more than 16%. In the extreme case that all of the increase went to them, their revenues would have increased by 27%. Column 6 reflects our assumptions about the effect of fare increases on the skippers’ revenues. Finally, the trekschuiten on most routes were equipped with roeven in the course of the eighteenth century. On one route we know that an average of 25% of the passengers used the roeven. Since the average roef fare was 50% above the ordinary fare, total revenues rose by 12.5%. But, again, since the roef supplement accrued to the skipper, whose proportion of the total fare was about 60%, roef passengers increased his revenues by about 20%. These revenues are estimated in column 7. The estimates of total passenger revenues, the sum of columns 5, 6, and 7, are presented in column 8. To be complete our revenue
estimate should include an amount for non-passenger revenues (mail, parcels, baggage). Unfortunately, we have nothing on which to base such an estimate. The assumption that such revenues were 10% of passenger revenue (excluding roef receipts) is reflected in column 10. All that can be said for it is that it probably does not enormously exaggerate this source of income.

The evolution of skippers' expenditures and receipts in the century and a half after 1650 is presented graphically in figure 5.6. It should not be interpreted as an approximation of the course of affairs on every route. Some routes were relatively more profitable, others less profitable than this composite picture of all Holland-Utrecht routes. The great variability of route profitability is made obvious by a comparison of the skippers' profit estimates of 1650 and 1670. In 1650 the nine routes then in operation generated more surplus than the completed network did in 1670. Between these two dates the number of daily barge-kilometers and horse

![Figure 5.6](image_url)

**Figure 5.6.** Estimated total revenues and expenses of the Holland-Utrecht skippers' guilds, 1650-1800.

![Figure 5.7](image_url)

**Figure 5.7.** Estimated total surplus of the Holland-Utrecht skippers' guilds, 1650-1800.

Source: Table 5.4.

176
expenses more than doubled, but the number of passenger-kilometers — and, thus, revenues — rose by only 60 percent. The routes built during the second trekvaart boom were considerably less profitable than those built before 1650.

From 1670, when the system was complete, figure 5.7 lets us follow the fortunes of the skippers’ guilds: the sizeable surpluses divided annually among the skippers in the 1670s (an average of f155–f278 for each of the approximately 245 skippers) gradually declined and in the early eighteenth century disappeared as revenues fell much more rapidly than did costs. Steadily increasing deficits were experienced until the 1730s and 40s. After those desperate years revenues began to rise. Increased demand accounted for only a minor percentage of this rise. Most was the result of fare increases and, even more important, the revenues from the new first class accommodations. By the 1770s and 80s a modest profitability had been restored, but in the last years of the century

![Graph](image-url)

**Figure 5.8.** Total revenues, expenditures, and surpluses of the Haarlem-Leiden skippers’ guilds, 1723-1730, 1759, and 1780-1818.

Figure 5.9: Total annual income (wages plus distributed guild surplus) per member of the Leiden and Haarlem skippers' guilds, 1723–1730 and 1780–1818.

Sources: G.A. Leiden, Trekvaarten en jaagpaden, no. 108; G.A. Haarlem, kast 24, no. 45 (1097).

the system was once again threatened with deficits, this time because of rapidly rising costs.

We can test the validity of this simulation of skippers' surpluses by comparing it to the previously introduced accounts kept by the skippers on the Haarlem-Leiden trekvaart. These unique records also enable us to identify the factors that determined skippers' surpluses in the short run.

Figure 5.8 presents the annual expenses, revenues and surplus of the Leiden guild for the period 1723–30 and the Haarlem guild for the period 1780–1818. The annual earnings of the skippers are presented in figure 5.9.

The long-run evolution presented in these figures is consistent with the generalized picture presented above. The only real difference is the consequence of this route's being relatively more profitable than most of the others. In the 1720s, when many guilds must have been suffering deficits, the Leiden skippers to Haarlem just managed to break even. From other sources we know that this precarious balance did not last long. Already in 1728 the six Haarlem skippers had booked a f1020 deficit (receipts f10528.55; expenditures f11548.95); the Leiden skippers soon followed the same path, for in 1737 they petitioned their municipal government to increase the f500 subsidy granted in 1735 to f1000. Without the subsidy, they wrote, the operating costs of the trekschuit service could not be met.38

Four years later the municipal governments agreed to raise the skippers' receipts per passenger by 6.3% and at about this time the barges were rebuilt to provide first-class service. The second of these measures had a positive impact on the skippers' financial position, for when we again have access to the records, this time those of the Haarlem skippers, the guild is enjoying annual surpluses of about f2000 which, in the 1790s grew to over f3000 per year. The difference between the lack of surplus of the 1720s and the handsome surpluses of the 1780s and 90s is almost
entirely attributable to the extra revenue brought in by the sale of seats in the roeven.

In these years the Haarlem skippers enjoyed very high incomes, as figure 5.9 shows. In addition to their annual wages of over f300, the six skippers each received f400 to f600 as their share of the distributed surplus.

The first decade of the nineteenth century closed the curtain on this era – or interlude – of prosperity. Expenses rose while receipts fluctuated around a stationary line until the end of the decade. Then demand collapsed and the use of every possible expedient to reduce expenditure (such as deferred maintenance, continued use of aged horses, failure to pay rental charges) could not suppress expenditures far enough to avoid big deficits. Since the f400 of working capital with which the guild began each year offered no ability to absorb large deficits, the guild quickly came to be burdened with debt. The guilds’ debts would have been even greater had the French administration of this period not made available a complicated subsidy program.39

The size of the guilds’ debts and assets offers yet another view of the general financial position of the skippers’ enterprise. The critical remarks of the Haarlem officials in 1729 regarding the financial conduct of the Haarlem skippers is our first direct information that the guild then carried a heavy debt. According to the officials the skippers’ irresponsible habit of distributing surpluses among themselves long after true surpluses had ceased to exist was the source of their indebtedness, which then totalled f7000.40 The judgment of the officials cannot be checked, but given the indispensable role that the distributions had played in the maintenance of the skippers’ social standing, it is not difficult to understand how they might have been driven to commit such acts of financial irresponsibility.

The specific form that the Haarlem skippers’ indebtedness took is not mentioned, but it is likely that it was similar to that of their Leiden counterparts, whose debts totaled f4900 and consisted of six separate obligaties, all contracted with private individuals. The oldest outstanding debt, contracted in 1698, was a f1000 loan at 4% interest. The next one, f400 at 3%, was contracted 18 years later, in 1716, but thereafter the skippers borrowed anew every four or five years, usually at 4%. Their 1729 loan of f1000 proved sufficient to keep them going for only one year, for in 1730 they borrowed once again.41 The growing difficulties of the skippers in the early eighteenth century is very clearly reflected in the Leiden skippers’ debt records.

From 1730 until 1789 the records offer us no glimpse into the financial position of the guilds, but in the latter year the Haarlem guild had apparently succeeded in retiring its debts, for it had then built up its working capital account to f2000. The guild then decided that f2000 was too large a sum to have unproductively tied up for this purpose. By reducing
this account to f400, the guild freed f1600 for investment in two bonds of the Haarlem municipal treasury which at maturity would each yield f1000.42

The next view we have of the guild’s financial position comes in 1816. The f2000 investment had long since been sold, and the guild was saddled with debts totaling f6425. They were all owed to private individuals and had all been contracted since 1811. By 1818 some of those debts had been repaid: the outstanding debts then stood at f5175.43 The same financial deterioration affected the neighboring Amsterdam-Haarlem trekvaart. There, the Amsterdam guild was burdened by an f11,000 debt in 1814, which rose to f19,000 in 1828.44 The two periods of financial crisis identified earlier, the first culminating in the mid-eighteenth century and the second developing strength after the fall of the Republic are again visible in the scraps of evidence at our disposal concerning the financial condition of the skippers’ guilds.

While the long-term developments in the profitability of trekschuit operations compel our attention because of their historical importance, we should not lose sight of the short-term changes. The time horizons of the skippers themselves were obviously much shorter than the centuries-long retrospective view that we can now assume, and the volatility of the guild surplus fluctuations must have directed their attention all the more to short-run movements.

The annual surpluses of the trekschuit skippers depended on many factors, but two particularly conspicuous ones can be considered here. A glance at figure 5.4 suggests the existence of a strong connection between variations in total expenses and the variations in horsepower expenses, which were, in turn, strongly influenced by feed costs. This directs our attention to the price of grain, a variable which is also likely to have affected the demand for trekschuit travel, and hence skippers’ revenues. The price of grain played a double role. When prices were high the number of passengers was likely to fall a bit (for a full discussion of this rather complicated point see chapter X), and just when revenues were down, the horsepower expenses of the skippers were high. The surpluses of the Haarlem skippers responded sensitively in the period 1780-1806, when surpluses were negatively correlated with rye prices \( r = -0.40 \). The severity of winters is the second conspicuous variable since it determined to a large extent whether the trekschuiten, which together with the horses had to be maintained year-round, could generate revenues in the winter months. If the travelers who were unable to make their intended trips because of frozen canals simply postponed their departures to a later date, this factor could have little lasting importance, but, as will be demonstrated in greater detail in chapter X, this was not the case. Correspondingly, we find that the severity of winters (as measured
by the average winter temperature) directly affected skippers' revenues, and hence surpluses ($r$, the correlation coefficient of average winter temperature and skippers' surpluses = .29).

While the long-run profitability of the trekschuit skippers' enterprise depended on general economic conditions and the overall price level in relation to trekschuit tariffs, the short-run profitability depended in large measure on the severity of the winters and the price of grain. Moreover, it should be noted that the worst situation, severe winters and high grain prices was not a random occurrence; a tendency existed for the two to occur together.45 The financial status of the skippers was subject to fluctuations that are very nearly unknown outside of agriculture in modern economies. Judging from the records of the Haarlem skippers to Leiden, years in which they enjoyed total incomes three times above those of skilled workers could be followed, in a short period, by years when they earned little more than their helpers. The observation of such sharp income fluctuations makes one curious to know how the skippers' household expenditure patterns behaved. What did they regard as their 'permanent income', how were windfall incomes treated, what was the role of debt in smoothing out these fluctuations, what proportion of the labor force faced such fluctuations, what sectors of the economy were stimulated in good years? These and related questions about the stability of the pre-industrial economy are worthy objects of study for future historical research.
CHAPTER VI

THE MICROECONOMICS OF THE TREKVAART INDUSTRY

We now know the long-term course of skippers' aggregate profits, and we have identified several factors that account for a major part of the large annual fluctuations in the profits on one route. But, interesting as that information might be for an understanding of the economic position of the skippers, it is essentially superficial, for it takes as given the fare structure that determined revenues and the operating costs that determined expenditures. Over both of these factors the municipal trekvaart administrators and, to a more limited extent, the skippers themselves exercised control. It is therefore appropriate to inquire into their decision-making practices in the administration of what was, in effect, a regulated monopoly. Among the questions for which we seek answers in this chapter are the following: How and for what purpose were the fares set? What rationale governed the establishment of transport capacity? How efficiently did the skippers provide that capacity?

VI.1. THE PRODUCTIVITY OF LABOR

To take the last question first, we must begin by emphasizing a finding of chapter V, that the policies of the municipal administrations fixing price, capacity, and standards of service severely limited the range of factors over which the skippers' guilds could exercise a measure of control. The production function imposed by the available technology was also described in chapter V. There it was made clear that the inputs of the factors, labor, energy, and capital assumed fixed proportions. The efficiency with which all those factors were utilized was not called into question. Yet, if we look again at the average daily physical productivity of the various factors, it would appear that some questions are in order.

In the late seventeenth century the entire trekschuit industry of the Dutch Republic offered a physical capacity of 75 million passenger-kilometers per year. This was achieved by operating 8329 barge-kilometers per day in the summer months and about 5 percent less in the winter months. Following the estimates made in table 5.1, these 8329 daily barge-kilometers were produced by the labor of 349 skippers and equal numbers of helpers and jockeys, the energy of 504 horses, and the use of 364 barges. The average daily physical productivity of labor was thus 24.0 barge-kilometers, of horses 16.3 barge-kilometers, and of barges 22.5 kilometers. These productivity figures can be translated into hours
worked by dividing them by the average speed of trekschuiten: seven kilometers per hour. The average skipper, helper, and jockey spent 3.4 hours per day operating a trekschuit while the average horse spent 2.3 hours per day pulling a trekschuit, and the average barge was in revenue service for 3.4 hours per day.

As noted above, the labor productivity on high-capacity routes exceeded that of other routes. The skippers, helpers, and jockeys on the six routes connecting Amsterdam with Rotterdam via Haarlem, Leiden, and Delft produced an average of 31.1 barge-kilometers per day. They worked their barges an average of 4.5 hours per day while all other skippers worked an average of only 3.1 hours. These daily productivity figures do not take days of rest into account. In the case of labor it must be assumed that no one worked over six days per week. When this is done the daily hours worked increase to 5.2 on the high-frequency routes and 3.7 on the others.

The total hours worked exceeded those figures, of course. Besides the operation of the barges the crews had to clean and routinely maintain the barges, prepare the barge for departure, and most important, stand ready for a possibly lengthy period before departure time to receive passengers or provide an extra departure in case of heavy demand. Moreover, once at the destination the crews had to wait until their return departure was scheduled. Particularly on lower-frequency routes this wait could consume many hours, even a full day.

One other factor that reduced the operating hours of the crews on low-frequency routes was the fact that they often served as deliverers of parcels and mail. On the high-frequency routes specialized deliverers (bestellers) existed, but on the others the skippers often assumed responsibility for this function. The time required for all of these supporting and secondary functions must be added to the operating hours of the crews. Consequently, the total number of hours actually worked is not known. Yet it seems unlikely that the 5.2 and 3.7 hours per work-day figures are raised so high that we would be impressed by the long days put in by the operating crews. How impressed contemporaries were is another matter, for when the work-performance of trekschuit crews is compared with that of sailing vessel crews and coachmen, these modest achievements look very good. The average daily distance sailed by beurtveer skippers (based on their official schedules, uncompensated for winter shutdowns, etc.) never exceeded 18 km. And, whenever we have more precise data, this figure is lucky to reach 11 ship-kilometers per day.¹ The coachmen did no better: judging from the 1791 ordinance of the Rotterdam-Nijmegen postal coach, each coachman accounted for no more than 8.6 coach-kilometers per day.²

From this perspective we can say of the trekschuit industry that its technology allowed for a more regular work pattern and, hence, a higher level of performance than was common in a pre-industrial society.

183
Despite this, the workers' days, particularly on low-frequency routes, were filled with long periods of idleness and waiting time. This was imposed in part by the technology, but, in view of performance levels elsewhere in the economy, a factor of at least equal importance in setting the labor performance levels where we find them was the contemporary standard concerning appropriate workloads.

VI.2. VARIABLE, FIXED, AND TOTAL COSTS

While the workloads of the skippers and crews were to a large extent determined by social custom, the same cannot be said about the fares and schedules of the trekschuiten. Since the service was an innovation, precedent could not serve as a guide in these matters. More significantly, the officials should have recognized that the decisions made would be of crucial importance since, as we have noted earlier, the industry's dependence on a mass market was, for its time, uniquely high. In order to evaluate the decision-making behavior of the industry attention will once again be focused on one representative trekvaart, the Haarlem-Leiden trekvaart, for which particularly detailed information is available.

When the Haarlem-Leiden trekvaart was completed in 1657 the municipal officials issued an ordinance whose numerous provisions were to govern for over a century the service to be provided by the skippers. They set the fare at 11 st. (5 for themselves, to cover the costs of the canal, and 6 for the skippers, to cover the actual transport costs). In addition, the provincial government levied a tax, the passagiegeld, which amounted to 1 st. 10 p. The total cost of a one-way trip on this route was, thus, 12 st. 10 p. The administrators went on to stipulate that the two skippers' guilds provide eight daily barges in each direction plus a nachtschuit, an overnight barge. In total nine barges departed daily in each direction. The first left at 5:30 a.m., the last, the night barge, at 11 p.m.³

How did the administrators arrive at these decisions? They could, of course, benefit from the experience of other routes, some of which had been in operation for 25 years when the Haarlem-Leiden route was finally added to the network. Since we have very detailed information about cost conditions on the Haarlem-Leiden route, we will seek answers to our questions here, but one could with at least equal justice ask the same questions of every other trekvaart route.

To analyze the behavior of a firm, in this case the Haarlem-Leiden trekvaart administration plus the Haarlem skippers' guild, we must begin by describing its costs conditions.

The fixed costs of trekschuit service were those for which the trekvaart administrators held responsibility: the capital and maintenance costs of the trekvaart itself. The annual accounts of the Haarlem commissioners show maintenance and administration costs to have averaged £3900 per
As noted earlier the commissioners kept no capital accounts. But we know the amount invested. If the city treasury borrowed this sum, it paid interest; if the sum came from the treasury's reserves, it could have received interest by investing it elsewhere. Either way there is an interest rate real or implicit, which must be applied to the invested capital. In the absence of direct information we have assumed that a 3% interest rate had to be paid on the capital invested in the Haarlem-Leiden trekvaart. This interest expense, $6360 per year, added to the average annual maintenance charge of $3900, equals the total fixed cost. Regardless of the volume of traffic, an annual sum of $10,260 had to be spent on the fixed capital assets used to provide trekschuit service. Dividing this sum by the units of output sold (passengers carried over the length of the trekvaart) yields the average fixed costs at any level of output.

The variable costs of trekschuit service were entirely the responsibility of the skippers. As we have already seen, they used an unchanged technology in which production was characterized (very nearly) by fixed factor proportions. A small economies-of-scale factor was introduced by the imperfect divisibility of some minor overhead costs and by the increased efficiency with which labor could be used at high volume levels. On the other hand, increased volume imposed diminishing returns on the trekschuit operators because of the problem of capacity utilization. When only one or two barges depart for a given destination each day, potential travelers have no choice but to depart when the barges depart. If the capacity of the route is set to accommodate the average daily demand of the peak travel month, then its capacity will be under-utilized in the other months. The seasonal distribution of travel in the 1660–79 period on the four routes connecting Amsterdam with Delft and The Hague was such that only 80% of total physical capacity could actually have been utilized. The total passenger capacity multiplied by the 80% figure can be called the 'effective capacity'. If several barges per day are needed to provide sufficient capacity, then effective capacity is determined not only by the influence of the seasonal demand pattern on capacity utilization, but also by the distribution of demand within the day. Although this hourly demand pattern is not well known, the skippers' correspondence with the administrators is full of complaints of scheduled departures that were poorly patronized because of their departure hours. The barges had to sail, nonetheless, in order to permit later, well-patronized return sailings to take place. In short, as frequencies were increased to enlarge capacity, scheduling limitations imposed a progressively greater loss of 'effective capacity'. While the effective capacity on routes with one or two daily departures in each direction was in the neighborhood of 80% (caused by seasonal demand peaks), it may have fallen to 72% on routes with three to seven daily departures and to 65% on routes with eight to 15 daily departures.
In summary, variable costs, which showed a slight increasing returns tendency as physical capacity rose, showed a slight diminishing returns tendency once effective capacity is used as the measure of output.

The average total cost of providing trekschuit service is the sum of average fixed and average variable costs. Average total cost is typically dominated by fixed costs when output is low, but is increasingly influenced by variable costs as the output levels rise to make better utilization of the capacity of the fixed capital plant. The average cost curve of trekschuit service displays these typical features. It is, however, atypical — but similar to the cost curve of many other sorts of capital-intensive transportation enterprises — in its large range of declining or constant costs. The total capacity of the canal far exceeded the likely utilization. Consequently, there existed no costly barriers to increasing the output level. The relative constancy of variable costs is also confirmed by the cost statements made by several mid-eighteenth-century skippers' guilds, each operating at different effective capacity levels. Their costs all clustered around the average variable costs faced by the Haarlem skippers.

Finally, we must calculate the marginal cost of providing trekschuit service: that is, the addition to total cost resulting from the addition of the marginal, the last, unit of output. Since fixed costs are fixed, all additions to total costs are made by the variable costs, which were constant, or very gently rising over a broad range. Not surprisingly, then, the marginal costs of providing trekschuit service were also relatively constant, remaining very close to average variable costs. All of these (short-run) cost curves are displayed in figure 6.1.

We now know the cost structure of trekschuit service on the Haarlem-Leiden route as it was in much of the eighteenth century. This same cost structure can probably be applied to most of the other routes as well. Its application to the mid-seventeenth century would require that variable costs be increased somewhat, since horsepower costs were higher. (The shape of the curve need not change, only its vertical level). On the other hand, maintenance costs were a bit lower in the early decades of a trekvaart's operation than in later years. On the whole, it is unlikely that average total costs were significantly higher in 1660 than they were in 1750. Stable price levels and the absence of change in the size or technology of the industry permit us to assume that the short-run and long-run cost curves are essentially identical. By 1800, however, the variable cost curves must be raised vertically by around 30%. And in this case the fixed cost curve tended to follow in the same direction rather than compensate for the rising variable costs.
VI.3. THE DEMAND CURVE

Once the firm's cost structure is known, all that remains in order to identify the optimal price and output levels is an identification of the demand curve faced by the producer. Here we are not well informed. We know the demand level in the first decade of trekschuit travel on the Haarlem-Leiden route and the fare then in effect. That permits us to identify one point (R, in figure 6.3). What sort of demand curve passed through that point? That is to ask, what price elasticity of demand characterized the demand curve?

Just one other point would suffice to acquire a rough idea of the elasticity, but even this is unavailable. Fares virtually never changed, and when they did, the fare changes were exceedingly small. Thus, the reaction of consumers in the years immediately after a fare change cannot be isolated for use in estimating that second point.

Despite the absence of direct evidence, there is reason to believe that the demand for trekschuit travel was not insensitive to changes in price (i.e., was not inelastic). In the first place, the demand for transportation services in the modern economy is almost always found to be quite elastic. Second, the enormous difference between the volume of passengers carried on trekschuiten and the volume carried on routes served only by coaches indicates that the two- to threefold difference in price between the modes of transportation must have had a powerful influence on demand. That would not have happened if the demand were price
Third, the analysis of who made use of trekschuiten showed that its use was not confined to well-to-do business travelers. While the business demand for travel may have been relatively price insensitive, that surely was not the case for personal travel by ordinary folk. For them walking or traveling in freight-carrying sailing vessels would have been a substitute to which they could quickly resort when the trekschuit became more expensive, or from which they might flow to the trekschuit when the latter became cheaper. This availability of a cheaper substitute increases the likelihood that travelers would be sensitive to the price of the trekschuit.

Finally, the price elasticity of demand was probably considerably higher than 0 because the purchase of trekvaart services was an expenditure of importance to the budgets of most users. The 37.8 million passenger-kilometers of trekschuit travel purchased annually in the 1660–70s cost a total of £650,000. Since the million inhabitants of the provinces served by the trekvaart network can crudely be reckoned to have comprised 250,000 households, the average per household expenditure can be put at £2.12 st. The late seventeenth-century per household income is not known, of course, but there is plenty of evidence – some presented in this study – that a fully employed adult male worker was fortunate to earn £300 per year. For such a household, average use of the trekschuit would have absorbed about 0.9% of gross annual income. Given the large amounts of that annual income that had to be devoted to unavoidable subsistence expenditures, the sum spent on travel assumes a sizeable percentage of discretionary income. Because travel costs were not a petty expenditure, it is reasonable to assume that the demand would be sensitive to price.

The records of the Amsterdam-Haarlem trekvaart appear to demonstrate the sensitivity of travelers to the price of trekschuit travel, and the willingness of a segment of the travel market to make substitutions depending on the price. Figure 6.2 displays the annual volume of passenger travel on the trekschuiten in ten-year averages, and the approximate annual number of people who walked on the towpath that followed the bank of the canal. Here our concern is not directed at the absolute volume of travel, which is likely to have been influenced by the level of income. Rather, the division of total travel between the trekschuit (costing 5½ st.) and the towpath (costing 2 st. in tolls) is of interest. As the real cost of travel rose (the tariff divided by the general price index) the appeal of the trekschuit diminished: an increasing proportion of travelers chose to walk. After the 1690s, as the real cost of travel trekschuit fell, we observe the opposite substitution process; an increasing percentage of all travelers chose to use the trekschuit.

For all these reasons the assumption that demand was inelastic seems unacceptable. However, just how elastic it actually was remains a mystery. Since the outcome of the following analysis is sensitive to the
elasticity one assumes, we will begin with the probably modest assumption of unitary elasticity (that demand increases one percent when price falls one percent, that demand falls one percent when price rises one percent) and try to identify how important results would be altered by other elasticities.

Figure 6.3 shows the cost curves presented in figure 6.1 and a demand curve of unitary price elasticity that passes through the observed demand point (R) in the first decade of the Haarlem-Leiden trekvaart's existence. (For convenience and clarity the demand curve has been drawn as a straight line. The elasticity of this line is progressively less than unitary as one moves to the right of point R.)

The demand curve shows at a glance the level of demand that would be forthcoming at any given price level. The total revenue that would be received at any point on the demand curve is thus simply the price times the quantity demanded that corresponds with the point in question. The firm is also interested in the marginal revenue curve, which shows the addition to total revenue attributable to the addition of one unit of output. The curve identifying the marginal revenue for each level of output is labeled MR.
VI.4. Determining the Price

Where should the firm that faces this demand and cost situation set its price? There exist many possible answers to this question, for the optimal price depends on what is being maximized and how the industry is organized. Consider first the situation in which trekshuit services were offered competitively by many small firms of skippers. The price would eventually have settled down at the equilibrium position B. At this point marginal cost (the firm's supply curve) equals the market price. But while carrying passengers at a fare of 6 st. could have been a stable equilibrium point in the short run, it would not have been in the long run. At that competitively determined price the skippers could cover their variable costs, but hardly anything would remain to cover the fixed costs. Since in the short run nothing could be done to avoid the fixed costs, production would have proceeded. A stuiver per passenger to cover fixed costs would have been better than nothing. But in time the service would have been abandoned, or its organizational form altered. This problem never arose, of course, because trekshuit services were never offered in a competitive market structure. The problems that would have been faced are thus purely of academic interest. However, it is worth noting that these problems of instability are not different from the economic difficulties of many modern modes of transport (characterized as they are by large fixed costs) when they are forced into a competitive economic setting.

190
Suppose next that the trekvaart were operated as a profit-maximizing monopoly enterprise. The monopolist would, of course, produce up to the point where his marginal costs equalled his marginal revenue. Production to the right of that point would entail additional costs that would exceed additional revenue. That is, it would detract from total profit. The optimal output point (where $MR = MC$) is in this case $Q_M$ (57,000 passengers). The fare levied by the monopolist is found by striking a vertical line through the point $MR = MC$ to the demand curve. To fill the trekschuiten at the annual rate of 57,000 passengers, the monopolist need charge a fare no lower than 14 st. (point $M$). The monopoly profits of the enterprise are indicated by the vertical distance from the average total cost curve to the demand curve (minus the provincial tax).

The shape of the cost curves that characterized the trekvaart industry (and that are typical of most modes of transportation) and the elasticity of the demand curve combine to make the impact of monopoly very great. In comparison to the competitive solution, the price is more than doubled and the output is pushed back from 100,000 to 57,000 passengers. A greater elasticity than assumed here would make the impact of monopoly on the consumer even more severe.

These undesirable conditions would have obtained if the monopolist had been free to set his own price. Government regulations could have forced the monopoly to forego a large part—even all—of its monopoly profit. This could be achieved by setting a price below $P_M$ (14 st.). The closer the government set the price to $P_C$, the more it would have forced the monopoly to behave like a competitive firm. Here finally, we arrive at the microeconomic theory that fits the historical reality of the Haarlem-Leiden trekvaart—and all the other routes as well. The skippers' guild was a regulated monopoly. Had it not been regulated, we could have expected it to set a price around $P_M$. But the city governments forced the guild to function under an ordinance that fixed the price it could charge. Where did the officials set the price and what sort of policy did their pricing decisions reflect?

If the cities had regarded their trekvaarten as a public utility whose most important function was to facilitate the mobility of the population, we would expect them to set a price near point $C$. At this point output is maximized without incurring loss. (Point $B$ would not have allowed the cities to cover their fixed costs.)

When the cities of Haarlem and Leiden set the fare, they reserved for themselves a flat 5 st. per passenger. This amount had to cover the fixed costs for which the cities were responsible. If, given this decision, the cities had set the total fare to maximize their own profits as operators of the trekvaart, the optimal price would be at point $P$. (The proof for this is easily read from figure 6.4.)

But the observed behavior of the cities was consistent with neither of these maximizing policies. Instead they set the price at point $R$, a point
very close to that which a profit maximizing monopoly enterprise would have chosen for itself. (Moreover, the higher one assumes elasticity of demand to have been, the closer \( M \) approaches \( R \).) In so doing the cities, by their regulatory decisions, presented the skippers’ guild with a monopoly profit very nearly as great as the skippers could have achieved if they had been unregulated monopolists. At the same time the cities failed to maximize their own profits (for this goal, point \( P \) would have been optimal).

VI.5. Determining the Supply

Price-fixing represented less than half of the municipal officials’ regulatory task. They went on to dictate to the skippers the passenger-carrying capacity they had to offer. In the case of the Haarlem-Leiden trekvaart the effective capacity made available by their imposed schedule happened to be very close to the actual demand for travel given the fixed price. The cities’ accurate judgement in the estimation of demand contrasts sharply with their judgement of the average total cost of the product.

### Table 6.1. Load factors of trekvaart routes in the 1660s and 1670s.

<table>
<thead>
<tr>
<th>Route number</th>
<th>Daily passenger-carrying capacity</th>
<th>Average daily number of passengers</th>
<th>Load factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>960</td>
<td>816</td>
<td>85%</td>
</tr>
<tr>
<td>2</td>
<td>540</td>
<td>362</td>
<td>67%</td>
</tr>
<tr>
<td>3</td>
<td>1080</td>
<td>604</td>
<td>56%</td>
</tr>
<tr>
<td>4</td>
<td>1620</td>
<td>993</td>
<td>61%</td>
</tr>
<tr>
<td>5</td>
<td>960</td>
<td>530</td>
<td>55%</td>
</tr>
<tr>
<td>6</td>
<td>360</td>
<td>78</td>
<td>22%</td>
</tr>
<tr>
<td>7</td>
<td>300</td>
<td>91</td>
<td>30%</td>
</tr>
<tr>
<td>10</td>
<td>180</td>
<td>91</td>
<td>51%</td>
</tr>
<tr>
<td>11</td>
<td>60</td>
<td>31</td>
<td>52%</td>
</tr>
<tr>
<td>12</td>
<td>60</td>
<td>9</td>
<td>15%</td>
</tr>
<tr>
<td>13</td>
<td>180</td>
<td>104</td>
<td>58%</td>
</tr>
<tr>
<td>16</td>
<td>480</td>
<td>226</td>
<td>47%</td>
</tr>
<tr>
<td>17</td>
<td>360</td>
<td>136</td>
<td>38%</td>
</tr>
<tr>
<td>18</td>
<td>420</td>
<td>159</td>
<td>38%</td>
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<td>19</td>
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<td>300</td>
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<td>15%</td>
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<td>12%</td>
</tr>
<tr>
<td>28</td>
<td>180</td>
<td>52</td>
<td>29%</td>
</tr>
<tr>
<td>32</td>
<td>240</td>
<td>79</td>
<td>33%</td>
</tr>
</tbody>
</table>

* For the identification of route numbers, see Appendix.
But in this regard the Haarlem-Leiden trekvaart was atypical. A glance at table 6.1, shows that the capacity of many routes greatly exceeded the demand in the first decades of trekschuit operations. In these cases regulation imposed a double inefficiency: it set a price that insured monopoly profit and reduced demand and it fixed supply far above that artificially reduced demand.

So far we have described the cost curves from the point of view of the cities, which could regard their activities and those of the skippers (whose activities they regulated) as part of a single enterprise. But for the skippers’ guilds, which functioned as firms in their own right, municipal regulation of prices and schedules had the effect of forcing the curves to assume different shapes.

Figure 6.4 shows how the skippers’ average costs varied from the ‘real’ cost curves of figure 6.3. The dashed line RATC is the average total cost curve of figure 6.3, presented here for reference purposes. In the fare set by the cities a constant 5 stuivers per passenger went to the cities to cover fixed costs, regardless of the number of passengers carried. The cities’ fixed costs were, therefore, variable costs to the skippers. The horizontal line SAFC represents this cost. The skippers’ own costs of operating their trekschuiten, curve AVC in figure 6.3, must be added to SAFC to determine the average total costs of the skippers: SATC. But, as we have just observed, the skippers were not free to reduce their schedules in response to reduced demand. Below a level of output which in the case of the Haarlem-Leiden trekvaart stood near 58,000 passengers per year most of the variable costs of operation ceased being variable. SATC’

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**Figure 6.4.** Cost curves faced by the skippers on the Haarlem-Leiden trekvaart, c. 1670.

- RATC ‘Real’ average total costs (from fig. 6.1)
- SATC ‘Skippers’ average total costs
- SAFC ‘Skippers’ average fixed costs

For explanations of other symbols, see text.
represents the effect of municipal regulation of schedules. Note that the average total cost curve faced by the skippers is at every point above the real average total cost curve. The vertical distance between SATC' and RATC can be regarded as the excessive costs imposed by municipal regulation. Below an output of about 50,000 passengers, schedule regulation is the chief source of this excessive cost; above that level the excessive municipal user fees are chiefly responsible. From figure 6.4 one can read that the skippers received ab of the monopoly profit generated by price PR while the city received cd. (Had the cities, seeking to maximize their own profit, set the price at P_p, the skippers would have gotten nothing, while the cities received ef per passenger.)

VI.6. THE AIMS OF MUNICIPAL POLICY

We are left with the problem of explaining the conduct of the cities in their regulation of the trekschuit services. Their own descriptions of their conduct emphasized that trekschuit transportation served the needs of commerce and contributed to the well-being of the population. But we have seen that their pricing policies were, to put it mildly, inconsistent with their stated aims. The proximity of the established tariff P_R to the monopolists' profit-maximizing fare could suggest that the cities treated their trekvaarten as businesses from which they sought to extract a maximum profit. But as soon as we investigate their further regulation of the skippers' guilds this image of the cities as profit maximizers dissolves into thin air. In their division of revenues between city and guild, and particularly in their imposition of often unnecessarily frequent schedules, they contradict – indeed undermine – the profit maximization policy.

Could it be that we are imposing unfair standards of business rationality on our seventeenth-century subjects? After all, one might argue, these gentlemen had never had the benefit of a university course in micro-economics. Nor did they have vast statistical services at their command. Perhaps the inconsistencies that we see in their policy making was chiefly the result of insufficient information and lack of conceptual ability.

There are three reasons to reject this argument in defense of the municipal administrators. First, all of the data, without exception, that have been used here to describe the cost curves of the industry have been drawn from the records of the trekvaart administrations themselves. No information that remained unknown to them has been made available to us. The argument that the twentieth-century economist can do more with these data than could our seventeenth-century ancestors has some validity, but should not be exaggerated. Their approach to business administration showed notable differences from our own, their failure to distinguish capital from current expenditure being a particularly significant difference. But it should not be forgotten that the men who governed
the Dutch cities in the seventeenth century had in their hands the management of the most sophisticated business economy of Europe. There is no reason why we should not take them seriously.

Finally, as evidence of their conceptual abilities, we can point to one seventeenth-century analysis of trekvaart management that was cognizant of the desirability of setting fares close to actual costs and recognized the inconsistencies in levying high tolls on an installation that was intended to function as a public utility.

Ironically, the trekvaart administration in which these views were discussed was the first one to be established in the Holland-Utrecht region, and, unfortunately, it is one for which our information is severely limited. When the Amsterdam-Utrecht trekschuit service was being planned in 1626 an anonymous official submitted a report to the city of Utrecht which argued in favor of exempting the trekschuiten from any user fees that might be levied on the newly built trekvaart. The report argued as follows: the point of the new service is to stimulate commerce and this is to be achieved by making travel to Utrecht less burdensome. By levying tolls on travelers this aim will be frustrated, yet the toll revenues will certainly not suffice to cover the total costs of the expensive new trekvaart. The report implicitly concluded that it would be better to achieve fully one aim rather than neither. That is, it recommended that the maintenance of the new route be paid for from the general revenues so that trekschuit travelers could be offered lower fares.¹⁰

I was able to find no specific reaction to this proposal. It is clear enough that the proposal was not accepted, since tolls were in fact levied on the new trekvaart. But the tolls for trekschuit passengers were low in comparison with other trekvaarten, forty percent of the average level in the Holland-Utrecht region. Correspondingly, the cities set the total fare at a level far lower than any other trekschuit route. The 9 st. fare amounted to 3.1 p. per km in comparison with the 5.5 p. average for the Holland-Utrecht region. In 1744 the fare had been raised to 14.5 st., which brought it into line with the fares prevailing on the other routes. It is not known how long the 9 st. fare remained in effect, but if it was still in effect in 1665, it could help explain the surprisingly high volume of traffic that was then recorded on the route. The toll-collecting rights were leased from the beginning making it impossible to know the annual number of passengers, but in 1665 the collector of the toll on passengers traveling from Utrecht to Amsterdam swore to having counted 55,000 passengers.¹¹ Under the reasonable assumption that a like number traveled in the opposite direction, the passenger volume stood at a level significantly above that of other routes (holding constant the size of the cities served and the distance between them).

Seventeenth-century people existed who could identify with clarity the policy options and their consequences. But, this capacity notwithstanding, the observed municipal trekvaart policies are most noteworthy.
for their irrationality or, at least, confusion. They maximized neither profit nor consumer welfare. On the other hand, one characteristic that runs like a thread through the trekvaart policies of almost every city is an interest in maximizing the frequency of the schedules. But, once again, what rational policy could this reflect? This and other questions about the seemingly perverse effect of municipal regulations will be pursued further in the following chapter, where the reaction of the cities and of the skippers to the long-term decline of demand will be examined. Their responses to the growing necessity to change the initial seventeenth century policy decisions provide us with another opportunity to identify the motives and assumptions that stood behind those policies. For this reason, I will postpone an assessment of municipal policy to the next chapter.
VII.1. The Decline in Demand

A curious feature of the trekvaart system is that it attained its peak as an economic institution as soon as it was completed. The habits of consumers adjusted almost instantly to the newly offered travel opportunities. Soon after the completion of the network, travel volume on many of the routes began to decline. Although yearly fluctuations and short cycles of rising and falling volume could obscure the long-term trend for a while, the trend was, by the 1680s, obvious on nearly every route. By the mid-eighteenth century the overall volume handled by the trekvaart network had fallen to half of what it had been around 1670.¹

The trekvaart administrators and the skippers’ guilds alike faced a long-term decline of their industry: year by year, decade by decade, the number of people presenting themselves at the trekschuit loading docks diminished. This phenomenon of decline presents us with two distinguishable issues: why did the demand for intercity trekschuit transportation decline, and how did the administrators and skippers respond to this decline?

Before anyone could prescribe remedies for, or seek to minimize the adverse impact of, the long-term decline in demand, the phenomenon had to be diagnosed. When we read through the correspondence of the trekvaart administrators with their counterparts in the other cities and with the skippers’ guilds, the fact stands out that complaints about declining business and, hence, declining revenue do not become frequent before the 1720s and 1730s. Only after the process of decline had been under way for nearly two generations and (in retrospect) had all but run its course did the skippers begin to petition the cities for financial relief and did the municipal officials begin to discuss reforms and economy measures.

Only one exception to this curiously delayed response has been found. The skippers on the three trekvaart routes serving Utrecht began to petition for financial relief as early as the end of the 1680s. Their precocity is not difficult to explain. The economy of Utrecht and its hinterland suffered severely from the French invasion of 1672-73. Moreover, Utrecht’s economy did not spring back to life when French troops finally withdrew and communications with Holland could be restored. The annual lease revenue from the tolls levied on the towpath-equipped River Vecht between Nieuwersluis and Hinderdam fell from £5400 in 1668-72 to £3150 in 1674-84. By 1704 the revenues had sunk further to £2300. Likewise the volume of passengers carried on the Leiden-Utrecht trek-
vaart in 1677–80 was only 78%, and in 1687–90 only 63% of the immediate pre-war years. Elsewhere the decline in passenger volume had yet to assume such proportions, but was nonetheless perfectly obvious.

The failure of the trekvaarten outside of Utrecht to deal with the decline in demand can perhaps be explained if we look once again at figure 5.7 in chapter V. In that attempt to calculate the profits of the skippers, the system as a whole does not sink below the break-even point until early in the eighteenth century. Obviously, for individual routes that point could come earlier (i.e. the Utrecht routes) or later (as we have seen, the Amsterdam-Haarlem and Haarlem-Leiden routes). But for most routes deficits were faced only long after the process of decline had begun. The reason for this can be found in the fact that the fares set by the municipal authorities in the first years of the trekvaarten usually insured the skippers handsome monopoly profits. Only after demand had diminished sufficiently to cause the higher unit costs of low-volume operations to eliminate those profits did the skippers face real distress. In short, the regulations governing trekschuit operations endowed the entire system with a thick layer of financial fat. We begin to read complaints and reform proposals only after that layer had been eaten up.

VII.2. CONTEMPORARY EXPLANATIONS OF DECLINE

Contemporary diagnoses of the phenomenon of a declining volume of trekschuit passengers focused on four factors, two usually identified by the skippers and two by the municipal officials. The officials believed that poor service standards (by which they meant everything from less frequent schedules to uncivil conduct by crew members) chased passengers away. At the same time they were inclined to suspect that the steady decline in demand observable in their own financial records was at least partly a product of fraud on the part of the skippers. The skippers, in their petitions for relief, drew attention to two other causes. Competition from unregulated carriers provoked several skippers’ guilds to complain. Skippers on both the Amsterdam-Hoorn and the Utrecht-Leiden routes complained of wagon drivers who lurked near the trekschuit loading docks before departure times and enticed travelers away from the trekschuiten with the promise of immediate departure. On the Leiden-Delft and Amsterdam-Haarlem routes the complaints emphasized the damage done by the increasingly more widespread use of private coaches and government yachts.

Skippers placed their primary emphasis on a second cause, which they variously described as the decay of the economy, the collapse of commerce, or the bad times. Their conviction that they suffered from a general economic problem rather than from one specific to a given route or the conduct of certain bad skippers was drawn from the knowledge that
skippers on other routes faced the same powerful trend toward a lower demand, and that the number of passengers originating on connecting routes was steadily diminishing.

The diagnosis of municipal administrators, which identified the moral character of the skippers as the source of ‘apparent’ decline, led to proposals of administrative reforms. Some cities introduced elaborate bookkeeping and reporting systems in the hope of reducing the opportunities for fraud. For instance, Leiden, Delft, and The Hague ordered special tickets and bookkeeping forms printed after 1737 and prescribed a complex system in which the commissioners and skippers each kept separate books which could be checked against each other. Other cities, despairing of their own capacity for vigilance, sought to lease the trekschuit toll collections to private parties, usually the skippers themselves. Such leases, which had long been used for the exploitation of tollgates along the towpaths, were resorted to for the collection of trekschuit tolls on the Amsterdam-Weesp route in 1728, Amsterdam-Gouda in 1730, Delft-Rotterdam in 1739, Amsterdam-Haarlem in 1761, and Haarlem-Leiden in 1768.

These leases did not always prove to be satisfactory solutions to the supposed problem of dishonesty and fraud for reasons best expressed by an official of Leiden in his analysis of a proposal from Delft to lease the trekschuit toll collections on the route connecting the two cities. Delft made this proposal in 1744, enclosing in its report a table of toll receipts for the previous 13 years. This table showed a steady decline which Delft proposed to remedy by leasing the operations to the skippers in return for a fixed annual payment. Leiden was unenthusiastic about the proposal.

As the official charged with the task of responding to Delft’s request put it: The skippers are either honest or dishonest. If they are honest, the diminution of the toll receipts has other causes, and the establishment of a fixed annual lease payment will only speed the complete financial ruin of the skippers’ guild. If they are dishonest, this proposal is not a means to make them honest. [In this case] their current dishonesty directed against the cities, will be directed against each other, and the biggest cheaters will profit at the expense of the honest skippers.

By leasing the trekschuit tolls, he went on, the cities will come to know even less about the true situation than they now know, a situation that can only increase the likelihood of fraud. This report, written by secretary van Roijen in 1745 and used again in 1752 in response to a second lease proposal from Delft, sought to emphasize that skippers’ fraud was not a major cause of the decline of toll revenues. Instead, this well-informed municipal official emphasized the following causes:
1. the general collapse of industry and prosperity
2. the increased use of private vehicles and municipal yachts
3. the discontinuation in 1729 of the night barge service.

The third cause, particular to the Leiden-Delft route, was in keeping
with the trekvaart administrators’ belief that the level of demand reacted sensitively to the quantity of service offered. They typically encouraged the skippers to introduce first class service on the barges and (as we have already observed) resisted every effort to reduce schedule frequency.

In the first two causes, van Roijen was taking the side of the skippers, who saw the decline in demand as something exogenous to their own conduct. Van Roijen had only to look at the records of the two other trekschuit operations administered by his city to see that all three services, each operated independently of the others, showed the same general downward sloping trend. The petitions of the skippers rarely failed to cite the general condition of the economy as their foremost problem. Already in 1687 the Leiden skippers to Utrecht spoke of the ‘long-lasting bad business conditions (langdurige slecht negotie)’ as the chief cause of their falling profits. A report on the Leiden-Delft/The Hague trekchuit routes written around 1740 noted ‘that the service has diminished not only here, but throughout Holland, which has as its cause the weak economy and which up to now has not improved’. In 1747 and again in 1751 the Haarlem skippers to Amsterdam wrote to their city government complaining of the diminution of their traffic, ‘the badness of the times, and the collapse of commerce (de slegtheid der tyden en de verval in de negotie)’. In 1751 the Leiden skippers to Delft joined the chorus with a complaint that ‘the business of the supplicants has noticeably diminished in the last years... because of the collapse of commerce’.12

VI1.3. RESPONSES

As is so often the case, superficial explanations of the trekvaart industry’s problems flourished – withstanding criticism with ease – because of their appealing characteristic of justifying superficial remedies. It should not surprise us, therefore, to find the eighteenth-century records of trekvaart administrations filled with discussions of the first three of the four basic explanations identified above. But by the 1730s and 40s, when the ‘bad times and collapse of commerce’ had undermined the financial viability of even the busiest routes, the fourth and fundamental explanation of the industry’s distress could no longer be avoided.

How did the skippers and municipal administrators seek to adapt the trekschuit service to the altered circumstances? Among the several possibilities they devoted the greatest amount of attention toward cost-reducing measures. Since nearly all of the skippers’ guilds’ costs were variable, the guilds could, theoretically, stave off unprofitable operations by simply reducing their capacity in step with the leftward shifts of the demand curve for trekschuit travel. In practice this was not so easy. Figure 7.1a, based on the eighteenth-century records of the Haarlem-Leiden trekvaart, shows what was at issue. In this representation of the
costs and revenues of the skippers’ guild, line FAB is the total cost curve while OD is the total revenue curve. The higher the volume handled the greater is the profit (the vertical distance between OD and FAB). The break-even point is very near to O, the origin. The fares were set sufficiently high and the operating costs of the trekschuiten were sufficiently divisible to make possible operation at nearly any level of demand. But the actual total cost curve was not FAB; the ordinances under which the skippers’ guild operated imposed service and staffing levels that put a floor on total costs at CA. The total cost curve was, thus, CAB. Under this constraint the break-even point stood at E. In the 1720s and 1730s, when the demand curve moved to the left of E, the operations of the skippers’ guild showed a loss. This loss could have been avoided if the cost curve CAB could have been brought closer to the theoretically possible FAB. But numerous obstacles stood in the way of realizing this possibility.

The skippers’ petitions for relief from their unprofitable situation, which poured forth after about 1720, usually proposed modest reductions in schedule frequency and staffing. Thus, the Leiden-Delft skippers proposed in 1714 the discontinuance of the night barge between their cities. This vessel, they observed in their petition, only sailed during the seven summer months anyway and, to judge from its limited patronage, ‘would create as good as no inconvenience to anyone’.13 This request was repeated several times after 1714, always to no avail, until finally in 1729, the city officials granted permission to cease operating the late night departures from the two cities. Standing opposed to this – and other similar requests – were first of all, the helpers employed by the skippers’ guild. Since they were paid by the trip a reduction in the number of scheduled departures would directly reduce their incomes. After the second skippers’ petition of 1717 the helpers submitted their own petition opposing the proposal and, at the same time, suggesting as ways to increase patronage the inauguration of roeven and the elimination of the requirement to change barges at Leidschendam.14

The helpers were joined in their opposition by the commissioners. A portion of their income was derived from a per-departure fee paid to them by the skippers. The proposed reduction would therefore reduce (in a modest way) their income. But this was not their stated reason for opposition. They pointed to the deleterious consequences of frequency reduction on the volume of travel. The entire schedule was part of a delicate tissue maintained in co-operation with connecting routes. In the case of the night barge at issue, they emphasized that its existence made it possible for passengers to travel overnight from Amsterdam to Rotterdam. The removal of this link would reduce travel on other still existing services and would divert through travelers to the competing route via Gouda. The preservation of the integrity of the schedules seemed so important that over a decade after the night barges were discontinued,
and the decline in passenger volume had proceeded much further, the Leiden secretary van Roijen continued to point to that discontinuation as one of the three major reasons for the decline of the entire Leiden-Delft trekshuit service. He went to the trouble of counting the number of passengers who had traveled on connecting Haarlem-Leiden barges for the six years before and the six years after the 1729 discontinuation of the night barge. What he found by no means proved that the discontinuation had itself reduced the aggregate demand for the service as a whole. But, so convinced was he that such damage must have occurred that he interpreted the figures as an important cause of decline anyway.

The resistance to this modest cost-reducing measure was sufficiently great to delay its implementation for 15 years after being proposed, and to permit its desirability to continue being questioned 22 years after it occurred. Think how much greater was the opposition to more radical proposals that entailed the reduction of both the schedule frequency and the size of the labor force. Not only did the helpers and commissioners oppose such proposals, but the skippers themselves were, naturally enough, extremely reluctant to make them. Only when there existed no alternative did the skippers make such a request.

In 1691 the skippers of the Utrecht-de Vaart route petitioned the city of Utrecht as follows:

On this route [the livelihood of] 12 skippers and 6 jockeys depends... [The business of] this route diminishes more and more every day such that they must sail most of the time with few or no passengers, to their disadvantage and sorrow. During cold winters they must maintain their horses and there are among the supplicants many who have nothing [but this source of support] and who face great difficulties in the support of their families since much of the time there is no dry bread to be earned. The cause of this is that the quantity of skippers and jockeys is too great. A much smaller number would suffice.

The supplicants went on to request that:

the skippers' positions must die out to 10 or 11 and the jockeys to 4 or 5, whereby they hope that they will be able to support themselves a bit better.

In the eighteenth century many other skippers' guilds asked that their numbers be allowed to die out by one or two skippers. The Haarlem skippers to Amsterdam actually received permission in 1757 to reduce their number, through attrition, from 15 to 10, but seven years later the city changed its mind. 'We have come to the discovery', it reported with a certain indignation, 'that the skippers' job has come to provide more than an ordinary burger's income'. In the light of this information the city rescinded its decision of 1757 and permitted the number of skippers to die out to no less than 12.

This story exposes several peculiar limitations to the skippers' cost-reducing efforts. In the first place, the cities show themselves to be very
sceptical about the wisdom of this form of rationalization. The argument that the service could be operated just as well with fewer skippers and other workers did not impress them as a valid one. They agreed to such a reduction only when the continuation of the trekschuit operations was in jeopardy. If the skippers’ incomes improved a bit, this was reason enough to re-evaluate the employment-reducing decision. Secondly, this remedy, when approved, worked very slowly. Seven years after the ‘hiring-freeze’ had been imposed by the Haarlem skippers’ guild it still had not reached its goal. In the meantime the unnecessarily high costs continued to eat away at trekschuit revenues.

Moreover, as we have seen in chapter V, the skippers were unwilling to leave fewer job openings for the next generation without proviso that their heirs be compensated. This had the effect of imposing new debts on the guild just when its financial situation was weakest, which, in turn, had the added effect of increasing the extra cost for new skippers as the expected return on the invested capital declined – indeed disappeared. In short, the post of skipper became steadily less financially attractive. Why, then, did it continue to find takers? We do not hear of the fraternity of trekschuit skippers shrinking because of a reduction of supply. The solution to this dilemma is to be sought, I suspect, in the chronic problem of high unemployment that hung over the eighteenth century Dutch economy. In that context, a relatively secure wage income – modest though it was – became increasingly more attractive. The capital investment can then be seen as the purchase price of job security. Desperate men went heavily into debt (often borrowing from the widows or heirs who were selling the positions) in order to secure for themselves nothing more than steady work. Economic decline had converted a lucrative capital investment into a form of worker exploitation.

The fraternal character of the guilds and the rights of the skippers’ heirs conspired to make a contraction of the size of the guild a very imperfect, exceedingly gradual method of cost reduction. Gradual though it was, the municipal officials remained convinced that reductions in service – even when only a small fraction of capacity was being used – were highly undesirable. Their firm insistence on the maintenance of the original schedules, even when capacity far exceeded demand, stemmed in part from the conviction that the skippers’ financial position was not so bad as they claimed it to be. Perhaps because the administrators knew the size of the monopoly profits that their regulations conferred on the skippers, they tended to doubt the authenticity of the skippers’ complaints. The Haarlem officials who gathered in 1729 to rule on the complaint of the skippers to Leiden that they faced imminent ruin unless the fares were raised, were forced to admit that revenues had declined. Their own research in the form of a table of the annual number of passengers going back to 1690 made that much clear. ‘The service has for some years been in notable decline’, they observed, ‘[but we] have been unable to
find out when this decline began'. They also had to concede that revenues no longer sufficed to cover all the skippers' expenses, that the skippers' guild had run up f7000 in debts, and that it was without reserves to pay current expenses.

But the municipal officials were not inclined to sympathize with the skippers' plight. 'The true reason for this great decline [in the financial position of the skippers]', they reported, 'is not so much the reduction of traffic, although this is now much reduced from previous years, but rather other factors, mainly concerning the skippers and their unreasonable, profligate conduct'. According to the officials, the skippers did not manage their affairs well. Their debts had been incurred primarily through their habit of distributing too much of the guild's revenue as profit. Their high operating costs could be ascribed to slothful, inattentive management. The skippers, and their business manager, the vinder, bought bad horses, which quickly became useless because of the skippers' habits of spending so much time at the tavern at Halfwegen that they had to overtax their horses on the second half of their trip in their effort to make up for lost time. Furthermore, their oats and hay costs were excessive because they did not pay their bills on time. In short, inattentive administration and slothful abuse of the horses caused the skippers' operating expenses to be far higher than was necessary.

The Haarlem officials' response to the skippers' cries of distress was to recommend more economy in that narrow range of costs over which the skippers could exercise some discretion. They were not prepared to alter any of the ordinance requirements that determined the revenue per passenger and the overall level of service (and hence cost).

Even if all the accusations leveled against the Haarlem skippers had been true, it is hard to see how they could have accounted for more than a small portion of the skippers' financial difficulties. The major cause of their high costs was the municipal requirement to offer an extravagantly excessive passenger-carrying capacity. But, as we have seen, the trekvaart administrators were rarely willing to permit the reduction of schedule frequency and employment. So great was their reluctance that they preferred to subsidize the skippers' guilds - their suspicion of the skippers' ineptitude notwithstanding - rather than agree to a scaling down of the industry's capacity. Thus, the Leiden skippers to Delft received from their municipal government f500 per year in the 1730s. At the same time the Delft-Rotterdam skippers were each receiving f200 per year. The Leeuwarden-Bolsward skippers each received f200 per year in 1761 and in 1781 their subsidy was increased to f300.

According to an Amsterdam official writing in 1837, the city of Haarlem had from at least the 1790s until the 1820s pursued a secret subsidy policy. The city allowed its skippers to underreport their collection of the gabelle, and to pocket the non-reported amount as a subsidy. Consequently, Haarlem's financial records showed a smaller number of
passengers than were in fact carried. The beauty of this form of subsidiza-
tion was that when Haarlem met with Amsterdam officials at the end of
each year to equalize their revenues and expenses, Haarlem’s records
showed smaller revenues than Amsterdam’s. This obliged the latter city
to transfer a portion of its revenues to Haarlem. In this way Amsterdam
was tricked into paying a portion of Haarlem’s secret subsidy to its
skippers.  

As the demand for intercity passenger travel declined, the trekvaart
industry proved to be unable to reduce its costs. Technically such cost-
reductions were perfectly feasible, but the organizational form assumed
by the industry, together with the puzzling conduct of the municipal
officials conspired to all but rule out a cost-reducing response to the
industry’s problems.

A possible source of municipal resistance to schedule frequency reduc-
tions can be identified in the division of total costs between the municipal
trekvaart administrators and the trekschuit skippers’ guilds. The main-
tenance and debt repayment costs of the former were almost entirely
fixed costs, while the trekschuit operating costs of the latter were almost
entirely variable costs. On the other hand, the revenue of both derived
overwhelmingly from the fares paid by the passengers. Figures 7.1a and
b show the break-even points of these two organizations, using the Haar-
lem-Leiden trekvaart as an example. As discussed earlier, the break-even
point of the skippers’ guild, in the absence of capacity regulations, would
have stood near O, the origin. An appropriately sized skippers’ guild
could have made a profit at almost any level of demand. For the municipal
trekvaart administrators matters stood rather differently. Since their
costs were fixed, no adjustment to changing demand was possible. Hence,
the horizontal line indicates their costs, and point G is the break-even
point. A minimum of 40,000 passengers per year were needed for the
municipality to cover its maintenance and debt repayment costs.

Was there any way that the municipal officials could guarantee that
they would always enjoy the toll revenues of at least 40,000 passengers?
One thing they could do was insure that the skippers’ guild that exercised
the monopoly rights to carry those passengers would always offer a
service with a capacity sufficient to make the transport of 40,000 passen-
gers possible. Since the officials did not themselves bear the costs asso-
ciated with providing that capacity, this was an easy requirement for
them to make. By changing the skippers’ cost curve from FAB to CAB the
officials insured that the two organizations would both begin to suffer
financial distress at about the same time. It remains the question whether
the availability of over-abundant passenger-carrying capacity actually
made the total demand for intercity travel greater than it otherwise would
have been.

It cannot be denied that schedule frequency is an important charac-
teristic of a transport service. A service offering eight daily departures is
in several respects a different and much superior service to one offering only four daily departures with precisely the same technology and price. This is particularly true when the duration of trips is short relative to the intervals between departures. But could the need for immediate departure have been such that a significant portion of travelers would not have made their contemplated trips, or would have used other modes, if trekschuit departures had been less frequent? From what little we know of the motives and needs of seventeenth-century travelers, it seems unlikely that small changes in schedule frequency could have affected the level of demand.

206
The municipal officials may have valued frequent departures for another, related reason. Even if the traveling public in general were indifferent to the frequency of departures, it may have been believed that business travelers derived important economic advantages from this characteristic of the trekschuit service. Since it was this group of trekschuit passengers that the cities had in mind when they committed themselves to the creation of the network, it may be that they felt the external benefits created by frequent departures and captured by businessmen justified the financial burden imposed by the preservation of overcapacity in the industry. Once again, it must be noted that no direct evidence exists to support such a description of municipal aims. Moreover, it is difficult to find specific examples of the economic advantages offered by the very high departure frequencies of the trekschuiten in Holland and Utrecht.

Another possible motive for the maintenance of excess capacity is a municipal policy of maintaining employment levels. This, too, is not particularly convincing. In the light of the cost curve analysis of chapter VI there existed a second and superior path to the maintenance of employment among trekschuit crews. So long as the demand for travel was thought to be price-elastic, a policy of lower fares would have been a less costly way to achieve this aim.

Finally, it may well be that the high departure frequencies insisted upon by the cities had nothing to do with either the creation of an economically valuable flexibility or the maintenance of employment. Instead, a craving for municipal prestige may best explain the seemingly wasteful policies of the cities. Conceivably the high mightinesses who ruled the proudly autonomous Dutch cities saw a frequent trekschuit service as one more symbol of the splendor and importance of their cities. No positive evidence exists to document this interpretation of municipal trekschuit regulation, but it is consistent with municipal policy in other areas.\footnote{23}

If the preservation of this excessive schedule frequency was a dubious way of encouraging high-volume demand, another of the available policy tools — pricing policy — could surely have achieved a great deal. We have already established that the fares imposed by the seventeenth-century ordinances stood far above average total costs and awarded the skippers handsome monopoly profits (see figure 6.3). Those profits declined, of course, as the demand curve shifted continually further to the left between the 1670s and the 1740s. Figure 7.2, continuing the cost curve analysis begun in chapter VI, portrays the situation faced by the Haarlem-Leiden trekvaart around 1700. The demand curve of 1700 has moved decisively to the left in comparison to the curve of 1670, but it continues to reflect our modest assumption of unitary demand elasticity around point R. Once again, we can identify the optimal pricing points for various policy objectives, ranging from monopoly profit maximization
(point M) to maximum mobility (point C). At the price set by the municipal administrators (PR - unchanged from 1657) the trekvaart operations as a whole broke even (after taxes). The monopoly profit of 1670 had disappeared: partly because of the reduction of demand, partly because of the unnecessarily high costs imposed by municipal schedule regulation. (This cost is the vertical distance between ATC' and ATC.) If we concede the impossibility or undesirability of lowering costs, then only the pricing instrument remains to stave off deficit operations. Note that a much lower tariff than PR would have increased the demand for trekschuit travel (and thereby increased employment) without harming the profitability of the enterprise. Point C would have been optimal in this regard. The more the elasticity of demand exceeded the modest assumption made in figure 7.2, the more a price decrease would have improved the financial health of the industry.

In the mid-1740s, when the Haarlem-Leiden route and the industry as a whole reached a historical low point, there was no possible way to make the industry profitable. The economic crisis had assumed such proportions that both the cities and the skippers' guilds suffered heavy losses and the demand curve stood to the left of the average total cost curve at every point. Figure 7.3 portrays this situation using the separate cost curves as faced by the skippers and the cities. Here we can see that at price PR the skippers suffered a loss of AD while the cities' fixed costs exceeded their 5 st. per passenger revenue by EF. Both enterprises booked

![Figure 7.2. Average costs and assumed demand curve on the Haarlem-Leiden trekvaart, c. 1700.](image-url)

For identification of symbols see the text and figure 6.1. In addition, AVC' and ATC' represent average variable and average total costs when carrying capacity cannot be reduced below the level established in 1657.
heavy losses, and the skippers were able to keep going only through subsidies from the cities. In figure 7.3 it is once again possible to show that tariff reductions would have increased demand without increasing the losses incurred by the cities and skippers. Once again, the results become more favorable, the more elastic is the demand. And, of course, it remained possible to reduce the schedule frequency and the size of the skippers' guild and thereby reduce the guild's loss from AD to BD.

The demonstrations force us to return once again to the problem of the price elasticity of demand for trekschuit transportation. In chapter VI, I presented several arguments and indirect evidence in support of the proposition that the elasticity was at least -1 (unitary). In the chapter that follows an attempt is made to identify the early nineteenth-century elasticity with results in all cases in excess of -1. With the benefit of hindsight we can use the cost curve analysis presented here and in chapter VI to fault the pricing policies of the cities as counterproductive and even irrational. But what did the skippers and administrators themselves believe to be the shape of the demand curve that faced them?

Many skippers' guilds acted as though they believed demand for their services to be inelastic. This is evident from their repeated requests for fare increases to counteract the fall in their revenues caused by diminishing business. For example, the Haarlem-Leiden skippers requested fare increases repeatedly from at least 1729 until 1741 (when a small increase was granted), and the Leiden-Delft/The Hague skippers badgered their cities for increases from 1725 until an increase was granted.
in 1738. Their belief in the inelasticity of demand is also reflected in their extremely sceptical attitude toward the proposals to introduce *roeven*. This innovation, which proved so beneficial to the financial position of the skippers, was invariably recommended by others – the cities, the commissioners, even the helpers – and always opposed by the skippers. Their opposition was based on the belief that the introduction of *roeven* imposed conversion and maintenance costs that would never – because of the static character of the market – be compensated by increased revenues.

The municipal officials apparently had a different vision of the market for trekschuit service. They pushed for the introduction of *roeven* (even though the cities rarely stood to derive any direct financial benefit therefrom) and they rejected almost all requests for fare increases. The fact that the municipal officials even preferred subsidizing the skippers to authorizing fare increases is consistent with the belief that the demand curve was quite elastic. More direct support of this view is provided by the Haarlem officials who responded to the 1729 Haarlem-Leiden skippers' request for a 3% fare increase with the observation that:

This should not be permitted because in the opinion of old persons experienced in this matter nothing more can be expected [from a fare increase] than the diversion of traffic and, thus, the total ruin of the entire trekschuit service.24

The Haarlem officials' belief that demand was elastic was, judging from the fact that fares rose much less than the general price level in the eighteenth century, shared by the officials in most other cities. But, there is no evidence that anyone ever acted on this belief to propose a reduction of fares until the last days of the trekvaart industry, when it faced destruction at the hands of the new railroads.25

VII.4. TECHNOLOGICAL CHANGE

Besides adjusting prices to increase demand and rationalizing operations to reduce costs, a declining industry can also hope to improve its situation by introducing technological changes that increase a mode's competitive position *vis à vis* other modes. The addition of *roeven* to the trekschuiten in the course of the eighteenth century, while not a true technological change, is an example of how a transport mode can acquire new characteristics capable of uncovering new markets or extracting more revenue from an existing market. As a marketing innovation the *roe* may have attracted a few travelers who otherwise found the trekschuit beneath their dignity, but its chief effect was to extract a higher fare from status-conscious travelers. The resulting extra income, as we have seen, accounted for most of the improvement in the skippers' earnings in the second half of the eighteenth century.
The introduction of roeven aside, the trekschuiten of 1800 were technically the same as those of 1630. Their speed, crew size, and comfort remained essentially unchanged throughout this entire period. This constancy is perhaps understandable in view of the almost total absence of inter-modal competition in the market for intercity passenger transportation. There was little the trekschuit could do to attract the upper end of the market that made use of private carriages and yachts. At the lower end, where the chief alternative to the trekschuit was walking, we have shown that a marketing rather than a technological solution was called for. Although the skippers sometimes complained of coach competition, regularly scheduled coach services (as distinct from unregulated wagon drivers) never directly competed with trekschuiten. Never, that is, until the last decade of the eighteenth century. Then the spread of paved roads and the introduction of better sprung coaches made road transport competitive with trekschuiten for the upper income sector of the market for public transportation. The industry then faced a situation that called for a response that would improve the competitive position of the trekschuit. In the late eighteenth century the demand for trekschuit travel had long since ceased declining and even showed modest signs of growth. But that growth could not proceed without adapting the ancient trekschuit technology to the more competitive environment prevailing around the turn of the nineteenth century.

An appealing innovation that might have answered to the demands of the time was the vliegende schuit (the flying barge). It was not much of a technological innovation: a vliegende schuit was simply a trekschuit pulled by two horses instead of the customary one. Indeed, nothing stood in the way of introducing the vliegende schuit in the seventeenth century. A barge pulled by two horses was capable of maintaining an average speed of 10 or 11 kilometers per hour, an improvement of 3 or 4 kilometers per hour over the ordinary barge, and nearly equal to the speed of coaches on paved roads. This speed improvement could be won at a cost of doubling the number of horses used to pull the barge. Since the annual maintenance cost of a horse was not inferior to the annual-earnings of a skilled adult worker, this cost was not trivial, but was far less than the cost of the coaches with which the vliegende schuit would have competed.

The first mention of an extra-speedy barge that I have found dates from 1744. In that year a new ordinance for the Amsterdam-Utrecht route stipulated that during four summer months a second barge had to stand ready at every scheduled departure to accommodate any overflow demand. If the commissioner put a second barge into service the passengers ‘who wanted to make more than ordinary speed’ had the right to request that a second horse be hitched to one of the barges. For this special service the speed-craving passengers had to pay a total of 60 stuivers.

The vliegende schuit was still no more than an option available on a privately negotiated basis. Indeed, the ordinance went on to forbid the
use of two horses when only one barge set sail, and to prohibit the second barge from overtaking the first barge en route. All of this was felt necessary to guarantee regular service to passengers at intermediate stops.26

A regularly scheduled vliegende schuit, with a set rather than negotiated fare, did not exist before the nineteenth century. Once again, the Amsterdam-Utrecht route took the initiative in this matter. The competitive advantages of the vliegende schuit over the two other modes of transportation available on this route in the 1820s can be read from table 7.1. For the traveler seeking to bridge the 46 kilometers separating Amsterdam from Utrecht the regular trekschuit offered the cheapest service while the coach offered the fastest. But the three hour time saving of the coach over the trekschuit did not come cheap: it cost 17 st. per hour. The appeal of the vliegende schuit lay in the fact that it saved almost as much time as the coach while its cost did not far exceed the trekschuit. By using the vliegende schuit one could save time at a cost of only 6.4 st. per hour. Or, to put it another way, the only people who used a coach when the vliegende schuit was available were those prepared to spend an extra 38 st. for the one hour time saving.

The Amsterdam-Utrecht vliegende schuit operated, apparently with success, until the coming of the railroad in 1843.27 In 1825 the skippers on the Amsterdam-Haarlem route requested permission to operate a vliegende schuit twice per day during the month of June.28 Why they limited their request to but one month per year, what changes they proposed for the schedule of the ordinary barges, and what fare they intended to charge are not known. Nor is the fate of their request known, but there is no indication in the travel guides of later years that vliegende schuiten operated on the Amsterdam-Haarlem route.

For reasons that remain obscure, the vliegende schuit, which saved

<table>
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<th>Transport mode</th>
<th>Trekschuit</th>
<th>Vliegende schuit</th>
<th>Coach</th>
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<tr>
<td>Time (in hours)</td>
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<td>5</td>
<td>4</td>
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<td>Cost (in stuivers)</td>
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<td>68</td>
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<td>Speed (km per hour)</td>
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<td>Cost per km (in stuivers)</td>
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<td>0.65</td>
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<td>17.0</td>
<td>38.0</td>
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</table>

Source: G.A. Utrecht, Archief 1815–1851, nos. 1280, 1300.
travel time at a much lower cost than the coach, did not flourish on the Dutch trekvaart network. It manifested its potential in Great Britain instead. There, ‘swift boats’ pulled by two horses that were changed every two miles, plied the new canals at an average speed of 11 km per hour. They were most numerous in Scotland. On the Forth and Clyde Canal such barges were introduced in 1809 to carry passengers between Glasgow and Edinburgh. Very quickly they succeeded in building up the volume of traffic from the 5000 yearly passengers carried before the introduction of the swift boats to 44,000 in 1812 and nearly 200,000 in 1836.29

VII.5. AN ASSESSMENT

The passenger transportation industry of the Dutch Republic was large by contemporary standards. Not only did it give employment to perhaps 2000 men, it required the investment of a large amount of capital: 4.6 million guilders for the construction of the trekvaarten plus several hundred thousand guilders for horses and barges. It provided a service that in the late seventeenth century claimed in the vicinity of 1% of the average household’s gross income and annually absorbed 6 hours of the time of every man, woman, and child in the region served. The industry’s achievements were unique in a pre-industrial economy. It is hard to find another example of a large investment of capital in an innovation that depended on the generation of mass demand for its success. By offering a service at a price far below that prevailing elsewhere for comparable service, the industry was initially financially successful at the same time that it offered the urban public a unique degree of physical mobility.

The industry was large, but no effort was spared to insure that its operating and decision making units be as small as possible. Even the smallest routes possessed at least two trekvaart administrations and two skippers’ guilds. One, the trekvaart connecting Amsterdam with Hoorn, had no less than five of each. The splintering of authority is partly explainable by the strong tradition of municipal particularism that characterized the Dutch Republic. Since the state was created in part to preserve municipal independence, it would be unreasonable to expect that the more efficient operation of a municipally created transportation service would be a sufficient reason to compromise that principle. But the splintering went further: cities owning more than one trekvaart did not unify their administrations of these similar enterprises, nor did they place the operation of the barges under the direct control of the trekvaart administrations. The responsibility for what was, after all, a single unit of enterprise was awkwardly divided among a multiplicity of relatively autonomous agencies. This organizational structure required that there
be agreements and compacts among the parties, and because they were difficult to achieve they became difficult to change. This only reinforced a strong existing tendency to reduce to routine the functions of all the constituent units.

All went well so long as the tasks to be performed repeated themselves year after year without change. But the nature of this industry—particularly its capital intensity and its reliance on a mass market—insured that managerial initiatives requiring a high order of business ability would have to be taken. And such initiatives proved nearly impossible to take. Those closest to the business, the skippers and commissioners, depended on the municipal officials for authority to introduce changes. These, because of the division of financial responsibility between the cities and the skippers’ guilds, often saw the problems and their potential solutions very differently from the skippers. Moreover, a policy change that affected the fare or the frequency of service required the agreement of both (or all) of the cities that participated in the operation of a given trekvaart route. Finally, even when two or more cities could come to a decision on such a matter, it might still have little effect unless the operations of other routes were altered as well. For instance, if an official of the city of Haarlem believed that the Haarlem-Leiden trekvaart would better achieve its goals if the fare were reduced by 20%, he would have had to persuade his counterpart in Leiden of the desirability of his proposal. But, since a large proportion of the passengers on this route were through travelers who also made use of connecting routes, a lowered fare would have had its full desired impact only if the other routes followed suit. Otherwise, the decision of the Haarlem-Leiden trekvaart would have increased demand by less than the desired amount while at the same time presenting the connecting routes with an externality, a ‘free gift’ of higher demand.

With this knowledge of the organizational weakness of the industry we can better comprehend why the officials and skippers, when faced with a decline in demand in the eighteenth century and new competition in the nineteenth, did virtually nothing in response. Despite the much altered circumstances, the service offered in 1820 was almost exactly what it had been in 1660. By delving into the cost structure of the industry, the demand schedule that it faced, and the potential of the technology, I have sought to demonstrate that this observed inaction was by no means ‘natural’ or inevitable. A considerable number of possible measures had the capability of softening the impact of decline or actually increasing demand, but virtually without exception these measures were not adopted.

It is sometimes argued that the railroad, the first industry to develop the techniques of modern management, organization, and bookkeeping, was also the first industry which, because of its size and capital intensity, actually required such innovations. The history of the trekvaart industry
is testimony to the fact that industries do not always get the organizational forms that they need. A complex industry was put in the hands of two forms of readily available organization: municipal administration and guild. There, perhaps, we have a clue that helps explain the seemingly inappropriate, certainly unclear, management policies that governed the trekvaart industry. The typically static, administrative character of these organizational forms tended to obscure the true nature of the business entrusted to the care of the responsible authorities and prevented them from making use of more than a portion of the full potential of the technology.

The awkward organizational form imposed on the industry does not, by itself, explain everything. After this factor is taken into account, the behavior of the municipal officials still exhibits puzzling features. What they were trying to achieve remains unclear. They invested large quantities of capital in an industry and then, apparently, ignored the capital costs in their bookkeeping. The profitability of that investment depended on mass demand, but they pursued a pricing policy that succeeded only in throttling a significant amount of demand for intercity travel. At the same time they imposed on the skippers service requirements that only made sense if the demand had been much greater than it was. However senseless this wasteful game was in the first years of trekschuit operation, it was doubly senseless in later decades when the authorities had had more opportunities to know what the supply and demand conditions really were like, and when the decline of aggregate demand was robbing the system of its profitability.

When these contradictory policies plunged the skippers' guilds into financial difficulties, the cities preferred to subsidize them rather than rationalize the regulations. That is, they chose what was for them the most expensive solution.

Clearly, a model of the profit-maximizing, capitalist firm fits this industry badly. It makes a bit more sense to approach it as a public utility established by the cities to stimulate their commerce and provide employment. But the policies designed to achieve those goals were distinctly suboptimal. They were an expensive way to maximize the movement of barges rather than the movement of people. Not wishing to dismiss the work of the municipal officials as irrational or the product of sheer laziness, I have suggested that municipal prestige considerations might be capable of explaining some of that suboptimality. We are left, then, with a model of the public utility as municipal status symbol as the most satisfactory description of trekvaart management, a model that, upon reflection, might find many modern applications in the field of transportation regulation.

When viewed from a distance the trekvaart industry must impress us as something quite wondrous. This, indeed, is how foreign contemporaries regarded it. It could persuade us that there is perhaps still merit in
Huizinga’s view of Dutch civilization as an almost miraculous creation, suspended above the rules that otherwise govern European history. But when the microscope is applied to the trekvaart industry it comes tumbling back down to earth, exposed as no less flawed and tarnished than any other of early modern Europe’s economic institutions. Dutch capitalism is here shown to have fallen on its face when it left the well-trodden path of trade and finance. The successful organization and management of large-scale production (even of a service) for a mass market required innovations for which the pre-industrial capitalist’s range of experience did not prepare him. Hence the reliance on an older tradition, administrative and corporate.

But before writing off the trekvaart industry as precocious but essentially premature, one final observation must be made. The mismanagement of transportation industries did not end with the trekvaart – on the contrary, its modern history can be said to have begun there. Most essential elements of the transportation problem as it affects regulated transport industries today were present in the age of the trekschuit. Nothing is new.
CHAPTER VIII
SOCIAL SAVING TWICE CONSIDERED

VIII.1. THE CONCEPT OF SOCIAL SAVING: ITS USES AND LIMITATIONS

The trekvaart network has now been analyzed from several perspectives: as a physical and temporal phenomenon that endowed the Dutch Republic with a unique time-frame, as a social institution that assisted in endowing the Republic with its special 'social fabric', as a technological innovation, and as an industry with a whole series of economic influences on the economy of the Republic. We have seen the system as, among other things, an employer of labor, a stimulator of transport-intensive industries, a saver of time, a user of energy. Is it possible to summarize these heterogeneous influences into a single measure of economic impact? Such a measure could permit a better assessment of the importance of this innovation. Its impact could then be compared with that of later transportation innovations, as well as with other contemporary developments in the economy of the Dutch Republic.

The 'social saving' of an innovation is often used to identify its net economic contribution to an economy. Specifically, the calculation of social saving attempts to measure the portion of an economy's GNP whose existence can be attributed to the presence of the innovation in question. A technological innovation in the production of a good or provision of a service usually liberates resources. Its greater efficiency permits the same output to be attained at lower cost. The liberated resources are thus free to be used in other sectors of the economy. The measure of the importance of the innovation is thus the calculation of how much of the economic resources would have to be channeled back into the sector in question if the innovation did not exist. That diversion can be expressed as a percentage of the GNP that would, under this assumption, have to disappear.

There are many reasons to disapprove of this social saving concept. In the over twelve years since economic historians began attempting to apply it to the assessment of the historical importance of technological innovations, these objections have been persuasively argued. The fundamental objection is that the strong assumptions that must be made to compare an economy as it was with an economy as it would have been in the absence of the innovation in question do violence to both historical reality and most people's credulity. What is the real meaning of a comparison with something that never was? This objection to 'counterfactual' history loses some of its force when the comparison is made immediately after an innovation is introduced. Then the counterfactual situation (the economy minus the innovation) is not so far removed that its description
must be fanciful. On the other hand, such a comparison is bound to underestimate the social saving of a truly important innovation. That social saving assumes its true dimensions only when the economy has fully adjusted to its presence. It is just then, however, that the dynamic process of adaptation makes the counterfactual situation all but impossible to recapture.

There are other, more practical problems. Social saving calculations must usually assume that different technologies produce the same product - such as ‘transportation’. The differing qualities of transport by various modes as regards speed, comfort, status, flexibility, are assumed to be economically unimportant. These non-pecuniary differences can be included in a calculation of social saving, but at the cost of changing its definition, and making its meaning even less precise than the definition provided above. Another problem concerns the data used in making the comparisons: it must be assumed that markets are perfectly competitive and that prices equal average costs. If this is not the case, the use of monetary units in the calculation of the real resources saved by an innovation will be distorted. One must further assume constant long-run costs over the entire relevant output range. This is necessary so that the available price data can be used in counterfactual situations where the scale of output has changed, but it tends to trivialize the issue of the impact of technological change.

These objections to the use of the social saving concept - and there are more - are very serious. There is really only one general justification for continuing to use the concept and that is that there exists a great interest in assessing the overall economic impact of an innovation. It is better that such an assessment be based on explicit, refutable assumptions rather than on vaguely described impressions. In the case at hand there is another, specific, justification. The innovation being assessed attained its full development quickly and in a sharply delineated geographical area. It also disappeared very suddenly. Therefore, the comparisons between the Dutch economy with and without the trekvaart network can be made with a minimum of counterfactual assumptions. Finally, it should be added that the purpose of this exercise is not to test an ‘axiom of indispensability’. No one has ever argued that the Dutch economy could not have grown without the trekvaart. The calculation will be made solely to acquire a rough idea of the possible dimension of the resource savings attributable to the trekvaart. Was it so small as to be indiscernible or did it conceivably play some role in increasing the economic well-being of the population?

Before proceeding to an estimation of social saving, which measures the static – resource saving – impact of an innovation, we should consider its possible dynamic impact. Following Albert Fishlow the economic effects of a transport innovation can be divided into three categories: the direct resource savings, or social saving, the forward linkage, and the
backward linkage. The last two are dynamic effects that are not directly captured in a calculation of social saving.\(^2\)

The forward linkage refers to the response of other sectors of the economy that is induced by the availability of the transportation innovation. The strength of that response depends upon the structure of the economy, and specifically, the extent to which transportation is a significant input: if transport as a factor of production is substitutable with other inputs, if the ratio of transport costs to total costs is high, and if the cost reduction introduced by the innovation is large, then this forward linkage can be of great importance. In this case the innovation will induce a change in the production functions of other industries. The forward linkage effect of passenger transportation on the economic structure of the Dutch Republic was considered in chapter III. There it proved impossible to offer concrete examples of such an induced response. But the impact of improved passenger transportation on an industry is notoriously difficult to trace. It affects transactions costs (which include the cost of transportation, the cost of acquiring information, closing and enforcing contracts, and making payments) rather than production costs, and the induced effects can be very gradual in making themselves felt.

The backward linkage refers to the resource demands generated by the innovation. At first glance this is the mirror image of the direct resource saving of the innovation that social saving tries to measure. But it is possible for an innovation to have a major effect in both categories, for, while the total volume of all resources is important for the social saving calculation, the backward linkage effect is stronger the greater the magnitude of demand for specific inputs, which themselves have growth-inducing qualities. Thus, the backward linkage effect is stronger if the innovation requires a large quantity of an input whose production benefits from economies of scale than if it requires small quantities of a large number of readily available inputs.

The resource demands generated by the trekvaart system were described in chapters IV and V. Once the trekvaarten were built – which temporarily required thousands of workmen – the yearly resource demand for canal maintenance and trekschuit operation can be summarized as follows in table 8.1.

Two categories of expenditure dominate the average annual total expenditure of nearly £600,000: direct labor costs and horsepower. The employment total, nearly 2000, was by no means insignificant in a region with a male labor force of about 400,000,\(^3\) but its impact was not enormous in any one place since this demand was spread over at least thirty cities. The trekvaart system imposed no demand for new or unusual skills. The extensive bookkeeping requirements of the trekschuit service required more than basic literacy of the skippers, but that aside, the skills were such that the labor force could be drawn from a vast pool of labor active in inland navigation and dike and ditch maintenance.
### Table 8.1. Average annual resource use of the trekvaart network.

<table>
<thead>
<tr>
<th></th>
<th>Man-years</th>
<th>Annual workers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Labor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canal maintenance and administration</td>
<td>464</td>
<td>c. 800</td>
</tr>
<tr>
<td>Skippers</td>
<td>349</td>
<td>349</td>
</tr>
<tr>
<td>Helpers</td>
<td>349</td>
<td>349</td>
</tr>
<tr>
<td>Horse and barge maintenance</td>
<td>128</td>
<td>128</td>
</tr>
<tr>
<td>Adult male labor</td>
<td>1290</td>
<td>1626</td>
</tr>
<tr>
<td>Jockeys</td>
<td>349</td>
<td>349</td>
</tr>
<tr>
<td></td>
<td>1639</td>
<td>1975</td>
</tr>
<tr>
<td><strong>2. Horsepower</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horses</td>
<td>504</td>
<td></td>
</tr>
<tr>
<td>Maintenance and depreciation costs (at f 300 per horse/year)</td>
<td></td>
<td>f 151,000</td>
</tr>
<tr>
<td><strong>3. Materials</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand, gravel, iron, wood, brick, etc.</td>
<td></td>
<td>f 70,000</td>
</tr>
<tr>
<td><strong>4. Barges</strong></td>
<td>364</td>
<td></td>
</tr>
<tr>
<td>Depreciation costs (f 1000 per barge, 20 yr. average life)</td>
<td></td>
<td>f 18,200</td>
</tr>
<tr>
<td>Maintenance costs (estimated two times the depreciation costs)</td>
<td></td>
<td>f 36,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f 54,700</td>
</tr>
</tbody>
</table>

**Average total costs**

<table>
<thead>
<tr>
<th></th>
<th>Mid-17th century</th>
<th>Mid-18th century</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trekvaart administration</td>
<td>f 232,000</td>
<td>f 232,000</td>
</tr>
<tr>
<td>Skippers' guild</td>
<td>f 350,000</td>
<td>f 290,000</td>
</tr>
<tr>
<td><strong>Total direct expenditure</strong></td>
<td>f 582,000</td>
<td>f 522,000</td>
</tr>
<tr>
<td>Capital costs</td>
<td>c. 150,000</td>
<td>c. 150,000</td>
</tr>
<tr>
<td></td>
<td>f 732,000</td>
<td>f 672,000</td>
</tr>
</tbody>
</table>

Sources: Tables 4.3, 4.5, 5.1, and the text of ch. 5.

When we return to the system's demand for horsepower and materials, the same absence of significant backward linkage becomes apparent. There was nothing required to operate the system that could not readily be supplied in the needed quantities by the existing economy. Backward linkages exerted no dynamic influence on the economy.

By using direct resource saving of the trekvaart network as a global measure of its economic impact, we are probably underestimating that impact, but not by an enormous amount. Growth-inducing backward linkages were not important; forward linkages may have been important...
to the development of an urban system and to the efficient operation of
certain industries, but the linkage is difficult to specify, let alone measure.4

We turn, then, to the measurement of the social saving of the trekvaart
network. Since the first efforts to measure the social saving of transport
innovations, the concept has been redefined and elaborated upon several
times. What the earliest studies had in mind was conceptually really
quite simple – but historically very difficult. Robert Fogel, in his book
Railroads and American Economic Growth: Essays in Econometric History, in-
tended to measure the social saving generated by railroads in the move-
ment of agricultural commodities. To him the social saving was simply
‘the difference between the actual cost of shipping agricultural goods in
that year [1890] and the alternative cost of shipping exactly the same
collection of goods between exactly the same set of points without rail-
roads’.5 Albert Fishlow, who sought to measure total railroad social
saving in 1850, defines the concept in the same way, noting that the
‘alternative cost’ was the cost of that mode of transportation that would
most likely have provided the service on any given route.6 Both Fogel
and Fishlow assume that the prices of transport were accurate reflections
of actual costs of providing the service. This is important because social
saving seeks to measure ‘the real inputs made “redundant” by the innova-
tion and hence available to increase aggregate output’.7 Further, both
assume that the demand for transportation is completely inelastic.
Facing the alternative technology with its higher costs, the economy
nevertheless seeks to move goods and people over exactly the same routes
in exactly the same quantities. The economic unreality of this assumption
is clear. At the very least it would produce an overestimate of social
saving. It was used anyway because of its indispensability in the identifica-
tion of a unique value for the social saving of the innovation.

What we need to know to calculate social saving as Fogel and Fishlow
define it is the volume of transportation produced in the period for
which the measurement is to be made, the cost of providing that service,
and the cost that would have been incurred had the economy sought to
produce the same service with the appropriate alternative technology.
It is the counterfactual character of this last necessary information that
makes the estimation so hazardous and historically problematical.

VIII.2. THE SOCIAL SAVING OF THE TREKVAART NETWORK IN 1670

VIII.2.1. Direct resource saving

In the case of estimating the social saving of the trekvaart network
around 1670, the counterfactual content of the necessary data is very
small. Given the geographical isolation of the trekvaart network and
the technological stability of the competing modes, we need not guess at
what the costs of alternative transport would have been.
In the discussion on passenger transport tariffs in chapter III, it was established that trekschuit fares ranged from 4.5 to 6.5 p. per kilometer. An average fare can be set at 5.5 p. per kilometer. Of that, 0.85 p. was tax, the *passagiegeld*. Sailing vessels in this period cost from 2.5 to 4.0 p. per kilometer. Most of our quotations refer to vessels that plied the open waters of the Delta and Zuider Zee. The costs of navigating in rivers and canals were higher, but we will nonetheless assume an average cost for sailing vessels of 3.5 p. Coaches in the Dutch Republic charged fares that ranged from 10 to 18 p. per kilometer. The coach fares on routes in the region served by trekschuiten were at the lower end of that range.

Since wagon routes that *would have had* to exist in the absence of trekvaarten probably would have shared the characteristics of these high-frequency coach routes, we will assume their fares to be typical of the passenger transport costs using the coach alternative.

The data summarized in table 8.2 are sufficient to calculate the social saving of the trekvaart. In the absence of trekvaarten the Republic could have used sailing vessels to produce the 37.8 million passenger-kilometers between the various city-pairs of the trekvaart network. This would have cost f416,000 in place of the f556,000 cost incurred in the use of the trekvaarten, for a net social loss of f140,000 per year in the use

<table>
<thead>
<tr>
<th>Table 8.2. Social saving (direct resource saving) estimate, 1665–1675.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volume</strong></td>
</tr>
<tr>
<td><strong>Fares</strong></td>
</tr>
<tr>
<td>Trekschuit</td>
</tr>
<tr>
<td>Coach</td>
</tr>
<tr>
<td>Sailing vessel</td>
</tr>
<tr>
<td><strong>Total cost</strong></td>
</tr>
<tr>
<td>Trekschuit</td>
</tr>
<tr>
<td>Coach</td>
</tr>
<tr>
<td>Sailing vessel</td>
</tr>
<tr>
<td><strong>Social saving</strong></td>
</tr>
<tr>
<td>Trekschuit vs. sailing vessel</td>
</tr>
<tr>
<td>Trekschuit vs. coach</td>
</tr>
<tr>
<td><strong>Gross regional product estimate</strong></td>
</tr>
<tr>
<td>300,000 households × f 350 (average annual income) = 105 million</td>
</tr>
<tr>
<td><strong>Social saving as % of GRP</strong></td>
</tr>
<tr>
<td>Trekschuit vs. sailing vessel</td>
</tr>
<tr>
<td>Trekschuit vs. coach</td>
</tr>
</tbody>
</table>

Sources: Tables 3.8, 3.9, and 9.1.
of the trekvaart. This figure overestimates the advantages of the sailing vessels, however, since the routes that these vessels had to use were more circuitous than the trekvaart routes. This circuity varied enormously from route to route, but 15% is surely a modest estimate of the circuity-saving of the trekvaart network. Since the production of 37.8 million passenger-kilometers per trekschuit would have required 43.5 million passenger-kilometers per sailing vessel, the cost comparison is now £556,000 for the trekvaart versus £475,000 for the sailing vessels. The social saving of the trekvaart network is £81,000.

A more appropriate identification of the alternative transport mode to the trekvaart is probably the coach. Elsewhere in Europe and in those parts of the Dutch Republic where the trekvaart could not be used the coach came to assume the chief burden of intercity passenger transportation. One can readily believe that, had the trekvaart network not been built, a much more extensive network of coach routes would have been developed to assume the chief burden of intercity transportation. This is precisely what happened in neighboring countries.

The social saving of the trekvaart network in 1670, assuming the coach as the universal alternative, is the difference between the total cost of trekvaart service £556,000 and the total cost of producing 37.8 million passenger-kilometers of coach service, £1,417,000. Since circuity is not a factor in this case, the social saving of the trekvaart can be calculated directly. It amounted to £861,000.

The first objection one might raise to this estimate is that the fares used did not accurately reflect costs. We have already demonstrated in chapter VI that the municipal regulation of trekschuit fares did not seek to set them equal to average total costs. However, we can test whether the £861,000 figure is roughly correct by attempting to identify the cost of the actual inputs saved by using trekschuiten instead of coaches.

By far the greatest expense of coach transportation is horsepower. We know that the 75 million passenger-kilometers per year capacity of the trekvaart network required the energy input of 504 horses. How many horses would have been needed to provide that same capacity using coaches? At an average capacity of 8 passengers per coach, 9.4 million coach-kilometers per year would have to have been produced, or 28,500 coach-kilometers per day (assuming 330 days of full operation per year). If each coach were pulled by 4 horses, and each horse were run 40 kilometers per day (over twice the distance covered by the trekschuit horses), 2850 horses would have had to be maintained. If the annual maintenance and depreciation costs of coach horses were comparable to those of trekschuit horses (£300 – see p. 169), the horsepower costs of the coach alternative would have exceeded the trekschuit’s horsepower costs by £702,000 (£855,000 – 153,000). The labor productivity of the coachmen certainly did not exceed that of the trekschuit crews. On the contrary, the evidence presented in chapter VI (p. 183) shows the average
daily distance covered by coachmen to be no more than 8.6 kilometers. The three-man crew of a trekschuit covered a comparable distance (24.0 barge-km/3 = 8 km per crew member), yet their conveyances could carry nearly four times as many passengers.

We could go on to compare the construction and maintenance costs of roads versus trekvaarten, but what we now know is sufficient to convince us that the social saving estimate of f861,000 is not a gross overestimate. Using the Fogel-Fishlow approach to the measurement of social saving, we can conclude that the trekvaart in the period 1665–75 released annually inputs valued at f861,000 that could be used to increase aggregate output when the alternative transport mode is the coach. When the alternative is identified as sailing vessels, the social saving is negative: the economy’s net loss amounted to f81,000.

Are these numbers large or small? The first step in answering this question must be to express the social saving as a percentage of the gross national product of the Republic’s economy in the period 1665–75. It need hardly be said that this information is unknown. We do know that a fully employed adult male worker could not expect to earn much more than about f300 per year. In addition, we know that the English national income accountant Gregory King estimated Dutch per capita income in 1695 at £8.2, 97 guilders at the prevailing exchange rate. If we set average family size at four, King’s estimate amounts to f388 per year per family. A rough estimation of GNP in the provinces served by the trekvaart network can be made by multiplying the approximately 300,000 households by f350. The Gross Regional Product (GRP) estimated by this procedure amounts to f105 million. If this can be accepted, the trekvaart caused an annual reduction of the GRP by 0.08% when the sailing vessel is the alternative. When the coach is held to be the alternative – and this is how contemporaries tended to see it – the trekvaart can be said to have released resources capable of generating a net gain in the economy equal to 0.8% of GNP.

This social saving estimate of just under 1% of GNP in the 1665–75 period can be compared to the results of similar exercises performed on the passenger services of nineteenth-century railways. Fishlow reckoned the social saving of U.S. railways in 1850 at 1.7% of GNP, while Hawke concluded that British railways in the 1850s generated a social saving of about 1.5% of GNP. One might be tempted to conclude from this exercise that the trekvaart innovation exercised an influence on the seventeenth-century Dutch Republic smaller than, but not utterly dissimilar to, that exerted by railroads, in their capacity as passenger carriers, on the mid-nineteenth-century American and British economies. Given the scarcity of technology change in pre-industrial economies, the trekvaart stands out as a very unusual innovation. On the other hand, the social saving of the trekvaart tended to decline after the 1670s while
railroad social saving tended to grow with the growth in the volume of their business. It would be exceedingly irresponsible to dwell for long over these social saving calculations. They can, I believe, support one conclusion: the passengers carried on the seventeenth-century trek­schuiten could have been conveyed on the coach alternative only at a significant economic cost. Had the economy not invested heavily in the trekvaarten, it would either have assumed a very different, less trans­port intensive, form, or would have achieved a lower level of GNP.

But perhaps we should not start drawing conclusions so quickly. There are many reasons to reject these social saving estimates as hopelessly simplistic. In the first place, the available modes of passenger transporta­tion possessed other important characteristics besides price. Besides the direct charges, any user of transportation would consider such attributes as speed, freedom from seasonality, flexibility, and comfort. Fishlow recognized this fact — and noticed that it could outweigh cost alone as a basis for choice among modes — but he rejected the introduction of these attributes into a social saving estimate. Even when their value to the consumer can be quantified, he reasoned, these attributes do not register in national income accounts. If we try to include the value of these attributes in our estimates, the definition of social saving must be altered; it can no longer be synonymous with direct resource saving.11

Another objection to the conventional (Fogel-Fishlow) approach is its assumption of zero price elasticity of demand. In the counterfactual case the economy without the technological innovation is forced to provide the identical services — in quantity and location — as the economy with the technological innovation. The substitutions that would inevitably occur if the innovation were, in fact, suddenly removed are not allowed to take place in this exercise. A more realistic exercise should attempt to identify the price elasticity of demand that governed consumers’ reaction to the introduction of a lower-cost form of transportation.

Hawke, in his study of the social saving of British railways shows himself to be sensitive to the non-price attributes of transport modes by including ‘comfort’ as a factor. In his social saving estimates the alter­natives to railway passenger service vary with the classes of railway transport. His calculation of social saving is therefore very sensitive to how one identifies the pre-railway equivalent of first, second, and third class rail travel.18 Otherwise Hawke’s approach is the same as that of Fishlow. To go further would require a redefinition of what is meant by social saving.

VIII.2.2. Consumers’ surplus

Such a redefinition was attempted by Gary Walton and J. Haydon Boyd in their estimate of the social saving of U.S. railroad passenger transportation.13 The value of the other attributes can be captured if one asks what an innovation is worth to the consumers rather than what
physical resources are liberated for use by the rest of the economy. The total gains to travelers in the Walton-Boyd measure are a summation of not only the difference in direct costs (fares) but also of the value of time saved. They seek to estimate the consumers' surplus enjoyed by the economy rather than the direct resource saving that can be attributed to a transport innovation.

The Walton-Boyd approach does not measure the amount by which GNP would have declined had the innovation not existed; it measures instead what passengers would have been willing to exchange for the privilege of using the trekschuit instead of the alternative. Their model does not measure all the non-price attributes. But since the trekschuit was undoubtedly superior to its rivals in schedule frequency, physical comfort, and year-round dependability, a model that focuses only on fare and time savings will surely not exaggerate the redefined social saving (consumers' surplus) of the trekvaart network.

Figure 8.1 shows what is to be measured. The total price of each mode of transport consists of its fare plus the value to the traveler of the time used in making the trip. \( P_{TV} = F_{TV} + V_{TTV} \), where \( P_{TV} \) is the price of trekvaart travel per kilometer. It is equal to the fare per kilometer (\( F_{TV} \)) plus the average speed of this mode of transport (\( T_{TV} \) expressed in hours-per-kilometer) times \( V \), the value that the average traveler places on his time. The price of each mode of transportation, thus reckoned, is measured on the vertical axis. The horizontal axis measures annual travel volume in passenger-kilometers. The demand curve, \( D \), must be drafted to reflect the price elasticity of demand prevailing in 1665–75.

![Figure 8.1](image-url)
The consumers’ surplus, the amount the consumer would be willing to give up out of money income for the privilege of purchasing at the lower rather than the higher price, is measured by the area between the two price lines under the demand curve:

$$P_c ab P_{TV} = \int_{P_{TV}}^{P_c} Q_0(p) dp$$

The size of the area $P_c ab P_{TV}$ depends not only on the difference in the total cost (time plus money) of the transport modes, also on the price elasticity of demand. The demand for travel can be expressed as $Q = \lambda P_c^e$, where $\lambda = Q_{TV} P_{TV}^{-e} \ln e$ in a given year (in this case the average for 1665–75) and e is the elasticity of demand. Total social saving (G) is thus

$$G = \lambda (P_c^{e+1} - P_{TV}^{e+1})/e + 1$$

or, when $e = -1$, $G = \lambda \int_{P_{TV}}^{P_c} p^{-1} dp$;

which integrates to

$$G = \lambda (P_{TV} \ln P_c - \ln P_{TV}).$$

The following data are needed to apply this concept of social saving. For each mode of transportation we must know the average fare and the average speed of travel. In addition we must have an estimate of the demand elasticity and of the value of travel time. Finally, we must know the passenger-kilometers traveled via the trekvaart in the period 1665–75. Table 8.3 provides the known data, plus estimates for those which are unknown.

The two parameter estimates in table 8.3, $e$ and $V$, require explanation. The price elasticity of demand in this period is not known, but the discussion of its likely value presented in chapter VI gives us reason to expect that demand was elastic. The rapid growth in travel volume when the trekvaart was introduced, the large difference in demand levels between routes served by coaches and by trekschuiten, and such information as we have concerning the demand elasticities for passenger travel in modern societies, all point in this direction. Unitary elasticity, $e = -1$, should be regarded as a lower-bound estimate. Under unitary elasticity the total amount spent (in this case, in money plus time-value) remains the same. Consumers respond to price (and speed) changes in such a way that the total expenditure neither rises nor falls. With elasticity of −2, the quantity demanded rises or falls by 2% for every 1% fall or rise, respectively, in price. An elasticity of −2 is adopted as an upper-bound; although no positive evidence supports this view, it seems unlikely that the elasticity exceeds −2.

The approximate value of $V$, the average value placed on travel time, poses a much greater problem. How should the time saving of a transport mode be valued? The method often used in modern studies, and that we have applied here, is to value all time at the average hourly wage. In
## TABLE 8.3. Social saving (consumers' surplus) estimate, 1665–1675.

**Volume**  
37.8 million passenger-kilometers in 1665–1675  

**Fares**  
<table>
<thead>
<tr>
<th></th>
<th>penningen per pass.-km</th>
<th>guilders per pass.-km</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_v$</td>
<td>4.65 p.</td>
<td>f 0.015</td>
</tr>
<tr>
<td>$F_c$</td>
<td>12.00 p.</td>
<td>f 0.038</td>
</tr>
<tr>
<td>$F_s$</td>
<td>3.50 p.</td>
<td>f 0.011</td>
</tr>
</tbody>
</table>

**Travel time** (hours per kilometer)  
<table>
<thead>
<tr>
<th></th>
<th>$T_{tv}$</th>
<th>$T_{tc}$</th>
<th>$T_{ts}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/17</td>
<td>1/16</td>
<td>1/14</td>
</tr>
</tbody>
</table>

**Parameter estimates**  
- $V$ (value of travel time) = f 0.10 guilders per hour  
- $e$ (price elasticity of demand) = -1 and -2  

**Total price** ($P = F + VT$)  
- $P_v = .015 + .10(V_{tv}) = f .029$  
- $P_c = .038 + .10(V_{tc}) = f .050$  
- $P_s = .011 + .10(V_{ts}) = f .036$  

**Social saving estimates**  
<table>
<thead>
<tr>
<th>Alternative mode</th>
<th>Demand elasticity</th>
<th>Social saving</th>
<th>% of GRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sailing vessel</td>
<td>-1</td>
<td>f 246,000</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>-2</td>
<td>f 213,000</td>
<td>0.20</td>
</tr>
<tr>
<td>Coaches</td>
<td>-1</td>
<td>f 612,000</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>-2</td>
<td>f 460,000</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Source: Table 8.2.

### Notes

- In the seventeenth century and eighteenth century a daily wage of 20 stuivers was typical (see table 4.6). Assuming a ten hour day, the hourly wage can be set at 2 stuivers, or f 0.10. Another approach is to try to uncover the implicit value placed by passengers on time. Seventeenth- and eighteenth-century travelers cannot be interviewed, but their behavior when faced with a choice of transport modes, can sometimes be reconstructed. To begin, we know that sailing vessel services ceased to attract passengers on nearly every route where trekschuiten were introduced. The trekschuit offered other advantages besides speed, but if we focus on this one factor, then we could conclude that the great mass of travelers valued time at at least $\frac{1}{2}$ stuivers per hour. At that rate the average total cost of travel by the two modes (other things being equal) was equalized.\(^\text{16}\)

- We also know that scheduled coach services never competed directly with the trekschuiten until the turn of the nineteenth century. Presumably the implicit cost of the faster, but much more expensive coaches.
exceeded the value placed on it by the vast majority of travelers. From 1660 until the end of the eighteenth century the one coach service that did parallel trekvaart routes was the Amsterdam-The Hague postal coach. In this case passengers could choose between a trekschuit fare of 25½ st. versus a coach fare of 104 st. The 78½ st. premium for coach travel gained those who paid it a five hour time saving. The trekschuit took 11 hours while the coach, the fastest in the Republic, covered the 62 km. distance in six hours (when the roads were dry). Only an upper class clientele was prepared to buy time at the rate of 15.7 st. per hour.

In the early nineteenth century many coach routes were established to compete with the trekschuiten. Table 8.4 summarizes the implicit cost of the time savings on these routes. What is perhaps remarkable is that in the early nineteenth century there did exist enough people who implicitly valued their time at 13 to 18 st. per hour to make these competitive services viable. Before then the trekvaarten faced no direct, scheduled competition apart from the above mentioned route. This may have been partly because an insufficient number of passengers then valued their time so highly. However, another factor was that early nineteenth-century road improvements permitted for the first time coach speeds high enough to reduce the cost of time savings to the 13–18 st. per hour range. This suggests that a small but important segment of the travel market behaved as though it valued its time at or above 7 to 9 times the average wage, and as soon as coach speeds could be raised to a few kilometers per hour above trekschuit speeds, that market was diverted to the coaches. All of this reasoning does not allow us to be very specific about the value of travel time: public behavior is consistent with an average value of V somewhere in the enormous range stretching from 1½ to 18 st. per hour.

Here it must once again be emphasized that these time savings cannot usually be regarded as a direct resource saving. There is no reason to

Table 8.4. Implicit value of time for coach passengers in 1821–1830

<table>
<thead>
<tr>
<th>Route</th>
<th>1821</th>
<th>1830</th>
<th>1830</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam–Utrecht</td>
<td></td>
<td></td>
<td>Amsterdam–Rotterdam</td>
</tr>
<tr>
<td>Trekschuit time (hours)</td>
<td>7</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Coach time (hours)</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Time saved by coach (hours)</td>
<td>3</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Cost by trekschuit (stuivers)</td>
<td>17.25</td>
<td>40</td>
<td>38</td>
</tr>
<tr>
<td>Cost by coaches (stuivers)</td>
<td>68</td>
<td>120</td>
<td>130</td>
</tr>
<tr>
<td>Extra cost of coach</td>
<td>50.75</td>
<td>80</td>
<td>92</td>
</tr>
<tr>
<td>Cost of time saving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(stuivers per hour)</td>
<td>16.9</td>
<td>13.3</td>
<td>18.4</td>
</tr>
</tbody>
</table>

Sources: Table 7.1 and 's-Gravenhaagsche Stads-almanak voor het jaar 1830 (The Hague, 1830).
believe that much of the time saved by faster modes of transportation contributed directly to increasing GNP. It did, however, represent a significant welfare gain to travelers. Since it was often decisive in the choice of which mode of transportation to use, it should not be ignored.

To measure the direct economic impact of time savings, we must ask what did society have to offer up for the time required in the use of the slower means of transportation; that is, what was the opportunity cost of the extra time spent on the slower mode? We know that many passengers traveled on the overnight sleeping barges, and that many others were engaged in leisure time activities. Presumably none of these passengers had the opportunity to earn wages if he had not been sitting in a barge. But then there were those passengers who were traveling during ‘business hours’, but who would not have had the opportunity to earn income if they had not been traveling. Here the question is: would such people have been able to earn more — would they have been more productive, if they had traveled faster? One could argue that only large increases in speed — capable of shortening a trip by days rather than simply hours — could play a significant role here. A one or two hour difference could simply have been absorbed by a reduction in the traveler’s leisure time, a loss for the traveler that was worth something to him, but that did not constitute a direct resource loss. In short, it is only the time consumed in traveling that could otherwise have been devoted to production (in the case of the leisure traveler) or that otherwise could have been used more productively (in the case of the business traveler) that can be regarded as a social saving in the conventional (Fogel-Fishlow) sense.

The social saving of the trekvaart in the period 1665–75 can now be calculated in comparison with both alternative modes, and using both –1 and –2 as values for the price elasticity of demand. The resulting estimates of social saving are presented at the bottom of table 8.3. Not surprisingly, the consumers’ surplus approach yields results which, in comparison to the direct resource saving approach, are higher when the trekvaart is compared with sailing vessels and lower when compared with coaches. In both cases time costs account for the difference.

The two approaches to the concept of social saving generate estimates which, when the coach is held to be the alternative mode, range from 0.5 to 0.8% of 1665–75 GNP. These results, while modest in comparison with the results usually achieved in studies of nineteenth-century railroads, should not be dismissed as insignificant. The surprising fact is that passenger transportation via public carriers was of sufficient importance to a pre-industrial society to permit an innovation — the trekvaart — to make such a measurable contribution to economic growth. How many other pre-industrial innovations had such an impact?

The one conclusion that can safely be drawn is that the trekvaart network was no marginal feature of the Republic’s economy. The generally modest and variable returns to the investing cities could give
that impression, but when the direct resource savings or consumers' surplus is added to the investors' returns, one must conclude that the f4.6 million invested in the trekvaart network was money well-spent. This conclusion is further strengthened when it is recalled that some of the trekvaarten also increased the efficiency of freight transportation and that the towpaths on all of them constituted a significant contribution to the improvement of land transportation in the Republic. The social saving of these dimensions of the trekvaart network are not even being considered here.

In contrast to nineteenth-century railways, the social saving of the trekvaart network gradually declined from the 1670s to the 1750s. It fell, no matter what measure is used, by half. It would then have been easier to get along without the trekvaart network. But since it already existed and since the technology of rival modes of transport did not yet show any capability to offer superior returns, the trekvaart network continued in operation, generating its more modest saving, into the nineteenth century.

VIII.3. THE INTRODUCTION OF A NEW MODE OF TRANSPORTATION

In the 1820s and 1830s, the last decades of large-scale trekschuit service, this two-centuries old means of transportation had already had to yield considerable ground to coaches using the expanding network of paved roads. By then the more well-to-do traveler had abandoned the trekschuit to such an extent that it was commonly referred to as the volksschuit - the barge for the common people. Despite these developments it must have seemed to contemporaries that the future use of canals for passenger travel was more likely to expand than to contract. The economic revival program of the Royal government in those years emphasized the construction of new canals: the North Holland Canal was cut through the entire length of the North Holland peninsula, and several new waterways - all equipped with towpaths - were pushed into hitherto unserved regions of the eastern provinces. These investments had as a side effect the establishment of several new trekschuit services - the first since the mid-seventeenth century. The new North Holland canal permitted a direct Amsterdam-Alkmaar trekschuit service to be introduced while the establishment of the port of Den Helder at the northern mouth of the canal gave rise to a new trekschuit service from Alkmaar. The remote province of Drenthe was also acquiring its first trekschuit services. In 1839 the Drentse Courant reported that only a few years before, Assen, the provincial capital, was served by only a single sailing vessel, sailing once per week to Meppel, where connections to the outside world were available. Then the first trekschuit service was established. 'It was regarded', reported the newspaper, 'as a hopeless
enterprise, but now two trekschuiten and the weekly beurtveer are all self-supporting.  

In the same year that Drenthe hailed the new trekschuit as a welcomed improvement to her regional transportation system, the long-established trekvaart network of Holland and Utrecht was given its death warrant. In that year a new technological innovation, the railroad, was introduced to Holland. The new mode of transportation proved so superior to the trekschuit and the coach alike that it almost immediately forced these venerable services to retreat to the provision of local services.

The first trekvaart to be confronted with the new competition was the greatest of them all, the Amsterdam-Haarlem trekvaart. The hourly schedule of barge departures that had plied this route for over two centuries suddenly lost its rationale when Holland’s first railway was put into operation in 1839. To serve local needs, two barges were kept running on this route, but three years later, when the railway was pushed through from Haarlem to Leiden, the skippers’ guilds on this route promptly disbanded. In 1847 the railway had been extended to Rotterdam, following a route that paralleled the trekvaarten. By the mid-nineteenth century the trekschuit had ceased to play an important role in intercity passenger transportation in Holland and Utrecht. The trekschuit was to linger on for another two generations as a carrier of local passengers and light freight, but the trekschuit era was over.

The first Dutch railways had in common with most early railways in all countries, a heavy dependence on passenger traffic. The Dutch railways distinguished themselves, however, in their ongoing dependence on passenger revenues. The Hollandsche IJzeren Spoorweg Maatschappij (HYSM) which operated the line from Amsterdam to Rotterdam via Haarlem, Leiden, and The Hague, continued to derive over 76% of its total revenue from passenger service as late as 1870. The remaining revenue was in large part derived from the carriage of baggage and parcels rather than heavy freight. The principal Dutch railway was, thus, a direct substitute for the trekvaarten which it paralleled. It provided the identical services without adding any significant new ones.

The construction of railways progressed slowly in the Netherlands. Map 8.1 shows the operating lines as of 1855. The 255 kilometers of route, which neither formed a single network nor connected the country with the extensive European network already in existence (Belgium alone had a network over five times as large) has long been regarded as a clear reflection of Dutch economic stagnation in the early and mid-nineteenth century. Even after discounting the special physical obstacles to railroad construction in the Netherlands, the slowness of railroad construction, and with it the slowness of economic growth, is striking and in need of explanation.

A new technology rarely is introduced in isolation. Typically, it must confront an existing technology in its struggle for acceptance. Interest
in technological change focuses almost invariably on the introduction and triumph of the new, superior technique. But the acceptance and diffusion pattern of new techniques is significantly affected by the character of that which it replaces. To put it another way, the economic impact of a technology is registered not only when it is introduced, but also when it is rendered obsolete. Hence, a complete study of the trekvaart era, viewed as the history of a distinct technology, requires an examination of the obsolescence process of the trekvaart network and the identification of the economic impact which that process had on the nineteenth-century Dutch economy. Correspondingly, railroad development in the Netherlands – given the fact that the railroads were direct sub-

MAP 8.1. The Netherlands’ railway network as of 31 December 1855.

stitutes for the trekschuiten – can sensibly be studied only in the context of the transition from trekvaart technology to railroad technology.

VIII.4. THE ECONOMIC IMPACT OF AN OBSOLETE INDUSTRY

The entrepreneurs who introduced the railroad to the Netherlands faced a unique situation: here alone there already existed a mass transportation system. The economically most important parts of the country had for nearly two centuries made use of an extensive network of canals over which dependable, frequent, and cheap passenger transportation was provided. This existing trekvaart network was no longer in its prime. Well-to-do travelers had begun to abandon it several decades earlier in favor of the faster coach services. But, nonetheless, it existed. What were the implications of its existence for the introduction of the railroad to the Dutch economy?

The existence of the trekvaart gave potential entrepreneurs and investors one great advantage: information about the market. While elsewhere guesses had to be made about the potential market, in the Netherlands that market had been, as it were, partially exposed. Decisions could be made based on more accurate estimates of the traffic that could be expected in the first years of operation. In this regard it is no accident that the first route ran precisely parallel to the most heavily traveled trekvaart, and that the next most heavily traveled trekvaart routes received paralleling railroads shortly thereafter. When in 1863 railroad construction finally began in the northern provinces, the first route, once again, paralleled the most heavily traveled trekvaart in that region – the Harlingen-Leeuwarden route.

Better information was the only advantage that the existence of the trekvaart network conferred upon railroad promoters. The remaining implications all tended to raise obstacles to railroad development. The municipalities that continued to own most of the trekvaarten saw in the railroad the destruction of the value of their capital while the trekschuit skippers saw clearly the specter of technological unemployment. The former dragged their heels in accommodating railroad promoters while the latter petitioned the king for the protection of their jobs. This opposition did not differ essentially from the obstructionist efforts of coaching firms in other countries. Only the direct involvement of city governments in trekvaart operation threatened to make this opposition a bit more effective. Rather different was the effect of competition, or to be more accurate, anticipated competition.

When the first railroad, connecting Amsterdam with Haarlem, was about to open, a pamphlet appeared presenting a conversation between the trekschuit and the railroad. The title, ‘Conversation between the railroad and the trekschuit, which [i.e., the railroad] will be inaugurated
on August 24th (so it is said)’, betrays the skepticism of the author who puts in the mouth of the aged but dignified trekschuit the words:

*Wat ik mij buigen? Ik, die jaren
Ja eeuwen heb mijn baan bevaren.*

What? Must I bow out; I who for years
Yea, for centuries, have served my route?

In retrospect the words must appear as the bravado of someone facing certain defeat, but one might wonder whether contemporaries saw it so. Could they not be excused for believing that the foreign transport mode would not succeed in suddenly stripping the venerable trekschuit, that Le Francq van Berkhey had called the ‘national means of transport’, of all its patronage?

The operators of the first railroad apparently did not take their victory over the trekschuit for granted. They felt compelled to set the third class fare exactly equal to the trekschuit fare. They were not willing to assume that the nearly 80% time saving was worth a penny to the vast public that had to be attracted from the trekschuit. Perhaps they feared that many travelers would be attracted to the hourly departures of the trekschuit in comparison to the four daily train departures. At any rate, the decision to set the fare equal to the trekschuit fare could not have been idly made, for it had the effect of setting the third class fare considerably lower than the prevailing fares in England. At the same time the f62,159 per kilometer cost of building the first line did nothing to make the total costs of running trains lower than in England. The third class fare, paid by 72% of all passengers, stood at only 72% of the average third class fare in England in 1865. In the 1840s the English fare was certainly higher still, but an exact figure is unavailable. The second and first class fares, on the other hand, were very nearly equal in the two countries.

The trekschuit operators fought back by lowering their fares. Nothing could persuade them of the wisdom of such measures when it could have done some good, but once the railroad came, and the abandonment of the trekschuiten assumed catastrophic proportions, the skippers and commissioners turned in desperation to fare-cutting. In January 1840, the remaining Amsterdam-Haarlem skippers reduced their fares from 40 to 30 cents (8 to 6 st.). In 1844, soon after the Amsterdam-Utrecht railway line had begun operation, the trekschuit skippers agreed to lower their fare from 90 to 65 cents (18 to 13 st.). Neither fare reduction proved capable of stemming the tide. The Amsterdam-Utrecht skippers wrote to the Utrecht officials in 1845:

That they had hoped that by lowering the fare a larger number of passengers would be attracted, but that they learned to their sorrow that not only did this improvement not materialize, but that they often had to sail with all but empty barges. As a consequence, [the
fare reduction] had made their receipts only smaller and has caused more damage than advantage.\textsuperscript{25}

The substantial fare reductions did not succeed in attracting passengers because of the enormous time saving offered by the railroad. The Amsterdam to Utrecht traveler reached his destination in one hour and ten minutes via the railway instead of the seven hours needed by the trekschuit. Even with a five stuiver discount, only travelers who valued their time at less than a stuiver per hour would have opted for the trekschuit, and we have already established that travelers' behavior was consistent with a valuation of time in excess of one stuiver per hour.

The anticipated competition of the trekschuit did not materialize. The great bulk of all travelers switched to the railroad as soon as it was introduced. For example, the 32,400 passengers making use of the Haarlem-Leiden trekvaart in 1841 shrank to 1,843 in 1843, the first full year of railroad competition. In the years after 1845, when the railway reached The Hague, the number of trekschuit passengers between Leiden and The Hague hovered around 3,000.\textsuperscript{26} As a result, the skippers' guilds were liquidated and trekschuit service was cut back to the provision of local passenger and light freight service.

With this experience in the first years of railroad operation, the directors of the HYSM felt sufficiently confident of the superiority of their transport mode to raise the third class fare by 12\% in 1844.\textsuperscript{27} One might wonder why the fare increase was so modest: it continued to stand 23\% below the average English third class fare. There was apparently a good reason for caution. With the Amsterdam-Haarlem third class railway fare raised from 40 to 45 cents (8 to 9 st.) and the trekschuit fare reduced from 40 to 30 cents (8 to 6 st.) the difference in fare amounted to a 10 cent (2 st.) premium per hour of travel time saved. At that level a portion of the third class market was prepared to defect to the trekschuit in bad times. 1851 was such a bad year, and the Provincial Report of North Holland gives an interesting glimpse into what happened. The number of passengers carried by the HYSM fell by 3\% compared with the previous year, with third class travel accounting for the entire decline. Then the Provincial Report goes on to observe, with undisguised incredulity, that 'the volksschuit between Amsterdam and Haarlem, overcoming the formidable competition that it must face from the HYSM, finds itself in a position of expansion'. In 1851 the two remaining barges carried 32,877 passengers, or 3000 more than the previous year. In other words, the trekschuit held a 9\% share of the third class market in 1850, but in 1851, when total demand for third class travel fell by 8\%, the trekschuit improved its position absolutely, capturing 11\% of the market.\textsuperscript{28}

In retrospect we can see that the trekschuit was capable of achieving even this modest amount of competitive success for only a short period. In the long run, trekschuit competition proved to be no more threatening than coach competition in other countries. But the measures required to
banish permanently this real and feared competition proved different from the measures that sufficed to destroy the coach because the trek-schuit operated at lower cost. This imposed decisions on the railroad operators that undermined the profit potential of the first railroads.

It must once again be stressed that all of the disadvantages to railroad construction caused by the existence of a trekvaart network were temporary. The obstacles may have delayed the first railroads but did not affect all subsequent projects. Consequently, the slowness of railway construction can only partially be explained by these factors.

VIII.5. THE SOCIAL SAVING OF THE RAILROAD IN THE MOVEMENT OF PASSENGERS

Of greater importance is the general economic impact of the railroad as a transportation innovation on the Dutch economy. Here it is not simply the speed of construction, but the growth-inducing impact of the railway once in operation that is at issue. Economic historians have observed before that the stimulating effects of railroad development in other countries are not observable in the Netherlands. This lack of response, in turn, made further railroad construction unattractive to investors. Royal and government initiatives were long required in order to make even the very slow progress in railroad construction that was achieved. These widespread views about the problem of the railroad in the mid-nineteenth-century Dutch economy can best be evaluated if we have a measure of the railroad’s actual contribution to the Dutch economy. Such a task forces us to return to the social saving concepts introduced earlier in this chapter. By estimating the social saving of the trekvaart-competitive Dutch railroads around 1850, we can acquire a better understanding of the magnitude of the railroads’ contribution to the growth of the Dutch economy. At the same time the influence of the obsolete trekvaart technology on that social saving estimate can be identified. We will then have traced the economic impact of the trekvaart technology from beginning to end.

Before proceeding to the data necessary to estimate railroad social saving in the period 1848-1853, some peculiarities of the estimates about to be made must be spelled out. In the first place the estimates are confined to a single railroad, the Hollandsche Izeren Spoorweg Maatschappij (HYSM). This company operated a single line connecting Amsterdam with Rotterdam via Haarlem, Leiden, The Hague, and Delft and paralleled the most heavily traveled trekvaarten. Secondly, railroad passenger travel is not being compared to a wholly hypothetical world-without-railways. Rather, it is being compared to trekvaart passenger travel just before the coming of the railways. This does violence to the social saving concept’s requirement that the economy with and without the tech-
nological innovation be compared at a single time. But, since the railroad is being studied in its first years of operation and the economy showed no dynamic developments in these years, the relaxing of this requirement seems justified. By doing this we can avoid having to guess the value of \( e \), the price elasticity of demand, since sufficient data exist to calculate it directly. In the case of coach travel, its volume is not fully known for the immediate pre-railroad years. Here estimates of demand elasticity must be made to establish a hypothetical pre-railroad travel volume.

This brings us to the final peculiarity of this estimation attempt. The alternative transport mode to the railroad will be held to depend on the class of railroad travel. First and second class travelers are assumed to have made use of coaches while third class travelers made use of trek­schuiten. This assumption is in accord with the observations of contemporaries and with their habit of calling the trekschuit a *volksschuit.* Moreover, the managers of the HYSM supposed this to be true when they first set their fares: first class was set equal to prevailing coach fares while third class, as we have already seen, was set equal to the trekschuit fare.

Using the data assembled in tables 8.5 and 8.6 the social saving in the

| Table 8.5. Railroad social saving on the Amsterdam–Haarlem route, 1840–42. |
|---------------------------------|-----------------|---------------|
| **Volume of travel**           | Railroad        | Alternative   |
| 1st and 2nd class              | 1.6 million pass.-km | ?             |
| 3rd class                       | 3.6 million pass.-km | 2.65 million pass.-km (trekvaart) |
| **Money costs (guilders per passenger-kilometer)** |
| \( F_{1r} \)                    | 0.063           |
| \( F_{2r} \)                    | 0.042           |
| \( F_{3r} \)                    | 0.021           |
| \( F_v \)                       | 0.021           |
| \( F_c \)                       | 0.075           |
| **Travel time (hours per kilometer)** |
| \( T_r \)                       | 1/41            |
| \( T_{tv} \)                    | 1/8.8           |
| \( T_c \)                       | 1/12.7          |
| **Value of travel time**       | \( V = 0.10 \) per hour |
| **Trip price (\( P = F + VT \))** |
| \( P_{1r} \)                    | 0.053 + 0.003 = 0.056 |
| \( P_{2r} \)                    | 0.021 + 0.003 = 0.024 |
| \( P_v \)                       | 0.021 + 0.011 = 0.032 |
| \( P_c \)                       | 0.075 + 0.008 = 0.083 |


238
TABLE 8.6. Railroad social saving on the HYSM, 1848–53.

<table>
<thead>
<tr>
<th>Volume of travel</th>
<th>Railroad</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st and 2nd class</td>
<td>6.7 million pass.-km</td>
<td>? (coach)</td>
</tr>
<tr>
<td>3rd class</td>
<td>15.7 million pass.-km</td>
<td>2.55 million pass.-km (trekvaart)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Money costs (guilders per passenger-kilometer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_{r1}$</td>
</tr>
<tr>
<td>$F_{r2}$</td>
</tr>
<tr>
<td>$F_{r3}$</td>
</tr>
<tr>
<td>$F_{tv}$</td>
</tr>
<tr>
<td>$F_{c}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Travel time (hours per kilometer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_r$ $\frac{1}{33}$</td>
</tr>
<tr>
<td>$T_{tv}$ $\frac{1}{10}$</td>
</tr>
<tr>
<td>$T_c$ $\frac{1}{10}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Value of travel time</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V$ $0.10$ per hour</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trip price ($P = F + VT$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{r1-2}$</td>
</tr>
<tr>
<td>$P_{r3}$</td>
</tr>
<tr>
<td>$P_{tv}$</td>
</tr>
<tr>
<td>$P_c$</td>
</tr>
</tbody>
</table>

Source: *Verslagen der H.Y.S.M., 1848–1853.*

first years of operation can be estimated for the first rail line and the entire HYSM. Remember that the comparison is not with a hypothetical world in which railroads disappear but with the actual situation, in so far as it is known, of the immediately preceding years.

The conventional (Fogel-Fishlow) measurement of social saving is not very interesting in this case. Since the third class railroad and trekvaarten fares were alike in 1839 the social saving must have been zero, assuming of course, that the fares were equal to average total costs. There is no evidence that the railroad enjoyed monopoly profits, but exact information is lacking. In the case of the trekvaarten, it was shown in chapter VI that the monopoly profit was large only when the demand for its services were in a range that permitted the trekvaarten to be operated near their minimum average total cost. Since average total costs were constant at the minimum level over a very broad range, a range which included the actual demand for railroad travel until far into the nineteenth century, once can plausibly argue that the trekvaarten were technically capable of transporting at lower cost the passengers handled by the railroad. We have seen that trekvaarten fares were capable of being reduced and that this was done immediately after railroad competition began to be felt. If the railway and trekvaart fares of 1844 and the years
thereafter are used, the social saving of the railroad in the period 1848–53 actually becomes negative (f125,500). Of course, the lower resource cost of the trekschuit reflected by this negative amount could have been garnered only at the expense of an enormous time loss.

In 1848–53 the third class traveling public annually spent a total of 467,000 hours traveling a total 15.7 million kilometers. Using trek­schuiten, that same distance could have been traveled at the lower money or resource cost, but at a time cost of 2,243,000 hours, 4.7 times that of the railroad. It is the Walton-Boyd approach, to which we will shortly turn, that attempts to include the value (not the cost) of that time in the social saving calculation. Here it is perhaps interesting to note that Holland’s late seventeenth-century population (which was 25% smaller than in 1850) was actually willing to spend 2,700,000 hours per year traveling over precisely the same route.

While the conventional definition of social saving shows the railroad to have presented the economy with a direct resource loss in the production of third class travel, it did effect some saving in the case of first and second class travel. Although the railroad directors claimed in 1839 to have set the first class fare equal to coach rates, they were actually somewhat lower. Moreover, the revised fares of 1844, which raised third class fares, actually lowered first and second class fares. The provision of railroad transportation for persons who would otherwise have used coaches (and assuming e = 0) generated a social saving of approximately f188,000 per year in 1848–53. The net direct resource saving of the total railroad passenger service amounted to only f62,500, or a trivial 0.04% of GRP.

The Walton-Boyd approach, which actually measures consumers’ surplus, gives a very different impression of the economic impact of the railroad as a transporter of passengers. But this impression is itself sensitive to the assumptions made about the two pieces of information in tables 8.5 and 8.6 that are not drawn directly from the historical data, the estimates of V, the average value of travel time, and e, the price elasticity of demand. The value attached to V is the same as that used for the 1665–75 period. Nominal wage rates changed very little in the intervening two centuries. The objections to this estimate are, thus, the same as those for our earlier calculation of social saving and are discussed above on pp. 227–229.

In the case of e, the demand elasticity, we do not have to make the arbitrary assumptions that were made in the estimates of trekvaart social saving. This is so because the level of demand in the immediate pre-railroad years is known, or can be estimated on the basis of direct evidence. Before proceeding to make estimates of social saving, we should ask the simple question: how did the demand for passenger travel respond to the introduction of the new railroad technology?

Consider the single route Amsterdam-Haarlem. In the 1660s and 70s
the trekschuiten carried an annual average of some 280,000 passengers over this 19 kilometer distance. This volume fell gradually until the 1740s when an annual average of 152,000 passengers paid for the service. By the 1790s a minor revival can be observed; the annual totals averaged 175,000. The second decade of the nineteenth century witnessed a sharp decline of trekschuit traffic. The average volume around 1815, which stood at only 125,000 passengers, was partly the result of the economic collapse brought on by the Napoleonic Continental System and partly the result of new coach competition that diverted first class travelers. Until the end of the eighteenth century the volume of trekschuit traffic represented essentially the whole of common carrier passenger transportation between the two cities. Thereafter that total demand was divided between the two transport modes. After 1815 trekschuit volume began to pick up, but the extent of the revival is unknown since full information ceases to be available after 1820. If we assume demand after 1820 to have remained proportional to the populations of the two cities plus the other cities, such as Leiden and The Hague, which significantly effected demand on this route, then trekvaart volume in 1839 could be set at about 140,000 passengers (125,000 × 1.12), or 2.65 million passenger-kilometers. 1840 was the first full year of railroad passenger service on the Amsterdam-Haarlem route. In that year, with the trekvaart suddenly robbed of nearly all its through traffic, the railroad carried 350,000 passengers. Apparently many were curiosity seekers, for in the next year the volume sank to 293,000. In the following years the gradual extension of the line to Leiden, The Hague, and Rotterdam (reached in 1847) had the effect of increasing the volume of travel on the original Amsterdam-Haarlem route. In 1855 when passenger data disaggregated by route segment are once again available, 413,000 passengers traveled by train between Amsterdam and Haarlem. This volume only very gradually increased until after 1862 (when volume stood at 462,000). Twenty-three years after the construction of the railroad, intercity passenger volume continued to stand at a level only 32 percent above that of the initial year, and not of a different order of magnitude from two centuries earlier. Only then did new economic currents begin to be felt; by 1870 the route saw the passage of over 820,000 passengers.32

To return to the first years of the new railway, the 300–350,000 passengers carried per year included all three classes. It is our assumption that only third class travelers, who made up 70% of the total, had formerly made use of the trekschuiten. Thus, third class travel between Amsterdam and Haarlem, which stood at an estimated 140,000 passengers in the last years of the trekschuit, jumped to 245,000 in 1840, sinking back to 210,000 in the two following years. By 1855 it had grown to 290,000.

Now, it is known that neither per capita income nor total population jumped dramatically in this short period between about 1838 and 1843. Moreover, the fares charged by the two modes of transportation were iden-
tical. The railroad was neither more comfortable than the smoothly gliding trekschuiten nor more convenient. The barges had departed hourly in each direction from 5 am until 8 pm while the trains set out only four times per day in each direction. For all these reasons it seems reasonable to seek the explanation of the increase in demand in the two factors $V$ and $e$: the value of travel time and the demand elasticity. If we knew one we could easily calculate the other. What we can do here is assume values for $V$ that seem appropriate to third class travelers and then see if the implied value of $e$ falls within a believable range.

For instance, if we set $V$ equal to the average wage, one guilder per day or f0.10 per hour, the arc elasticity of demand that describes the behavior of passengers suddenly confronted with the new technology is $-1.37$. That is, for every 1 percent decline in total cost (fare plus value of travel time), third class travelers in 1839–40 were prepared to consume 1.37% more passenger transportation. This result is believable; it falls in the range of demand elasticities that have been calculated in modern economies. Correspondingly, the value assigned to $V$, f0.10 per hour, seems to yield a plausible description of consumers' behavior. If $V$ were set twice as high, at f0.20 per hour, the associated value of $e$ would be $-0.74$. There exists no way to know which of the possible combinations is most 'true'. But, this second estimate seems less believable than the first because of its implication of less than unitary elasticity. Everything we know about the demand for passenger transportation gives the impression that it was a highly desired good on which an increasing portion of income was spent.

Whatever the true values of $e$ and $V$, the fact remains that the volume of third class passenger travel on the Amsterdam-Haarlem route did not leap upward with the introduction of the railroad. On a per capita basis, the railroad did not even reach the level of demand that the trekschuit had handled in the mid-seventeenth century.

The situation with regard to first and second class travel may well have been very different. The volume of such travel before the construction of the railroad is not known, but the cost saving conferred by the railroad was large no matter what value is assigned to $V$. It is, of course, reasonable to assume that such travelers valued their time at a rate in excess of the average hourly wage. If we nevertheless persist in assuming the same values of $e$ and $V$ that seemed to yield satisfactory results in the case of third class travel ($e = -1.37, V = 0.10$) the implication is that the volume of first and second class travel rose from 0.9 to 1.6 million passenger-kilometers, or from 47,400 to 84,200 passengers. When we assign a higher value to the time saving of first and second class travelers than the f0.10 assigned to third class travelers, the result is to increase the size of the leap in passenger volume between the pre- and post-railway construction periods. The impact is modest, however. Only when very high values are assigned to $V$—such as the values implicit in the choice
of coach over trekschuit travel in the 1820s (see table 8.4) — does the jump in estimated demand become important. If $V = 0.65$ (13 stuivers) per hour and $e$ remains at $-1.37$, the volume of pre-railroad coach travel was only 700,000 passenger-kilometers, or 36,800 passengers. The implication is that the volume of first and second class travel grew 130% (compared to 78% when $V = 0.10$) while the volume of third class travel is known to have grown only 36 percent.\(^3\)

Clearly, the value of the new railroad technology was not the same to all social classes. That value can be quantified using the Walton-Boyd approach to social saving (i.e. consumers’ surplus). The social saving of the first railroad in 1840–42, assuming $e = -1.37$ and $V = 0.10$ for all classes, was £83,550. Since the area served by this short line was so small, there is little point to expressing the social saving as a percentage of GNP. What is interesting about this figure is that 70 percent of it (£58,150) is attributable to the 30% of all travelers who used first and second class while only 30% (£25,400) represents the social saving of the 70% of travelers who used third class accommodations.

In 1847 the railroad was finally extended to Rotterdam. Now all the largest cities of Holland were served by the railroad, and the trekschuit, in this small but important region was a thing of the past. In 1848 the first full year of operation for the completed railroad, travel volume amounted to 21.1 million passenger-kilometers. A symptom of the stagnation of the Dutch economy in these years is the fact that travel volume barely rose in the succeeding six years. In 1853 travel volume was still only 22.4 million passenger-kilometers, which figure can also be accepted as the average for the six years 1848–53. Again third class travel accounted for 70% of the total or 15.7 million passenger-kilometers, while the first and second class accounted for 30% or 6.7 million passenger-kilometers.

The five trekvaart routes that had for two centuries provided passenger service between the same cities as were now served by the HYSM had, around 1800 (the last year for which full information is available), produced 8.8 million passenger-kilometers. Assuming that the trekvaart demand in the years thereafter kept pace with the region’s urban population growth (28%), trekvaart travel can be estimated at 11.1 million passenger-kilometers around 1840 (assuming further, for the sake of comparison, that no railroads had yet been built). By once again setting $V$ at £0.10, the demand elasticity for third class travelers was $-1.72$. This estimate, somewhat higher than our $e$ estimate for the Amsterdam-Haarlem route in 1840–42, does not inspire full confidence. In comparison to the earlier study, the estimate of pre-railroad travel volume is less well-based, and the elapsed time between the pre- and post-railroad construction data is greater — about a decade. Dynamic changes that could cause the demand curve to shift to the right have, in this case, more opportunity to take effect and to create an upward bias in any estimation of $e$.  

243
Table 8.7. Estimates of railroad social saving.

**Gross regional product estimate**

600,000 inhabitants × £245 per capita income = £147 million

**Social saving of HYSM, 1848-1853**

<table>
<thead>
<tr>
<th>Direct resource saving</th>
<th>Consumers' surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$e = -1$</td>
</tr>
<tr>
<td>first and second class</td>
<td>£188,000</td>
</tr>
<tr>
<td>third class</td>
<td>£-125,500</td>
</tr>
<tr>
<td>total</td>
<td>£62,500</td>
</tr>
<tr>
<td>% of GRP</td>
<td>0.04</td>
</tr>
</tbody>
</table>

**Social saving of HYSM, 1840-1841**

<table>
<thead>
<tr>
<th>Direct resource saving</th>
<th>Consumers' surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$e = -1.37$</td>
</tr>
<tr>
<td>first and second class</td>
<td>£36,800</td>
</tr>
<tr>
<td>third class</td>
<td>£0</td>
</tr>
<tr>
<td>total</td>
<td>£36,800</td>
</tr>
</tbody>
</table>

For the purpose of making social saving estimates one could justify the proposition that the 'true' $e$ is somewhat lower than the $-1.72$ of our calculation. But rather than quibble about these values it might be best simply to make two estimates of social saving: one where $e = -1$, a second where $e = -2$. Table 8.7 presents the results.

Expressing these social saving estimates as a percentage of GNP would be unreasonable given the limited geographical area served by the HYSM. The Gross Regional Product of central Holland would perhaps be the appropriate basis for comparison. A rough estimate of GRP can be made by multiplying the region's population, 600,000, by the most recent estimate of 1860 per capita income (245 guilders). The resulting estimate of £147,000,000 may be wide of the mark by a considerable amount, but will suffice to place the social saving of what was by far the most important passenger-carrying railroad in perspective. Regardless of one's estimate of $e$, the social saving does not amount to as much as 0.2% of GRP.

These consumers' surplus estimates plus the direct resource saving estimate of £62,500 presented earlier need not be accepted as gospel in order to draw the following conclusions about the early impact of the railroad in the Netherlands. First, the direct resource saving was exceedingly small. The resource-liberating impact of the trekvaarten in the seventeenth century had been more powerful. Second, the consumers' surplus produced by the railroad was at best (when the absolute amounts are directly compared) only half that of the trekvaart network in the seventeenth century. Even more striking than the smallness of the total consumers' surplus is its distribution: it was garnered overwhelmingly by high-income passengers.

244
If we ask why social saving estimates for the Netherlands in the 1850s are so much below comparable estimates made for Britain and the United States, the answer should be sought not in the shortcomings of Dutch railway policy, but in the existence of a pre-railway system of mass transportation. A truly counterfactual historical exercise would be to estimate what railway social saving would have been had the trekvaart network not existed. One can get a crude idea of what results such an exercise would yield by simply using the coach instead of the trekvaart as the alternative to third class railroad travel. Suddenly the consumers' surplus would accrue primarily to the lower-income travelers and direct resource saving would jump to much higher levels.

The impact of the railroad in a trekvaartless Netherlands would have been much more intense, not because more passengers would have been carried by the railroad than in fact occurred, but because pre-railroad transportation would have been so much more limited. In effect, the adjustment to cheap mass transportation — in such matters as industrial location, urban systems development, and social customs — that most countries made suddenly after the introduction of the railroad, had been made two centuries earlier in the Netherlands.

To some contemporaries the railroad was a foreign technology wholly inappropriate to the geography, economy, and society of the Netherlands. A publicist for a rival transport improvement, E. J. van Starkenborgh Strachouw tot Wehe, sought to dissuade the government from subsidizing railroad construction with the observation that 'the railroad is no more at home in the Netherlands than is a fish in the attic'. The difficulties inherent in throwing railroads across a landscape of canals, rivers, and boggy soils could persuade one of the truth of that remark, but in fact the publicist was completely wrong. The problem of the railroad was that it fit all too well into the Dutch economy of its time. The proof of this is to be seen in the comparatively minor adjustments in travelers' behavior, industrial location, and percentage of income devoted to transportation made by the Dutch economy when it was suddenly confronted with the new technology. Whereas the railroad in other countries endowed the economy with a whole new matrix of economically efficient locations — causing essentially new urban systems to arise — the railroad in the Netherlands could do no better than to confirm and strengthen the existing routes and the existing locationally optimal points. Whereas the railroad in other countries exposed a latent demand for passenger transportation among middle and low income people, the railroad in the Netherlands could only gradually enlarge the long-existing mass travel market.

Imagine, for a moment, that the introduction of railroad technology presented the economy with a once-and-for-all gift of direct resource
saving and consumers’ surplus. That gift, in the Dutch case, came in two parts, separated one from another by two centuries. Looking back one can only conclude that the welfare of the millions of people who lived between 1632 and 1839 was positively affected by that fact. But however much such a conclusion might interest a historian, a contemporary of the 1840s might be excused for ignoring it and asking, instead, how that state of affairs affected the prospects for the Dutch economy in the following decades. Would the same gift have affected post-1840 growth differently if it had come all at once rather than in two widely separated periods?

At issue here is the economic impact of an obsolete technology. Is it possible that an economy’s future development can derive advantage from a lack of development in the past? To put it bluntly, would the mid-nineteenth-century Dutch economy have been in a better position to develop if it had not enjoyed for two centuries the services of the trekvaart network? A theory of technological change that gives a positive answer to this question is the ‘penalties of the pioneer’ theory. It has several variants, not all of which are appropriate to the problem at hand. But at the heart of this theory, discussed most fully in Nathan Rosenberg and Edward Ames’ article ‘Changing Technological Leadership and Industrial Growth’, is the conviction than an economy endowed with an obsolete technology suffers some net disadvantages over an economy not so endowed when both seek to adopt a more modern technology.37

In figure 8.2 the two axes measure an economy’s endowment of technology: the vertical axis measures an old, or obsolete technology, while the horizontal axis measures a new, more productive technology. Country A is endowed with little of either technology. Country B is distinctly better off than A because of its extensive endowment of the old technology. However, country C is the best off of all because the composition of its technological endowment is dominated by the new technology. Now the question is: does country B suffer disadvantages relative to country A in the race to achieve the position of country C? In the case of nineteenth-century passenger transportation we can identify Holland as occupying position B, England holding position C, and countries with neither a mass transportation network nor yet with many railroads (such as Germany and France) as occupying position A.

The transition B → C could be more difficult than the transition A → C because of an economically irrational attachment to the old technology and the capital invested therein. To the extent that entrepreneurs refuse to write off obsolete capital and seek political protection for the value of their obsolete assets, the transition to position C could be more difficult from B than from A. This does not necessarily mean that B’s transition will not occur, or will occur later than A’s; it does imply that the move will be made at a slower pace.

In the case at hand, neither the obstructing role of vested interests
in obsolete technology, nor the technical problems inherent in modernizing the obsolete technology were of lasting importance. Since the new technology had essentially nothing at all in common with the old, and since the trekvaart-owning municipal governments had long been shorn of the all-but-sovereign powers they possessed in the seventeenth and eighteenth centuries, their protests and fears were without real obstructing effect.

A more strictly economic justification of a penalties of the pioneer argument, outlined by Ames and Rosenberg, reasons that the two economies A and B seeking to achieve position C each face transition costs (M) that are a function of the level of output already achieved by the economy in question. The further assumption is made that the production costs (C) of the existing technologies stand in the relationship

\[ C_a(X) > C_b(X) > C_c(X) \]

where \( X \) = output. In this case the transition costs of B will exceed those of A (since B's output level exceeds that of A) while the cost-reduction benefits per unit of output achieved by that investment will be less for B than for A, since \([C_b(X) - C_c(X)] < [C_a(X) - C_c(X)]\). If all the economies sell their goods at the same price, B would have less incentive than A to pay the transition costs needed to move to position C. Her costs are greater while her benefits per unit of output are smaller.

In the case at hand one cannot argue that B's (i.e., Holland's) transition costs exceed those of other countries. The new railroad technology did not face higher construction costs because of the existence of the old trekvaart technology. But the cost-reduction impact of the new technology was clearly much less for Holland than for A-type economies.

Ames and Rosenberg sought to examine the logic and plausibility of arguments for delay or failure of obsolete economies to invest in modern technology. In the case of the Netherlands I have shown that the existence of an obsolete mass transportation system raised up real obstacles in the path of transition: the private returns to the new technology were lower and the consumers' surplus was lower. But I am more impressed by the indirect retarding effects of the obsolete technology. Because of the more modest cost-reducing impact of the railroad in the
Netherlands, its dynamic forward linkage effects had less chance to make themselves felt. Much of the total change that the new technology was capable of introducing had been absorbed by the economy long ago and in a somewhat different form. The obsolete system had helped create an urban system that was capable of resisting the new opportunities offered by the modern transportation technology. Consequently, the latter was built more to reinforce the existing patterns than to create new ones.

Most penalties of the pioneer arguments suffer, as Ames and Rosenberg demonstrated as long ago as 1963, from imprecision and logical fallacies. But we should not conclude that the phenomenon they sought to explain is not a real one. The economic transitions represented in figure 8.2 by $A \rightarrow C$ and $B \rightarrow C$ deserve to be distinguished clearly.

The economy of the Netherlands in the nineteenth century was unquestionably backward in comparison to neighboring countries. Its overall growth was slow and its introduction of modern technology long delayed. The slow development of the railroad network is only one of many possible examples. One is tempted, therefore, to apply to the mid-nineteenth century Dutch economy Alexander Gerschenkron's concept of relative backwardness. Gerschenkron bases his theory of comparative economic development on this concept, which holds that the more backward an economy, the larger is the gap between what exists and what the introduction of modern technology can achieve. The larger this gap, in turn, the more development is characterized, when at length it is begun, by explosive rates of growth, large-scale projects, and the utilization of new institutions that can substitute for the absence of normal growth requisites. This brief summary of Gerschenkron's work does not do it full justice. Still, one need not proceed much further with his relative backwardness theory to be convinced that the nineteenth-century Dutch economy does not fulfill its requirements. Here the state of backwardness was no springboard from which one could leap to the state of modern technology; rather, it was a spongy surface to which everything adhered in an immobilized condition. When the Dutch economy finally did begin to grow, it was by no means an abrupt 'take-off', nor was it characterized by conspicuous institutional discontinuities.

There exist, it would seem, two types of backwardness. One might be called the 'primitive economy' endowed with very little of what modern technology finds relevant beyond natural resources; the other can be called the 'obsolete economy'. It too is poor and stagnant, but for reasons very different from those of the primitive economy. Its population is skilled, but with the wrong skills; its capital stock is large, but unproductive; its economic and legal institutions are stable and highly developed, but irrelevant to modern needs. It is, in short, obsolete. The development problems of the obsolete-backward economy differ fundamentally from the primitive-backward economy, because, as was shown above the type of economic transition it must make is different.
PART THREE

TRENDS, CYCLES, AND STRUCTURAL CHANGE IN THE ECONOMY OF THE DUTCH REPUBLIC
CHAPTER IX

LONG-TERM TRENDS IN THE DUTCH ECONOMY

IX.1. THE EVIDENCE

In the preceding chapters we have repeatedly referred to the total volume of passenger travel and the long-term trends in that volume. Now, finally, the passenger volume carried by trekschuiten will be described and analyzed in more detail.

The trekvaart system comprised 39 separate routes. (The two coach routes that functioned as links in the trekvaart network will also be considered here.) Our first task is to identify the annual number of passengers that traveled over each route during its years of service. Complete, or nearly complete, series have been preserved in only a few instances (routes 1, 2, 3, 11, 13, 32, 33), but for many routes a great deal of information is available. There are only a handful for which nothing or very little is known (routes 9, 14, 22, 27, 31). Even in these cases, the passenger-carrying capacity of the scheduled services is known, permitting us to suggest a range of likely passenger volumes.

The first and most general expression of these data is the total volume of passenger transportation produced by the entire system. Given the lacunae in the data, this global assessment can be made with accuracy only for the first years after the completion of the network, in the 1660s. I have also made estimates for two other periods, the 1740s and the first decade of the nineteenth century, but in these periods the volume of several routes — particularly in Friesland and Groningen — has had to be based on interpolations and projections.

These global assessments, which were introduced earlier in this study, testify to both the large scope of the industry and its profound decline. But to learn more about the trends and fluctuations of the industry we should have at our disposal a time series of annual passenger volumes. Since the data do not allow the construction of such a series for the network as a whole, we must content ourselves with the next best thing: aggregate series of the largest possible number of routes that still permit time series of considerable duration. For this purpose, I have assembled seven separate but overlapping aggregate series which, together, span the period 1648–1817. Each series represents the summation of the annual passenger volume of at least four routes; the largest of them, aggregate series D, embraces twelve routes. All of these aggregate series are displayed together in figure 9.1. A glance at these curves of annual passenger volume is sufficient to establish the mutual consistency of the several series. This is a reflection of the fact the yearly fluctuations and general trends of the various routes are all similar. The one exception to this
Table 9.1. Estimates of total passenger volume carried on the trekvaart network in three periods (in millions of passenger-kilometers per year).

<table>
<thead>
<tr>
<th></th>
<th>1660–70</th>
<th>1740–50</th>
<th>1800–06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam–Rotterdam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Routes 1–5*</td>
<td>17.5</td>
<td>7.7</td>
<td>8.9</td>
</tr>
<tr>
<td>Other Holland–Utrecht</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Routes 6–22*</td>
<td>13.8–16.3</td>
<td>6.1–7.1</td>
<td>7.1–8.2</td>
</tr>
<tr>
<td>Friesland–Groningen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Routes 23–37*</td>
<td>5.8</td>
<td>3.8</td>
<td>5.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>37.1–39.6</td>
<td>17.6–18.6</td>
<td>21.1–22.2</td>
</tr>
</tbody>
</table>

* For identification of route numbers, see Appendix.

generalization is series F, an aggregation of Friesian and Groningen routes. The travel volume on these routes followed a course that sometimes varied considerably from the routes of the Holland–Utrecht network.

The annual travel volume on several of the individual routes is presented in graphic form in figures 9.2 through 9.6. On the basis of all these curves a description can now be offered of the direction of change and the turning points in the volume of trekenschuit travel.

The overall course of demand for intercity passenger transportation in the Dutch Republic is clear. Given the high degree of correspondence among the individual and aggregate series, no ambiguity complicates the interpretation of the overall pattern. On routes where operations began sufficiently early a gradual increase in volume is observable that culminates in the 1660s. The disturbing effects of the First and Second Anglo-Dutch wars and the French invasion of 1672 make the unambiguous identification of a single peak period difficult, but for the system as a whole the late 1660s and early 1670s is the best candidate for that distinction. Virtually every route and every aggregate series shows a sharp downturn setting in after 1675. For the following 15 years decline is persistent, so that by 1690–91, at the trough, passenger volume has been reduced by nearly a third from its 1665–74 level. The following 15 years form an interruption to this downward trend. Again, the revival of demand in these years is evident on every route and every series. Until 1699 volume actually rises; thereafter it begins to decline again, but only after 1705 does the volume descend below the low point of 1690–91.

The decline which sets in at the beginning of the eighteenth century is, at the aggregate level, continuous to 1744–46. On individual routes the timing of decline varies. Thus, in North Holland and around Amsterdam the sharpest decline is confined to the decade after 1735, while in South Holland the earlier decades are most disastrous. But on all the routes of the Holland–Utrecht region the era of decline ends in 1744–46.

Thereafter all routes display a gradual revival or, at worst, stagnation.
Figure 9.1. Annual trekschuit travel volumes of aggregate routes A through D, and estimates of total volume in three periods.

Sources: For estimates of I, II, and III see table 9.1.

The following routes are included in the aggregate series:

A  1, 2, 3, 11, 13, 32.
A' 1, 2, 3, 11, 13, 16, 18, 19, 32.
B  3, 11, 13, 32.
B' 1, 2, 13.
C  1, 3, 4, 6.
D  1, 2, 3, 4, 8, 10, 11, 13, 16, 18, 19, 32.
Figure 9.2. Annual passenger volume on four trekvaarten, 1632–1820.
1. Amsterdam–Haarlem, 1632–1760, 1787–1820

Figure 9.3. Annual passenger volume on four trekvaarten, 1658–1820.
1. Amsterdam–Gouda, 1658–1729
2. Leiden–Utrecht, 1665–1817
3. Amsterdam–Leiden (night barge via Alphen), 1668–1793, 1808–1820

Figure 9.4. Annual passenger volume on the North Holland trekvaarten, 1664–1752.
1. Amsterdam–Purmerend/Monnikendam
2. Purmerend/Edam–Hoorn
3. Monnikendam–Edam. Note: From 1682 onward, the night barge between Amsterdam and Hoorn was routed via Monnikendam–Edam only in odd-numbered years. Consequently, the graph presents two lines, one connecting odd-numbered the other, even-numbered years.
4. Hoorn–Enkhuizen (a coach route)


Figure 9.5. Annual passenger volume on trekvaarten extending eastward from Amsterdam, and toll revenues from roads and waterways between Amsterdam, Utrecht, and the eastern provinces, 1675–1825.
1. Amsterdam–Naarden (passengers), 1709–10, 1716–21, 1750–1825
2. Amsterdam–Weesp (passengers), 1675–1726
3. Utrecht pasagiegeld revenue (levied on all vessels navigating the river Vecht north of the city), 1778–1805
4. Nieuwersluis–Hinderdam (toll revenue), 1704–1809
5. Utrecht–Amsterdam trekvaart (toll revenue), 1730–1825 (with gaps). Note, these are tolls collected at Nieuwersluis and Voetangel.
6. Soestdijck tollgate (toll revenue), 1720–1810
7. Nieuwersluis pasagiegeld revenue (levied on all vessels navigating the river Draa), 1778–1807
8. Eembrugge bridge (toll revenue), 1732–1810


256
at the level of the 1740s until the first decade of the nineteenth century. The year 1806 forms the turning point of this era of stability or slow growth. The imposition of the Kingdom of Holland in 1806 and still more the absorption of the Netherlands into the French Empire in 1810 went hand in hand with a disastrous, unprecedented collapse of passenger travel. The re-establishment of an independent Dutch state (and the dismantling of the Continental System) permitted the passenger volumes to revive from their 1813 low point. This revival continues beyond 1817, the last year of the aggregate series, but the handful of series that continue further into the nineteenth century make it clear that the pre-1806 volumes are never regained.

To summarize, the 39 trekschuit series are in agreement concerning periodization: 1632 to 1668-75, growth; 1675 to 1691, decline; 1691 to 1699, revival; 1700 to 1744-46, decline; 1744-46 to 1806 modest growth; 1806 to 1813, collapse; 1814-? modest revival. The Friesian routes form a partial exception to this summary of the major trends. There, most of the decline was concentrated in the period 1675-1691. The low point was reached earlier, in the 1730s rather than the 1740s, and the second half of the eighteenth century exhibited more growth than did the same period in Holland and Utrecht.

The individual routes show a high degree of conformity to this overall pattern, but they also display unique characteristics with regard to their rates of change within periods. For instance, the important Amsterdam-Haarlem route experienced a sharp drop in passenger volume between 1675, when it stood at 300,000 passengers, and 1691, when only 166,000 passengers used the trekschuiten. But in the next 45 years passenger volume stabilized around the 190,000 level. The eighteenth-century decline that occurred elsewhere did not bypass this route however, from 1735 to 1746 decline was almost continuous and thereafter passenger volume fluctuated for many years around the 150,000 level.

Much the same pattern is observable on the routes connecting Amsterdam with the cities of the North Holland peninsula, except that here the decline of 1675–1691 was largely concentrated in the first year. The floods of 1675–76 not only forced the suspension of service on portions

Figure 9.6. Annual passenger volume on trekvaarten in Friesland and Groningen, 1651-1809.

1. Leeuwarden-Harlingen, 1651-1693
2. Leeuwarden-Franeker, 1651-1693
3. Leeuwarden-Harlingen trekvaart (Leeuwarden receipts), 1694-1793
4. Leeuwarden-Sneek, 1663-1699, 1715-1808 (with gaps)
5. Leeuwarden-Bolsward, 1773-1789
6. Groningen-Winschoten, 1853-1809


259
of the North Holland trekvaart network, but had such a disastrous impact on the regional economy that the recovery of demand was much delayed.\(^1\) In fact full recovery never came, since before the short-term problems could be overcome, the long-term decline of the economy ruled actual growth out of the question. In North Holland, just as on the Amsterdam–Haarlem route, the downward trend ending around 1690 was not immediately resumed in the first years of the eighteenth century. In the first 35 years of the new century the decline of demand was very modest, but in the decade beginning with 1735 the volume of travel suddenly fell by half. The mid-1740s do not seem to have established a permanent floor on passenger demand in North Holland. The records of the five cities participating in the operation of this network of routes all show further decline in the second half of the eighteenth century. Unfortunately, there are compelling reasons to discard these records as untrustworthy.\(^2\) Consequently, we cannot follow the course of demand for trekschuit travel in this region after the mid-eighteenth century.

Another group of routes also show a noteworthy variation on the overall pattern described above. These are the routes connecting Amsterdam with the east. The Amsterdam–Weesp route, for which complete data are available only in the period 1676–1726, did not participate fully in the two great periods of decline. The seventeenth-century decline was modest (15% between 1676–9 and 1688–91) and the eighteenth-century decline was interrupted after 1715. The annual data cease after 1726, but the sharp decline of 1735–45 experienced by the other routes connecting with Amsterdam was apparently felt here as well, for the revenues collected when the operations of the trekvaart were leased to private parties fell by 23% between 1730 and 1750. In the second half of the century lease revenues rose again. By 1781 they even exceeded the 1728–30 level by 7%\(^3\).

The absence of massive, permanent decline is even more apparent on the Amsterdam–Naarden route, which competed with the Weesp route as a gateway from Amsterdam to the eastern provinces. Unfortunately, no records are available for this route before 1709. The seventeenth-century decline is, thus, unobservable. But from 1709 to 1721 volume hovered around the 40,000 passenger level. Thereafter, no records are available until 1750, when the lease revenues become available for most years until 1835. These data permit the following observations to be made: there was no significant decline in passenger volume between 1721 and 1750, volume in the 1790–1808 period stood about 25% above the 1750–70 level, the 1816 lease price was only 54% of the 1807–08 prices, and, finally, the lease price – and presumably the volume of travel – recorded an irregular, trendless pattern from 1816 until 1834. To summarize, both the Amsterdam–Weesp and Amsterdam–Naarden routes followed the periodization established for the network as a whole, but they did not share fully in the large, permanent decline.
in volume that took place elsewhere between 1675 and 1745.

Finally, it is worth observing that among the routes that did suffer declining demand in the period 1675–1745, the rate of decline varied considerably. Table 9.2 presents an overview of both the extent of decline between 1669–75 and 1742–48, the highest and lowest seven-year periods of the network as a whole, and the extent of recovery in the second half of the eighteenth century. In this latter case, the period of comparison with 1742–48 is that seven-year period for which the highest observable average passenger volumes were recorded. Note that the peak period recorded in column 3 is the observable peak for each route. The documentation on which these calculations are based breaks off at different times for each route; consequently, it is not always possible to identify positively the actual late eighteenth-early nineteenth-century peak period.

**Table 9.2. Percentage change in trekschuit passengers by route, 1669–75 to 1742–48 and 1742–48 to c. 1800.**

<table>
<thead>
<tr>
<th>Route number*</th>
<th>Cities connected</th>
<th>1742–48 volume as % of 1669–75 volume</th>
<th>Volume circa 1800 as % of 1742–48 average</th>
<th>Observable peak period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amsterdam–Haarlem</td>
<td>55</td>
<td>116</td>
<td>1800–06</td>
</tr>
<tr>
<td>2</td>
<td>Haarlem–Leiden</td>
<td>44</td>
<td>135</td>
<td>1801–07</td>
</tr>
<tr>
<td>3a</td>
<td>Leiden–The Hague</td>
<td>30</td>
<td>105</td>
<td>1794–1800</td>
</tr>
<tr>
<td>3b</td>
<td>Leiden–Delft</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Delft–The Hague</td>
<td>33 (1730–36)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Delft–Rotterdam</td>
<td>n.a.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Amsterdam–Naarden</td>
<td>n.a.</td>
<td>125</td>
<td>1792–1798</td>
</tr>
<tr>
<td>8</td>
<td>Amsterdam–Weesp</td>
<td>n.a.</td>
<td>125</td>
<td>1790–1808</td>
</tr>
<tr>
<td>9</td>
<td>Amsterdam–Utrecht</td>
<td>n.a.</td>
<td>129</td>
<td>1804–1808</td>
</tr>
<tr>
<td>10</td>
<td>Amsterdam–Gouda</td>
<td>54 (1723–29)</td>
<td>110</td>
<td>1802–1808</td>
</tr>
<tr>
<td>11</td>
<td>Amsterdam–Leiden</td>
<td>69</td>
<td>114</td>
<td>1787–1793</td>
</tr>
<tr>
<td>13</td>
<td>Leiden–Utrecht</td>
<td>38</td>
<td>113</td>
<td>1802–1808</td>
</tr>
<tr>
<td>15</td>
<td>Vianen–Gorinchem</td>
<td>n.a.</td>
<td>136</td>
<td>1793–1799</td>
</tr>
<tr>
<td>16–17</td>
<td>Amsterdam–Monnikendam/Purmerend</td>
<td>35</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>19–20</td>
<td>Edam/Purmerend–Hoorn</td>
<td>27</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Leeuwarden–Harlingen</td>
<td>n.a.</td>
<td>149</td>
<td>1781–1787</td>
</tr>
<tr>
<td>26</td>
<td>Leeuwarden–Sneek</td>
<td>50</td>
<td>170</td>
<td>1790–1797</td>
</tr>
<tr>
<td>32</td>
<td>Groningen–Winschoten</td>
<td>74</td>
<td>110</td>
<td>1797–1803</td>
</tr>
<tr>
<td>33</td>
<td>Winschoten–Nieuwe Schans</td>
<td>n.a.</td>
<td>155</td>
<td>1791–1797</td>
</tr>
</tbody>
</table>

**Aggregate route**

| A | 48 | – | 1787–1793 |
| B | – | 114 |                       |

* For identification of route numbers, see Appendix.

n.a. = not available.

Sources: See figures 9.2 through 9.6.

261
The direction of change and the turning points were the same for all routes, but, as table 9.2 demonstrates, the rates of change varied enormously. Particularly severe were the declines of the three routes forming a triangle between Leiden, The Hague, and Delft and the routes extending north from Amsterdam toward Hoorn. Notable for their above average resistance to decline were the remaining routes connecting with Amsterdam (i.e., routes 1, 10, 11, and the previously mentioned routes 7 and 8).

The extent of the revival of intercity passenger travel after 1745 also varied enormously among routes. The Friesian routes grew with particular vigor. In Holland, a motley pattern obtained. Overall growth was in the vicinity of 14%, but some routes grew by 35% while the routes from Leiden to Delft and The Hague remained essentially unchanged. With the possible exception of the North Holland routes between Amsterdam and Hoorn, for which the data are unreliable, no route declined absolutely in the second half of the eighteenth century.

IX.2. THE VALUE OF THE EVIDENCE AS AN ECONOMIC INDICATOR

The question that must be considered next is whether the annual volume of trekschuit passengers can serve as an indicator for the overall level of economic activity of the Dutch Republic. To answer this question positively we must become convinced that the consumer behavior registered by the trekvaart records was to a large degree influenced by the condition of the economy and that the influence of other factors, particularly those stemming from the peculiar characteristics of the trekvaart industry itself, are minor or capable of being identified and removed from the data.

There are three reasons to believe that these data can be used as a general economic indicator. In the first place, the data are likely to be meaningful for the simple fact that they represent a mass phenomenon. The network extended to nearly every city and served every social class of the population. We established earlier that the peak volume of the system was sufficient to permit every fare-paying inhabitant of the four provinces served by the trekvaart network to travel 40 kilometers per year. This, in turn, absorbed six hours of everyone's time and required an expenditure of nearly one percent of an average family's gross income. Since the trekvaart industry claimed a nontrivial amount of the entire population's time and income it is reasonable to assume that the observed demand for trekschuit transportation had deep roots in the economy and was not a marginal phenomenon, the product of whimsy or fashion.

A second reason for confidence in the significance of the trekschuit data rests in the industry's stability. From 1665, when the network assumed its ultimate size, until the 1830s, when the railroad and the river
steamboats altered travel patterns, no important new routes were introduced, no technological developments altered the cost, speed, or comfort of trekschuit transportation, and no major changes in schedule frequency altered the available supply of trekschuit transportation. In short, the parameters of the industry displayed a remarkable stability for about 175 years. The volume of passenger travel did not reflect major biases stemming from changes in these characteristics of the industry.

The third factor that must be considered is intermodal competition. The just established fact that the trekvaart industry changed very little after 1665 is, of course, no guarantee that competing modes of transportation were equally stationary. If developments in other modes increased their competitive position vis-à-vis the trekschuit or if even in the peak periods of the trekschuit, competing modes held a major share of the intercity transportation market, the data of passenger transportation per trekschuit would lose much of their general significance. In that case one could never be certain that changes in demand for trekschuit service were not simply the result of shifts in consumer preference among competing modes. Before we can use the trekschuit passenger volume data as general economic indicators it must be demonstrated that the trekschuit held a major share of the market for intercity travel and that it faced no new effective competition.

IX.2.1. Intermodal competition

To examine this problem we have divided competing modes into public, private, and unregulated transportation. Several aspects of the place of the trekschuit within the total public transportation system of the Dutch Republic have already been considered (see chapter III). We have been able to ascertain that the trekschuit accounted for the great bulk of public transport capacity in Holland, Utrecht, Friesland, and Groningen. In the Holland–Utrecht region the trekschuit provided 81% of all public transport capacity in the seventeenth century, and most of the capacity provided by other modes provided supplementary, or in any event, non-competing services. In Friesland and Groningen the trekschuit furnished 78% of public transport capacity, most of the rest representing Zuider Zee sailing vessels that maintained the connections with Holland.

In the course of the eighteenth century coach services (which provided only 6% of total transport capacity in the seventeenth century) were gradually expanded. In the 1770s the distances which coaches put behind them in the observance of their regular schedules exceeded by 50% the late seventeenth-century figure. But almost all of that growth occurred in the eastern provinces of the Republic. The travel guides of the 1770s continued to advise their readers to use the trekschuit wherever it was possible, and for good reason. The barge cost only a third as much as a coach, was more comfortable, and was, at worst, only marginally slower.
Only after the 1790s did a change in the relative competitive position of the coach and the trekschuit occur. The relative cost of the two modes remained the same, but coach construction was improved, offering more comfort, and the road improvements introduced during the French era permitted significant improvement in coach speeds. Only then did the trekschuit come to acquire the name volksschuit, reflecting the fact that most people of substance had ceased to make regular use of what a few decades earlier had been called, proudly, the 'national means of transportation'.

To summarize, the trekschuit dominated public intercity transportation from its inception until around the turn of the nineteenth century. Until then its low cost and the weakness of land transportation made significant competition impossible. But this situation changed gradually from the last decade of the eighteenth century onward. The records of trekschuit passenger volume for the early nineteenth century must therefore be interpreted with caution; it is unlikely that the trend of trekschuit volume adequately reflects trends in the general economy after about 1800.

The competition between regulated public transportation, dominated by the trekschuit, and private and unregulated transportation is a phenomenon that is more difficult to observe and measure. Skippers' guilds on several occasions complained to their municipal magistrates about teamsters who hovered around the trekschuit boarding docks and tried to entice would-be trekschuit passengers away by offering immediate departure and higher speed. I have found no quantitative materials that can put the scope of this form of competition into perspective, but it seems unlikely that it could significantly have affected the overall trends of observed intercity transportation. To divert a large portion of the trekschuit clientele, an enormous number of illegal wagons would have been needed. Moreover, the low cost position of the trekschuit meant that these unregulated competitors must have charged a fare that exceeded the trekschuit fare. The incredulity with which the Amsterdam–Hoorn skippers noted that their unregulated wagon competitors sought to attract customers from the boats arriving at Buiksloot from Amsterdam by offering fares at and below the barge fare is testimony to the difficulty that teamsters must have had in competing on the basis of price. Yet, these vehicles were not well-sprung coaches, they were wagons normally used for freight transport from which their owners were trying to earn a few extra guilders. Only on this marginal basis could a teamster hope to approach the trekschuit tariff and still find advantage in the activity. But unregulated competition on such a basis could never be anything but temporary, irregular, and limited to very short-distance traffic. Anything more would have required investment (for which there is no evidence), and investment would have necessitated fares considerably in excess of the trekschuit fares.
IX.2.2. Towpath toll receipts

By far the most important forms of competition were walking and the use of private vessels and vehicles. Luckily, some idea of the scope and development over time of these forms of competition can be acquired from the financial records of the trekvaarten. As was made clear in chapter IV, the trekvaart administrations derived their revenue not only from trek-schuit passengers, but also from the users of the towpaths and, in some cases, from the other vessels that made use of the canal. Since many towpaths functioned as important links in the road network of the Dutch Republic, it should be possible to trace the development of overland transportation from the financial records of the trekvaarten.

The theoretical promise of the trekvaart toll revenue records must be qualified by two weaknesses that adhere to these data. Their accuracy must be regarded as inferior to the just-discussed records of the trekschuit passengers because of the administrative problems inherent in both the collection of and the supervision of the collection of a complex tariff schedule at fixed, often remote, tollgate locations. These difficulties did not escape the attention of the trekvaart administrators, and their solution – the leasing of the toll collection rights to private parties – only compounds our difficulty in using these records. The leases were almost always let out for more than a single year at a time (in some cases they were renegotiated only once every six years), and it is not easy to discover whether the bidding for the toll collection privileges was, in fact, open and competitive. For all these reasons the toll receipts or lease revenues can only be used, in the best of circumstances, to uncover the long-term trend of towpath and/or trekvaart use. Even then, a further problem is that the composition of that traffic remains a matter of conjecture. At each tollgate each class of passing traffic was subject to a separate tariff, or no tariff at all. In the absence of the daily records kept by the toll-keeper, it cannot be known how much of the toll revenue was paid by passing pedestrians, how much for horses, cattle and other livestock, how much for coaches, wagons, or boats, etc.

Map 9.1 indicates the tollgate locations for which I have collected annual toll or lease revenue data. These series represent but a small fraction of the myriad tolls that plagued communications in the Dutch Republic (as well as all other pre-industrial European countries), but they do measure traffic along several key arteries. What do these data tell us about non-trekschuit passenger flows?

The two tollgates that guarded access to the towpath of the Amsterdam–Haarlem trekvaart levied identical tariffs on all passing traffic, and the tariff remained essentially unchanged for at least the first 130 years of its existence. Each pedestrian paid 1 st. at each tollgate (children, \( \frac{1}{2} \) st.); each person on horseback paid \( \frac{3}{4} \) st.; each horse, cow, ox, etc., \( \frac{1}{8} \) st. Until 1716 every sort of vehicle (wagon, coach, cart) was subject to a charge of 2 st. plus a stuiver for every passenger. The gradual increase
Map 9.1. Location of tollgates whose annual receipts have been collected for this study.

Amsterdam–Haarlem towpath
1. Sloterdijk
2. Haarlemmerliede

Haarlem–Leiden towpath
3. Aardenhoutslaan
4. Warmond

Leiden–Delft/The Hague towpath
5. Leidschendam

Leiden–Utrecht towpath
6. Koudekerk

Amsterdam–Gouda towpath
7. Huis aan de Drecht
8. Boskoop

Gouda–Rotterdam paved road
9. Gouda (Dijkpoort)
10. Honingerbos

Amsterdam–Muiden–Naarden towpath
11. Vianenbrug
12. Papelaan
13. Hakkebaarsbrug

*Oudekerk-Breukelen towpath
(Amsterdam–Utrecht trekvaart)
14. Voetangel
15. Nieuwersluis

*Vecht river towpath
15. Nieuwersluis
16. Hinderdam

*Eembrugge bridge toll
17. Eembrugge

*Soesdijk road toll
(Amersfoort–Naarden road)
18. Soesdijk

Amsterdam–Hoorn towpaths
19. Broekermeer (Schouw)
20. Achterdijktinge
21. Zedde
22. Zeevang (aan de Klem)
23. Oudendijk

Alkmaar–Zijpe towpath
24. Koedijkerbrug
25. Schoorl

Harlingen–Franeker–Leeuwarden towpath
26. Koetille
27. Kingmatille
28. Ritsumazijl

Groningen–Winschoten towpath
29. Roode Haan
30. Foxhol
31. SchieVel

(* See figure 9.5 for further information)
in the number of private coaches and the development of new types of coaches apparently induced the trekvaart administrators to alter their tariff structure. Beginning in 1716 the tariff schedule distinguished among four types of vehicle, ranging from coaches pulled by 6 horses (charged 5 st.) to chaises or carriages with one or two horses (charged 2 st.). In all cases the passengers of the vehicles also had to pay the 1 st. toll. Exempt from these tolls were the inhabitants of the villages through which the trekvaart passed, the owners and employees of country houses built along the trekvaart and the notables and officials of the region whose names were included on an official list of toll-exempt gentlemen. Thus, most purely local traffic did not contribute to these toll revenues.

If few animals were driven over the towpath, and horse drawn vehicles also were rare, then we could make an upper-limit estimate of the number of passing travelers by counting each collected stuiver as representing one traveler. The less this assumption were true, the lower the actual volume of private (and coach) travel actually would have been. Using this upper-limit assumption, the course of towpath use between 1632 and 1759 (whereafter the toll collections were leased and other presently to be discussed changes were introduced) is presented in ten-year averages in figure 6.2. Here the steady growth of towpath use from a maximum of 12,500 travelers per year in the 1630s (5% of all travelers) to 60,000 per year in the 1680s (22% of all travelers) can be observed. The continued rise of towpath use after 1675 was not nearly sufficient to compensate for the sharp decline in trekschuit use that began then. Consequently, the overall trends of passenger travel presented earlier are not altered by the addition of towpath users. But the towpath did become a significant travel artery. In the 1690s a maximum of 23% of all travelers between Amsterdam and Haarlem went on foot, horseback, or in a coach. But thereafter the towpath shares the downward path of the trekschuit. In fact, towpath use declines at an even faster rate.

Walking was obviously a substitute for trekschuit travel that could be quite significant, especially for short distances. Eighteenth-century travel guides recommended walking for short trips, and in travelers’ diaries one sometimes encounters even gentlemen traveling between two cities on foot. (We have already drawn attention to one Englishman who found the trekschuit so slow and the Dutch coach so clumsy that he regarded walking as the most dignified means of transportation available.) What factors influenced the average traveler in choosing between these two methods of reaching his destination? The distance of the contemplated trip and the amount of accompanying baggage were surely important considerations, but another significant factor is likely to have been the price. We have already shown, in chapter VI, how changes in the ‘real’ cost of trekschuit travel affected the popularity of the towpath. The trekschuit fare between Amsterdam and Haarlem remained the same between 1641 and 1759, but the general price level did not. Con-
sequently, the real price of trekschuit travel changed and, to the extent that the price elasticity of demand for travel by trekschuit was high, consumers can be expected to have responded to increased real costs by substituting the cheaper towpath for the more costly trekschuit, and vice versa. Figure 6.2, which shows the evolution of the real price of trekschuit travel plus the number of travelers using the towpath and the trekschuit, demonstrates that substitutions did in fact take place. With the single exception of 1700–09, the direction of change of the real price index and the number of towpath users is the same in each ten-year period. This correspondence confirms that walking was a potentially important competitor to trekschuit travel.

In the 1760s a new era began for the Amsterdam–Haarlem towpath. In 1762 the two cities agreed to pave the towpath, one of the first improvements to the trekvaart network taken in hand since the seventeenth century. The municipal particularism which had proved so burdensome to the execution of joint enterprises in the seventeenth century had not abated in the eighteenth. On the contrary, not only did it continue to flourish but it assumed a ridiculous form of ostentation. In this atmosphere Jan Wagenaar, who wrote his chronicle of Amsterdam while this paving project was under way, described with great solemnity how the construction teams of the two cities were working toward each other (they would meet at Halfweg). He regarded it of particular importance to call his readers’ attention to the fact that each city had chosen a different sort of paving stone for the project: Amsterdam used Brabant paving bricks while Haarlem preferred cobblestones.11

This initiative differed from the trekvaart construction projects of a century earlier in two important respects. While the new trekvaarten of the seventeenth century were put into operation with remarkable dispatch, this paving job stretched out over five years, and it somehow managed to cost the two cities about £335,000 or 26% more than the entire Amsterdam–Haarlem trekvaart had cost in 1632, and four and a half times more than the construction of the 21 kilometer paved road from Rotterdam to Gouda had cost in 1680.12

When, in 1767, the towpath was finally fully paved, the cities proceeded to negotiate increases in the annual payments of the tollgate leaseholders. Presumably the new facility attracted sufficient new road traffic to warrant the 39% increase in the annual payments observable in that year, but it remains a puzzle why most of that increase should have been paid by the leaseholder of the Sloterdijk tollgate (near Amsterdam). His payments rose by 53% while the tollgate near Haarlem yielded only a 20% increase.13

These results must have disappointed the municipal officials who had taken the initiative in this project. An investment of £335,000 proved capable of increasing trekvaart revenues by no more than about £4,000 per year. It is not possible to isolate the additional annual maintenance
expenditures generated by this investment, but even if no maintenance 
expenditures at all were involved, the return would still amount to only 
1.2%, far beneath the then prevailing interest rates.

This disappointing result places in a new light the failure of the proposal 
to extend the road improvement project by paving the road from Haarlem 
to The Hague. The failure to achieve this project until after the imposition 
of a centralistic government by the French has long been regarded as 
a result of the Republic's particularist obstructionism and the com-
placency of its elites about the inadequacy of its transportation infra-
structure. It is worth noting, however, that the just completed paving 
of the Amsterdam–Haarlem towpath proved to be both very expensive 
and disappointingly patronized. The entrepreneurs who requested 
{oetrooi} in 1768 to pave the road from Haarlem to The Hague were not 
ignorant of those facts and sought to protect themselves by asking to 
install no fewer than seven tollbooths on the 43 kilometer route. A 
pedestrian walking the full length of the proposed road would have had 
to pay $3\frac{1}{2}$ st. in tolls, while a four-wheeled coach would have had to 
pay 42 st. The high level of the proposed tolls quite understandably 
elicted intense opposition, just as the unprofitability of the just completed 
paving project understandably induced the entrepreneurs to ask for very 
high tolls.

As noted above, the paving of the Amsterdam–Haarlem towpath 
permitted the tollboth lease revenues to jump suddenly by 39%. It did 
not, however, set a general trend of increased road use in motion. The re-
cceipts around 1820 were only slightly above those of 1768. For the month 
of May, 1837 the daily records of the Sloterdijk tollkeeper have been 
preserved. This is worthy of our attention for the glimpse it affords into 
the role of road transportation just before the coming of the railroad. In 
the late eighteenth century regular coach service between Amsterdam and 
Haarlem consisted of the twice daily postal coaches to The Hague plus 
winter coaches installed when ice forced suspension of the trekschuit 
services. By 1837 the scheduled coaches had increased to four per day in 
each direction between Amsterdam and Rotterdam via Haarlem, Leiden, 
and The Hague. Altogether the tollkeeper recorded the passage of an 
average of 20 diligences per day. In addition, an average of 78 private 
vehicles (2 and 4 wheeled) plus several persons on horseback passed by. 
The diligences, most of which were recorded as being capable of carrying 
12 passengers, offered a carrying capacity of over 75,000 passengers per 
year while the private vehicles and horses may have carried as many as 
10,000 persons more. Even at this late date it seems likely that the treks-
chieft continued to transport the majority of travelers between Amster-
dam and Haarlem, but the diligence, assuming that a reasonable per-
cecentage of its capacity was actually utilized, now held a respectable 
second place, a situation that had not existed 40 years earlier.

The towpath of the Haarlem–Leiden trekvaaart did not form an im-
portant artery of long-distance travel. This function was fulfilled by a sand road (the unsuccessful attempt to pave which was discussed above). Still, the average annual receipts collected at both tollbooths were consistent with the passage of a maximum of some 16,000 persons per year. In contrast to the trekschuiten, which carried seven times as many passengers in the seventeenth century, the toll receipts on this route did not decline enormously in the first half of the eighteenth century. The toll receipts remained comparatively stable; a reason for this may be the local character of the passing traffic.\(^\text{17}\)

From Leiden southward the main road was, once again, not the towpath. The tolls levied on the towpath from Leiden to Leidschendam chiefly applied to vessels – apart from the regular trekschuiten – that were pulled forward by either human beings (usually women) or horses. Ships under sail could not be burdened with a toll since this waterway antedated the construction of the towpath. The new trekvaart could not erode the established rights of sailing vessels on this route. This peculiar characteristic of the Leiden to Leidschendam toll rights robs the annual revenue statistics of much of their significance. The toll receipts of northbound vessels, in particular, varied with the frequency of the prevailing south-west winds.\(^\text{18}\) Non-trekschuit passenger travel along this route was, however, of some importance. Not only did daily market boats use this route, but so did the Amsterdam to Rotterdam, The Hague and Delft beurtveer, the one regularly scheduled service that continued to offer an alternative means of transportation to the trekschuit between Amsterdam and the cities of southern Holland.

The preservation of the daily records of the toll collectors makes it possible to be very specific about the volume and composition of traffic on this route, but the enormous investment of time required to do so has deterred me from the task. I did analyze the tolls levied on southbound traffic for one month, June, 1749. In that month 290 horses, 150 pedestrians, 498 ‘westlanders’ and 927 market boat and beurtveer passengers set off south-bound from the Neksluis tollgate at the city walls of Leiden. What the ‘westlanders’ refers to is not altogether clear. (The Westland is the corner of Holland to the south of Delft and The Hague.) It appears that, per year, some 2500 horses, 1300 pedestrians, 4200 ‘westlanders’, and 8000 non-trekschuit passengers traveled south from Leiden.\(^\text{19}\) The number of pedestrians is trivial, but the number of non-trekschuit passengers is of interest. It has been shown above that the trekschuiten between Leiden and both Delft and The Hague suffered a diminution of patronage between 1675 and 1745 that was unequalled elsewhere. The market boats from Leiden to Delft and The Hague and the beurtveer vessels from Amsterdam to the cities of southern Holland did not compensate for this decline, but their several thousand passengers constituted a significant traffic flow which puts the sharp decline of trekschuit travel in a more complete context.
Another toll which chiefly affected waterborne traffic was levied by the Leiden–Utrecht trekvaart at Koudekerk, midway between Leiden and Alphen. The toll receipts, drawn from passing vessels making use of the towpath, passing horses, the passengers of all vessels, and passing market boats, show trends similar to those of the number of trekschuit passengers. Receipts rose to a peak in the 1680s, declined by half in the 1730s, and then displayed a partial recovery. The 1730s level was exceeded by 11% in the 1760s, 19% in the 1820s, and 25% in the 1830s. An examination of the toll collectors' daily records for 1681 and 1732 uncovers an interesting development in the composition of the passing traffic. In both years, (one at the peak, the other near the trough of this toll receipt series) about 1000 horses and 500 market boats passed Koudekerk. The latter passed almost exclusively on Saturdays, bound for the weekly Leiden market. (Empty vessels apparently passed free, for the returning market boats are never recorded.) The development that accounts for the fall in revenue from f2500 to f1500 is the decline in passengers in the vessels (including the beurtveer from Amsterdam to The Hague, Delft and Rotterdam) that passed Koudekerk mostly to and from Amsterdam. While about 20,000 passengers paid the toll in 1681, only 10,000 did so in 1732. If these passengers truly were long-distance travelers, we have again observed an important stream of traffic (in large part the same stream as paid the Leiden–Leidschendam toll). These non-trekschuit travelers do not approach the trekschuit travelers in number, nor is there evidence that the beurtveren and market boats acted as a competitive alternative to the trekschuit. The flow of non-trekschuit passengers passing Koudekerk declined just as much as did the volume of trekschuit passengers. Elsewhere the toll receipts show more stability than the trekschuit receipts, but nowhere is there evidence of an important shift from the trekschuit to other modes of transportation.

The receipts at tollgates on routes extending eastward from Amsterdam differ from those just considered in exhibiting a persistent rise throughout the eighteenth century. Just as the trekschuiten on these routes, the roads did not participate in the decline in intercity travel observed everywhere else in the first half of the eighteenth century. (See figure 9.5.) The lease revenues of the three tollgates stationed along the Amsterdam–Naarden trekvaart are known only from 1750. From then until the 1780s and early 90s they rise by 80%. Throughout the French period the tollgates yield somewhat lower amounts, but the receipts leap upward after 1815, only to decline again in the decade after 1825.

This picture is confirmed and amplified by other tollgates on east-west arteries. The lease revenue of the tollgate at Soesdijk, on the main road from Naarden to Amersfoort, doubled from 1720 to 1797, whereafter it declined sharply. The tollgate at the Eembrugge bridge also yielded gradually increasing lease revenues from 1732 until 1798–1800. Thereafter it, too, declined sharply.
The trekvaart extending from Amsterdam northward to Hoorn collected tolls at five points along its towpaths, one for each of the five cities that participated in the creation and operation of this enterprise. The trend of toll revenues is not particularly instructive since collection rights were leased for long periods at a time, a new ordinance significantly changed the tariffs in 1691, and the lease prices agreed upon displayed a disorderly behavior that renders suspect their usefulness as reflectors of actual traffic on the towpaths. Nonetheless, they are probably capable of making one useful point about travel on the North Holland peninsula. As we observed earlier, the records of trekschuit travel show the number of passengers to decline persistently throughout the second half of the eighteenth century (a trend observed nowhere else). Inconsistencies in these data have convinced me that they are not trustworthy, but if they were accurate one would expect to see some evidence that the travelers who had abandoned the trekschuiten were using the roads instead. The lease revenues of the strategically located tollgates lend no support to this view, remaining more or less constant from the 1730s to the 1790s. Moreover by the 1820s they had fallen to 85% of the eighteenth-century level, and by the 1830s and 40s had fallen a bit further.

Besides the tollgates on roads connecting Amsterdam with the eastern provinces and Germany, the only series of toll receipts that I have assembled shows a substantial rise in the course of the eighteenth century. The city of Groningen, which owned the Groningen to Winschoten trekvaart, collected tolls at three points along the route stretching eastward from the city. Past these tollgates streamed traffic from not only the Veenkoloniën of eastern Groningen but also from the rural province of Drenthe and from Germany. Once again, the available records present only lease prices. Since the leases were contracted for six years at a time, large changes come quite suddenly and perhaps only long after the objective conditions had changed. No subtle analysis is possible with such data, but we are probably justified in reading from them the long-term evolution of road traffic to the city of Groningen from the east and southeast. From the 1650s to the late 1670s annual lease payments increased substantially, but then declined back to their initial levels by the 1690s. Between 1704 and 1709 the revenues rise suddenly by 23%, whereupon stability reigns until 1752. The following year another sharp increase is observable, and thereafter almost every six-yearly renegotiation of the lease price became the occasion for an increase. Step by step the three tollbooths came to earn the city of Groningen 83% more in the first years of the nineteenth century than they had 50 years earlier. The number of passing pedestrians, wagons, and livestock that these tolls might have represented can be guessed at (assuming that the lease payments bore a reasonable relationship to the actual sums collected) as follows: if we ignore the tolls on horses and every sort of livestock, then the tolls collected at Foxhol in the eighty years after 1650 could have been generated by
the annual passage of either 6250 wagons or 50,000 pedestrians. Obviously some combination of the two actually passed by the tollgate, such as 3125 wagons and 25,000 pedestrians. That plausible combination would have amounted to no more than 10 wagons per day and to considerably fewer people than entered and left Groningen in the Winschoten trek-
schuiten. By the end of the eighteenth century these numbers could be increased by 60%. Then the lead of the trekschuit as the premier trans-
porter of people to and from the northern metropolis had been con-
siderably reduced, but had not yet disappeared.

The tedious and provisional character of this analysis of the tollgate receipts can be attributed to the weaknesses of the data and to the fact that the toll revenue series, in contrast to the trekschuit passenger series varied so greatly one from another. No single picture emerges from these data. I believe, however, that the four following generalizations can fairly be made. First, the volume of travelers using private modes of transportation – most notably walking – did not generally approach the volume of trekschuit passengers. On the other hand, walking was an always available substitute which surely affected the sensitivity of the volume of trekschuit travel to economic conditions.

Second, the volume of road transportation seems to have grown sub-
stantially in the early nineteenth century, but there is no evidence to support the proposition that the trekschuit suffered from massive and growing road competition before the end of the eighteenth century. Third, the paving of roads was not a paying proposition to private investors. In contrast to the profitability of such projects in England, which elicited sufficient private capital to build thousands of miles of turnpike road in the second half of the eighteenth century, the Dutch experience with the Amsterdam–Haarlem towpath (as well as the Den Bosch–Liege project and the financial position of the long-established Gouda–Rotterdam road) was different. The improvement did not awaken a large, latent demand for road transportation. This fact alone could in large part explain why the Netherlands entered the nineteenth century with but 140 kilometers of paved road. Fourth, and finally, a significant difference existed between the trends in travel on the roads that led to the eastern hinterlands of the Dutch Republic and those that connected the commercial cities with each other.

This reconnaissance of the streams of travelers that made use of transportation modes other than the trekschuit confirms the usefulness of the trekschuit passenger data as indicators of general economic activity. The volume of trekschuit passengers made up neither a minor portion of total travelers nor one that faced massive inter-modal competition until the beginning of the nineteenth century. Furthermore, these volumes were generated by a system possessing stable parameters and were the product of a mass demand emanating from nearly every social class and every region of the Republic’s maritime provinces.
IX.3. THE VALUE OF OTHER QUANTITATIVE INDICATORS

The paucity and uncertain value of the existing quantitative series that are available for the study of long-term and cyclical movements in the Dutch economy of the seventeenth, eighteenth, and early nineteenth centuries give this new body of data great potential importance. Although much important work has been done to chart and interpret the course of the Dutch economy in this period, the weaknesses of the available data have withheld from this work the achievement of conclusive results. Consequently, the questions of whether the Dutch economy declined, and if so, when, and by how much continue to elicit contradicting answers.86

Among the quantitative sources on which economic historians have hitherto relied, the following are the most important — the convooien,87 a peculiar form of import and export fee levied on foreign trade by the Republic’s five Admiralties, the imposten op waag, rondemaat, en grove waren,88 a sort of turnover tax levied on a wide range of goods when sold at the wholesale level, and several series of industrial production and agricultural marketing volume, of which the most important is the annual series of Leiden cloth production.89

The convooien, while theoretically capable of measuring the volume of foreign trade passing in and out of the Republic both by land and by sea, has in practice been able to tell us very little. Much trade was exempt from the convooien, successive tariff revisions so altered the character of the convooien as to befuddle generations of historians, the incidence of fraud and smuggling has often been thought to have assumed gigantic proportions, and the enforcement efficiency of the five admiralties is thought to have varied a great deal. Moreover, the tariffs were always levied partly on volume and partly on value, rendering unclear the meaning or changes in total receipts — which is the only information recorded — during periods when price levels and/or the composition of imports and exports were changing. For all these reasons users of the convooien have always been urged to exercise extreme caution; what users have never known, however, is just what types of biases must be guarded against.90

The imposten, while restricted to the province of Holland, are theoretically capable of measuring the turnover volume of both domestic and foreign trade. Since the collection rights to these taxes were leased until 1748, only the annual revenues after that date can be regarded as adequate reflections of the actual sums collected. The enormous enforcement task required to tax nearly all wholesale trade raises further questions about the correspondence between the sums collected and the actual turnover.

The various time series of industrial production, fishing catches, and agricultural marketing are less suspect for their reliability than the above
mentioned series. But the insight they can give into the fortunes of the overall economy is obviously limited. Inherent in these indicators is the weakness that they register the economic fortunes of but a portion of the total economy. Yet the greatest problems in analyzing an economy as a whole, certainly one experiencing structural changes such as the Dutch economy in the century after 1675, are precisely those of determining to what extent the rise of sector A compensates for the decline of sector B.

IX.4. THE ANALYSIS OF LONG-TERM TRENDS IN THE PER CAPITA INCOME OF THE DUTCH REPUBLIC

IX.4.1. The model

The use of trekschuit passenger data to study the fortunes of the Dutch economy in the seventeenth and eighteenth centuries is justified by our demonstration that the demand for trekschuit transportation was not so thin or so vulnerable to intermodal competition as to be a reflection of economically irrelevant factors. Their use is further justified by the shortcomings of the hitherto available series. To use these data for our intended purpose the task remains to identify and measure those economic variables that exercised the greatest influence in determining the level of demand for trekschuit travel.

My approach will be to assume that the demand for intercity trekschuit passenger travel (D) is a function of its price (P), the population of the cities served (I), and the per capita income of the population (Y). The contribution of the first two variables in the function \( D = f(P, I, Y) \) will be analyzed and measured in an attempt to identify the value of \( Y \), the unknown variable about which so many uncertain and conflicting opinions are in circulation. In order to minimize the problems of missing data and to avoid giving an impression of greater accuracy than the data can in fact achieve, this analysis will not be performed for the entire system. Instead it will be confined to the routes connecting the eight major cities of Holland for which our data are reasonably complete.

These cities are Amsterdam, Haarlem, Leiden, The Hague, Delft, Rotterdam, Dordrecht, and Gouda. The trekvaart routes that will form the basis for this study are numbers 1, 2, 3a, 3b, 4, 5, 10, and 11. (A ninth city, Utrecht, and the trekvaart routes 9 and 13 ought to be included in this study, but the weakness of the passenger data for route 9 have forced its exclusion.)

The analysis will be performed for four ten-year periods rather than for the entire 170 year time span over which the aggregate series stretch. However, these four periods 1660–70, 1700–10, 1740–50, and 1790–1800 can serve as appropriate bench marks for the study of the long-term evolution of the Dutch economy.

Column 1 in table 9.3 shows the annual average volume of trekschuit
TABLE 9.3. Estimates of price, population, and residual factors in the changing demand for intercity passenger transportation.

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Identification of columns:
1. Passenger volume in millions of passenger-kilometers.
2. Average fare per kilometer (indexed).
3. Posthumus price index (based on 26 commodities).
4. Real price of intercity passenger transportation (col. 2/col. 3 x 100).
5. Price-adjusted passenger volume (assuming e = -1).
6. Passenger volume estimate adjusted for population change only (see gravity model explanation).
7. Residual (col. 5 – col. 6).
8. Residual expressed as percentage of base period passenger volume (col. 7/col. 1 top row x 100).

Travel (expressed in millions of passenger-kilometers) among the eight cities included in this study for each of the four periods. Despite the fact that we are using only 8 of the Republic’s 37 trekvaart routes, the volume of travel in column 1 amounts to 53% of the entire network’s passenger volume, and the rates of change in the intervening periods correspond closely with those of the network as a whole.

IX.4.2. **Price changes**

The influence that price changes could exert on the aggregate demand for trekschuit transportation hardly needs reiteration. The response of consumers to a fare increase can be separated into two categories: one consisted of the increased use of cheaper modes of transportation (which we have shown to consist of walking) while the second amounted to decreased mobility. That is, consumers facing a rise in the cost of trekschuit travel might at best have increased their expenditures on transportation, but not enough to compensate fully for the increased cost of travel; at worst, some portion of the budget hitherto spent on trekschuit transportation would be diverted to other articles of consumption—having 276
nothing to do with transportation – that had, in relative terms, become 'better buys'. The extent to which these substitutions were made depended, of course, on the by now familiar concept of price elasticity of demand for trekschuit transportation.

At first glance these substitution processes had no chance to influence demand for many years for the simple reason that trekschuit fares did not change. Column 2 of table 9.3 shows, in indexed form, the average fares of the eight routes. It reflects the fact that no fare changes whatsoever took place until the 1730s, and that the increases before the 1780s were small and confined to a few of the routes. Even in 1800 the fares stood only 10% above the 1660 level. But consumers do not respond only to nominal costs. The 'real' price of trekschuit transportation, its price in relation to the general price level of the economy, must also be considered in an analysis of consumer demand. The increase or decrease of other prices will generate substitutions toward or away from trekschuit transportation even when the price of the latter remains unchanged. Ideally we should calculate the 'cross-elasticities' that characterized the demand for trekschuit transportation when specific other goods changed in price. Obviously, the price change of many goods would have exerted no, or only a tiny, influence on the demand for transportation, their association as either substitutes or complements being weak. But, it could be that large price changes for complementary goods (such as hotel accommodation) would dampen demand for both lodgings and transportation, despite the fact that trekschuit costs remained unchanged. Unfortunately our knowledge of prices does not extend far enough beyond commodity prices to permit this sort of analysis. We must content ourselves with the analysis of the substitution of demand between trekschuit transportation and all other goods and services taken together. To represent the price trends of all goods I have used a price index of 26 commodities assembled by N. W. Posthumus. It is presented in column 3 of table 9.3. Columns 2 and 3 provide sufficient information to calculate the real price of trekschuit transportation – the average fare level divided by the general price level (col. 2/col. 3) – which is shown in column 4.

From column 4 one can learn, among other things, that the decline of most prices between 1660-70 and 1700-10 had the effect of making trekschuit travel relatively more expensive by 10%. Now, how did consumers respond to a 10% increase in the real price of trekschuit transportation? The answer depends, of course, on the price elasticity of demand that best characterizes consumer behavior. This is a question that has been several times already the subject of discussion in this study. In chapters VI and VII we assumed it to be –1 (unitary); in chapter VIII we found the elasticity to exceed –1 at the time of the introduction of the railroad to Holland. In this chapter a correlation was noted between the real price of trekschuit transportation and the number of travelers on foot between Amsterdam and Haarlem in the 1632–1759 period. We
know that seventeenth-century demand was not totally price inelastic, that at the beginning of the railway age it probably exceeded -1, and that modern studies of transportation demand usually achieve results – or make guesses – that place the elasticity near -1. We cannot pretend to know exactly the price elasticity of demand for trekschuit travel in the seventeenth and eighteenth centuries (indeed, it may have changed during this long period), but reason exists to believe that an assumption of unitary elasticity will not be far removed from the true value.

Column 5 of table 9.3 displays the level of demand that would have existed if the real price in each period had remained at the level of the base period under the assumption of unitary demand elasticity. In other words, column 5 seeks to remove the effect of real price changes on the level of demand from the passenger volume series of column 1. For instance, the observed demand of 1700 was smaller than it would have been had the real price not risen by 10%. In place of 13.5 million passenger-kilometers we should have expected 14.9 million. Of the observed decline in demand between 1660–70 and 1700–10 (6 million pass.-km.) 1.4 million pass.-km., or 23%, is explained under our assumption by the real price change.

After 1700–10 a different situation prevailed. The real price of trekschuit transportation fell. Even when the nominal price rose in the second half of the eighteenth century, the prices of most other goods rose far more. Consequently, trekschuit transportation became a progressively better buy relative to most other goods that competed for the consumer’s guilder. By the 1740s the real price level of the 1680s had been re-achieved, by the end of the century it had fallen by a further 10.5%. *Ceteris paribus*, this price analysis would predict steadily growing demand. To put it another way, the observed demand in, say, 1790–1800 would have been 1 million pass.-km. less were it not for the fall in price. Consequently, the price variable can contribute nothing to the explanation of the actual decline in demand that took place in the first half of the eighteenth century. On the contrary, it only increases the magnitude of the phenomenon to be explained by the remaining variables in the model.

**IX.4.3. Population**

The impact of population size on the aggregate demand for intercity passenger transportation is, at first glance, obvious. Other things remaining equal, a decline in the population would result in a proportional decline in demand. But only a moment’s reflection is needed to realize that the problem is more complex. In the first place, which population forms the relevant base for the generation of demand? The trekvaart specialized in *intercity* transportation; we have already seen that rural-urban travel played a minor role on the trekvaarten of the Holland-Utrecht region since other services (market boats and beurtveren) catered to the transport requirements of the agricultural population.
For these reasons, the relevant population base is likely to be more accurately approximated by the urban population than by the total population.

The population of the eight major cities included in this exercise is known for only two years in the seventeenth and eighteenth centuries: 1622 and 1795. Between these dates no general censuses were held, but several cities held local censuses and for some the baptism, burial, and marriage records have been analyzed to a greater or lesser extent. Using all these scraps of evidence I have made estimates of each city's population in each of the four periods being used in this study. These estimates together with an account of the procedures and assumptions used in making them, are presented in table 9.4.

The eight-city total reached its peak in the 1660s and remained at that level until after 1700. By the 1740s our estimates show a 5% decline, a decline which is partially made good in the second half of the eighteenth century. We must bear in mind the approximate character of these estimates. Small adjustments in the population estimates of Amsterdam could double or cause to disappear the eighteenth-century population decline shown in table 9.4. We are forced to conclude, therefore, that changes in urban population can under the most favorable circumstances explain but a tiny fraction of the decline in aggregate demand for trek-schuit transportation. The per capita trek-schuit travel figures exhibit essentially the same trends as do the aggregate figures in column 1 in table 9.3. (In the only period of urban population decline, 1700–10 to 1740–50, the volume of traffic fell from 13.5 to 9.0 million pass.-km; if per capita demand had remained at the 1700–10 level, total volume would have fallen no further than to 12.8 million. In this most favorable period, population change can account for only 15% of the total decline in demand.)

While the decline of total urban population can explain very little

Table 9.4. Estimates of urban population, 1622–1795 (in thousands).

<table>
<thead>
<tr>
<th></th>
<th>1622</th>
<th>1660–70</th>
<th>1700–10</th>
<th>1740–50</th>
<th>1795</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam</td>
<td>105</td>
<td>200</td>
<td>200</td>
<td>210</td>
<td>217</td>
</tr>
<tr>
<td>Haarlem</td>
<td>39</td>
<td>38</td>
<td>33</td>
<td>27</td>
<td>21</td>
</tr>
<tr>
<td>Leiden</td>
<td>45</td>
<td>67</td>
<td>55</td>
<td>38</td>
<td>31</td>
</tr>
<tr>
<td>The Hague</td>
<td>16</td>
<td>20</td>
<td>33</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Delft</td>
<td>23</td>
<td>25</td>
<td>18</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>Rotterdam</td>
<td>20</td>
<td>40</td>
<td>48</td>
<td>44</td>
<td>57</td>
</tr>
<tr>
<td>Dordrecht</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Gouda</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>281</td>
<td>425</td>
<td>424</td>
<td>403</td>
<td>411</td>
</tr>
<tr>
<td>Index (1660–70 = 100)</td>
<td>66</td>
<td>100</td>
<td>100</td>
<td>95</td>
<td>97</td>
</tr>
</tbody>
</table>

Sources: See note 31*.
of the observed decline in trekschuit travel, the population estimates of table 9.4 suggest to us a second possible source of changing demand: the distribution of the urban population among the eight cities. It stands to reason that the per capita demand for intercity travel of an urban population of, say, 400,000 where 90% of the people are concentrated in one of the eight cities, is bound to be smaller than when the population is more equally distributed among the eight cities. In the first case most people could satisfy their needs to make contact with others without leaving their own city. Consequently, the demand for intercity travel would be smaller than in the second case.

Nothing as extreme as this example is apparent in the distribution of Dutch urban population, but from table 9.4 we can discover that behind the facade of a more or less stable total urban population, a profound redistribution was taking place. The three largest cities in 1795 (Amsterdam, Rotterdam, and The Hague) all grew in the course of the seventeenth and eighteenth centuries, while the remaining cities all declined absolutely. A progressively less equal distribution of total urban population came to characterize the urban system. Moreover, the greatest concentrations of population came in the course of time to be found at the extremities of the urban system, at Amsterdam in the North and Rotterdam in the South. Before we dismiss as insignificant the variable of population in explaining the decline of intercity trekschuit transportation between the 1660s and 1740s we must attempt to quantify the impact of these changes in the distribution of Dutch urban population.

IX.4.4. The gravity model

The impact of the level of urban populations and their distribution on the aggregate demand for intercity transportation can, in theory, be measured through the application of the gravity model. The gravity model is an adaptation by geographers of Newton’s law of gravity to the study of spatial interaction. In its most general form the gravity model holds that two places interact with each other in proportion to the product of their ‘masses’ and inversely to the distance between them. It takes the form of

\[ I_{ij} = A(M_iM_j/d_{ij}), \]

where

- \( I_{ij} \) = the number of ‘interactions’ (trips, in this case) between two cities \( i \) and \( j \) during some time period (a year)
- \( A \) = a constant
- \( d_{ij} \) = the distance separating cities \( i \) and \( j \), or some other expression of the resistance to interaction such as time or money
- \( M_i \) = some measure of the attractive power of city \( i \).

In its simplest form \( M \), the mass, or attractive power of the city, is held to be proportional to its population. But in more elaborate gravity models
M can be the sum of a long list of variables that affect interaction, such as per capita income, the presence of communications-intensive activities (such as government agencies, educational institutions, business headquarters), the rank of the city within the urban hierarchy, and white collar employment as a percentage of the labor force. In applying the gravity model to a pre-nineteenth-century transportation network we must count ourselves fortunate to know simply the population of a city in a given year. Consequently, in our application of the gravity model the mass will be represented by the population of a city and will henceforth be identified as P. For the purpose at hand, the simple form of the gravity model offers the added advantage of separating the 'pure' population impact from the economic impact, which I hope to be able to isolate for separate analysis.

The procedure to be followed here is to estimate the amount of interaction between each city pair \((I_{ij})\) of the trekvaart network on the basis of the populations of the cities and distances separating them. Once this is done for all city pairs, the \(I_{ij}\) values can be aggregated for the entire network. When this procedure is repeated for successive time periods, the effect of changes in urban population on the expected amount of interaction within the network can be identified.

Is this simple model actually capable of yielding satisfactory interaction estimates? Geographers hold varying opinions on this issue. Representative of those who are enthusiastic about the simplicity of the gravity model are the authors of a recent textbook on spatial organization. 'It [the gravity model] says so much and says it so well. Simplicity or elegance has always been a virtue of good scientific theories'. After noting that the theory has been 'logically fertile', they conclude that it is 'a valid representation of (P-plane) facts about spatial interaction'.

More skeptical are the geographers who note the absence of theoretical justification for the model's assertion that two places interact in proportion to the product of their masses and inversely to the distance between them. In fact, the gravity model is not a 'theory' at all. It is a model that finds its justification only in the results it can produce in concrete situations. Its power rests not in its specification of variables (mass and distance), which by themselves are not capable of saying anything interesting about the interaction between two places, but in the accuracy with which its parameters are identified. In other words, it is not enough to say that interaction is a positive function of population and an inverse function of distance. On the contrary, the gravity model is of no practical use unless the intensity of those functions is known. The applicable form of the model is thus,

\[
I_{ij} = a (P_i P_j)^{b_1} / (d_{ij})^{b_2},
\]

or, in logarithmic form,

\[
\ln I_{ij} = a + b_1 \ln(P_i P_j) - b_2 \ln(d_{ij}).
\]
where the parameters are:

\[ a = \text{a constant} \]

\[ b_1 = \text{the population exponent} \]

\[ b_2 = \text{the distance exponent}. \]

The greater \( b_1 \) is found to be, the larger will be the impact of a given amount of population growth in \( i \) and/or \( j \) on the amount of interaction between them; the greater is \( b_2 \), the greater will be the inhibiting effect of distance on the amount of interaction between two places.

The values of these parameters are specific to a given time and place. Among other things, the available modes of transportation, the time and cost of travel, and the structure of the economy will determine their values. In short, the gravity model identifies a pattern in the volume of travel (or other form of interaction) between the cities of a network. Its power depends directly on the accuracy and completeness of the data that describe the model’s variables.

IX.4.5. An application to the railroad network, 1857–61

The potential value of the gravity model, and the steps that must be taken to use it, can best be explained by applying it to the analysis of a transportation system for which our knowledge of the variables is full and reasonably accurate.

For the study of intercity passenger transportation in Holland these conditions are fulfilled beginning in 1855. In that year the Hollandsche Yzeren Spoorweg Maatschappij (HYSM), whose line from Amsterdam to Rotterdam via Haarlem, Leiden, The Hague, and Delft had been completed eight years earlier, began to publish in its annual reports tables listing the number of passengers carried from every station to every other station. The tables provide full information on the volume of travel between each of the 15 city pairs (\( I_{ij} \)'s) indicated in figure 9.7. In addition, the decennial censuses allow us to follow the course of urban population (to determine the values of \( P \)) while, needless to say, any map of Holland will yield the distances between the cities (\( d_{ij} \)'s).

Using the population data from the 1859 census and the average annual passenger travel data for the five year period 1857–61, I estimated the best fitting parameter values for the gravity model by using a least-squares regression analysis. The parameter values which minimized the sum of squares of the residual (the estimated volume of travel, \( I_{ij} \), minus the actual volume) were:

\[ a = -3.67, \quad b_1 = 0.92, \quad b_2 = 1.66 \]

\[ (10.06) \quad (10.64) \]

How much of the variation in travel volume among the 15 city pairs was it possible to explain using this two-variable model? The coefficient of determination (\( r^2 \)) is a very high .93, indicating that the two variables are capable of accounting for a very large portion of the observed pattern of travel. The ‘closeness of the fit’ can be expressed most clearly through
the use of a scatter diagram. By plugging the parameter values listed above into the gravity model equation the estimated values for each city pair can be generated. The scatter diagram will show at a glance how closely the estimates for each city pair stand to the observed travel volume. The better the fit, the closer the points will stand to the diagonal line, which represents equality between the observed and estimated values. If the points had been more or less randomly scattered across the diagram we would be forced to conclude that the variables included in the gravity model were not particularly significant determinants of travel demand. But in this case population and distance clearly exert a very strong influence on the pattern of travel demand. These two variables do not account for everything, however, and the scatter diagram’s next service is to identify those city pairs whose interaction was stronger or weaker than the average for the network as a whole. Once these are identified, it may prove possible to determine which other variables exerted positive or negative influences on the demand for travel.

Among the city pairs with a greater than predicted travel volume (points above the diagonal line) only numbers 7 and, particularly, 14 are conspicuous. Among the city pairs with a smaller than predicted travel volume (below the diagonal line) those with an observed volume over 15% less than predicted are numbers 2, 4, 5, 11, and 13. What sorts of city pairs are these? Do they exhibit common characteristics?

To begin with, two of the most conspicuously weak city pairs, 5 and 13, reflect in large part special circumstances. The observed volume of travel between Amsterdam and Rotterdam was only 60% of the predicted volume because there existed, beginning in 1855, a second railroad route between the two cities (via Utrecht). Judging from the number of travelers who made use of this alternative route in 1855, it is apparent that the actual volume of travel between these two cities over both routes at least equalled the predicted volume. The observed volume of travel between
The Hague and Delft was only half of the predicted volume because of the competition of alternative transport modes. Competition was effective here because the distance between the two cities was short, only 9 km., and the station in The Hague was badly located to attract this traffic.

As for the remaining deviants, it is notable that the weak city pairs all involve travel to and from Amsterdam, Leiden, and Delft, while the strong city pairs involve travel to The Hague and Rotterdam. Indeed, travel between the cities of The Hague and Rotterdam exceeded the predicted level by more than was the case with any other of the 15 city pairs.

When one adds together the observed and predicted travel volumes to each of the six cities served by the HYSM, then, once again, Amsterdam, Leiden, and Delft – cities with slowly growing populations and stagnant economies – show smaller than predicted travel volumes. The total travel volume to and from Haarlem, The Hague, and Rotterdam, exceeded the predicted volume. The reason for Haarlem’s strong attractive power to travelers from other cities is not clear, but for The Hague and Rotterdam the explanation is not far to seek. Their populations were in the midsts of rapid growth and their government- and harbor-based economies, respectively, were in a more flourishing state than was the Dutch economy as a whole.

The annual flows of passengers among the cities of Holland are also capable of offering another view of the urban structure of this region. If we examine the volume of travelers from one city to every other city of the region we can identify the dominant association, i.e. the destination with which it interacts the most. Once this dominant association is identified for each of the seven cities in the area, the orientation of the cities to each other can be analyzed. If a city’s largest flow is to a smaller city, it is ‘central’; if its largest flow is to a larger city, it is a ‘satellite’.

In 1855, for example, Haarlem’s most important city pair relationship was with Amsterdam, Leiden’s was with The Hague, etc. Amsterdam, the largest city in the seven-city system, was incapable of interacting with a larger city than itself; it could not avoid being a central city. But this form of analysis calls attention to the fact that Rotterdam’s dominant association was also with a smaller city. One can argue that the passenger flows, analyzed in this way, expose something of the structure of Holland’s urban system. Amsterdam and Rotterdam acted as the central cities. Of the remaining five cities, four were most closely associated with Rotterdam, while Amsterdam could count but one satellite city, Haarlem.

The same exercise performed on the 1864 data shows the same pattern, with the exception that Delft has changed its orientation. The Hague has replaced Rotterdam as its most important interaction partner. As a consequence, The Hague stands out more clearly as a secondary center in a three-tiered urban system.

We can draw three conclusions from this application of the gravity

City pair identification:
1. Amsterdam–Haarlem
2. Amsterdam–Leiden
3. Amsterdam–The Hague
4. Amsterdam–Delft
5. Amsterdam–Rotterdam
6. Haarlem–Leiden
7. Haarlem–The Hague
8. Haarlem–Delft
9. Haarlem–Rotterdam
10. Leiden–The Hague
11. Leiden–Delft
12. Leiden–Rotterdam
13. The Hague–Delft
14. The Hague–Rotterdam
15. Delft–Rotterdam

FIGURE 9.9. Dominant associations among the six largest cities of Holland in 1855 and 1864.

Source: *Verslag der Hollandsche IJzeren Spoorweg Maatschappij*, 1855, table G; 1864, table H.
model to mid-nineteenth-century railroad transportation. First, the
demand for travel between two cities was very sensitive to changes in
urban population (indicated by the fact that the value of $b_1$ was nearly
1.0. Second, the simple gravity model is capable of explaining a large
portion of the actual volume of travel. Finally, the model and the data
needed to use it are capable of providing important insights into the
structure of the regional economy, and are therefore useful quite apart
from our original purpose of isolating the role of population change in the
demand for trekschuit travel.

IX.4.6. An application to the trekvaart network, 1660–1800

Unfortunately, the nature of the data describing intercity travel during
the trekschuit era is less complete and disaggregated than that used
in the preceding analysis of mid-nineteenth-century railroad travel.
This deficiency both adds a complication to the application of the model,
and reduces the achievable accuracy of the parameter value estimates.

Among the data necessary for an analysis of trekschuit passenger flows,
d_{ij}, the distance between each city pair, obviously poses no difficulties.
P, the population of each city in each of the four periods selected for
analysis, is in large part the product of estimates and probably less
accurate than the census data available in the nineteenth century. The
greatest problem is created by the absence of direct evidence for $I_{ij}$, the
flow of travelers between each city pair. What we know instead is $I_{route}$, the
flow of travelers over each route of the trekvaart network. This infor­
mation is more aggregative than the desired city pair data. Over each
route connecting cities i and j moved not only travelers from i to j, but also
travelers from beyond i to j, from i to beyond j, and from beyond i to
beyond j (and vice versa).

To make use of the available route data the first task is to identify
the city pairs that contributed to the total flow of traffic over any given
route. The Haarlem–Leiden route, to take an extreme example, served
besides passengers between Haarlem and Leiden, passengers between
Haarlem and The Hague, Delft, Rotterdam, and Dordrecht, plus pas­
sengers between Amsterdam and Leiden, The Hague, Delft, and Rotter­
dam. On the The Hague–Delft route, the number of city pairs accounting
for the total volume of traffic was much smaller: The Hague-Delft, The
(Through passengers from points north of The Hague had no reason
to pass over this route.) Proceeding in this manner the relevant city pairs
for each route can be identified.

Two problems arise in the performance of this task. In the first place,
the trekvaart network was sufficiently well developed to allow a choice
of routes to traffic between certain city pairs. Usually, the one route can
be identified that offers unambiguous advantages over the other possibili­
ties, but in one notable case this is not possible. Travelers between
Amsterdam and Rotterdam could proceed either via Haarlem, Leiden, etc., or via Gouda. We know, in fact, that the two routes actively competed for this through traffic and sometimes took measures aimed at gaining the upper hand in this competition. All we can do here is suppose that the two routes divided the traffic equally.

The second problem is more profound. In this study (and in all others) the gravity model is being applied to a strictly bound network, comprising a limited number of city pairs. In fact, the number of city pairs which made some contribution to the total traffic flow over any given route was much larger than we can identify. Traffic between Haarlem and Leiden, for example, included some persons coming from points north of Amsterdam or south of Rotterdam and Dordrecht. Fortunately, one can defend as reasonable the simplification that ignores these city pairs. It will be shown later that these extra-regional flows were very small. A probable reason for the trivial size of these travel flows can be explained as the effect of 'intervening opportunities'. A gravity model in the simple form used here will estimate an equal flow of traffic between any city pairs where the distance and the populations of the cities are equal. But two cities that have a city of much larger size standing between them will almost certainly have less reason to interact with each other than two cities with no such intervening opportunity. In the Dutch Republic, Amsterdam certainly functioned as an intervening opportunity. The number of travel motives that required travelers setting off from a North Holland city such as Hoorn to proceed to a city beyond Amsterdam was surely small. Consequently, the travel demand from North Holland towns to the cities of the region being examined here has been ignored. To a lesser extent, but with increasing importance in the eighteenth century, Rotterdam probably played this role for traffic from Zeeland.

Within the urban region under analysis here, I have not applied the intervening opportunity concept. Given the fact that most of the central Holland cities fell within a population range of 15 to 40 thousand most of the time, it seems reasonable to suppose that none of these cities could have exerted much force as an intervening opportunity. Someone seeking something outside his own city of 30,000 was unlikely inevitably to be deterred by the nearest city of equal size; only a much larger city, i.e. Amsterdam, or eighteenth-century Rotterdam, was likely to act as an effective barrier to further travel.

For travel to and from the east this intervening opportunity concept is unable to assist us. The flow of passengers to Amsterdam from Naarden and Weesp, and to Utrecht from Vreeswijk, obviously cannot be accounted for by the dwarf towns in question. The flow of traffic from, say, Naarden to Amsterdam was, in fact, a bundling of dozens of tiny flows from originating points scattered throughout the eastern provinces and Germany. This was also the case on the Utrecht–Leiden route. The failure of Utrecht to act as a major intervening opportunity for traffic
from the east is demonstrated by the fact that the flow of traffic on this route far exceeded the gravity model's predictions under the assumption that the city of Utrecht was the only significant point at the eastern end of the route, and by the fact that the course of demand does not conform well to what is known of the course of Utrecht's population. These problems make it extremely difficult to include in the gravity model analysis those routes that acted as gateways to the east.

Since the trekvaart network under study here excludes routes to the east or to Utrecht, the worst problems identified above can be avoided. But enough has been said to indicate the problems inherent in having to use route data as a substitute for city pair data.

Once the city pairs that contribute to the aggregate flow over each route have been identified, it remains to find the weighting system that most correctly identifies the relative importance of each city pair's contribution to the total demand for travel. In other words, we must identify the parameters of the gravity model. For example, the relative importance of Haarlem–Dordrecht traffic on the Haarlem–Leiden trekvaart will depend on the values which are assigned to the parameters $b_1$ and $b_2$. The higher $b_2$, the less significant will be the relatively long-distance Haarlem–Dordrecht traffic to total demand on the Haarlem–Leiden route. The higher $b_1$ the less significant will be demand between two relatively small cities (such as Haarlem and Dordrecht) in comparison to the demand generated by city pairs with more populous cities.\(^4\)

The values of the gravity model parameters are found, just as in the mid-nineteenth-century railroad example, by cross-section analysis. The aim is to find those parameter values that minimize the sum of the squared difference between the actual and estimated passenger volumes for each route. To find these parameter values an iterative procedure is used, and to avoid the error of identifying local optima as the true optimal values, the iterative procedure is run several times, in each case with different initial parameter values.

The form of the equation used to determine the estimated passenger volume on any given route is:

$$I_{route} = \sum_{i=1}^{n} \sum_{j=1}^{n} A \left[ \frac{(P_i P_j)^{b_1}}{d_{ij}^{b_2}} \right].$$

The minimum value of $\sum \frac{(I_{route} - K_{route})^2}{K_{route}^2}$ (where $K_{route}$ is the actual, observed passenger volume of route $x$) identifies the optimal values of $b_1$, $b_2$, and the constant, $A$.

The results of this procedure for each of the four time periods and for the entire body of data taken as a whole is presented in table 9.5. The population exponent gradually rises in the course of the eighteenth century while the distance exponent, after dropping in the second half of the
seventeenth century, gradually rises to exceed the 1660 value by the end of the eighteenth century. The rise in the value of the population exponent, $b_1$, which is concentrated in the period 1700–10 to 1740–50, is a reflection of the growing attractive power of the largest cities relative to the smaller cities. Since one city, Amsterdam, was much larger than the others, and increased its lead in precisely this period, the rise in the value of $b_1$ tells us that Amsterdam increasingly was drawing intercity travel towards itself. This reflects an important development of the eighteenth-century Dutch economy to which we will return in chapter XII.

The fluctuations of the distance exponent, $b_2$, are also of interest. The fall in its value between 1660–70 and 1700–10 implies that distance had become less of an obstacle to travelers; in the latter period a larger proportion of those who set out on an intercity trip per trekschuit made relatively long trips. This is conceivably to be explained by the rising relative cost of trekschuit travel in these decades. This trend had the effect, on the Amsterdam–Haarlem trekvaart at least, of diverting some trekschuit passengers to the towpath. If the increasing real cost of trekschuit travel diverted primarily short-distance travelers, this would be reflected in a lower distance exponent for the remaining traffic that continued to use the trekschuit.

After 1700–10 the distance exponent increases. The rise is slow at first but by the end of the eighteenth century $b_2$ attains a very high level. By then long-distance trips had become something of a rarity in comparison with the beginning of the century.

We should pause a moment to consider the value of the parameter estimates of table 9.5 in the light of the considerable weaknesses of the available data. Instead of census data, we have population estimates. Instead of the 15 separate city pair observations on which we could base the mid-nineteenth century application of the gravity model, we have for the analysis of trekschuit travel only 7 route observations. Other routes for which data are available can be added to the estimations, increasing the number to a maximum of 11 in some periods, but the fact remains that the evidence (presented in table 9.6) is crude for the purpose at hand.

The possibility is real that the parameter value estimates of table 9.5

<table>
<thead>
<tr>
<th>Period</th>
<th>$b_1$</th>
<th>$b_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1660–70</td>
<td>0.86</td>
<td>2.1</td>
</tr>
<tr>
<td>1700–10</td>
<td>0.82</td>
<td>1.8</td>
</tr>
<tr>
<td>1740–50</td>
<td>1.10</td>
<td>1.9</td>
</tr>
<tr>
<td>1790–1800</td>
<td>1.21</td>
<td>2.2</td>
</tr>
<tr>
<td>Average</td>
<td>1.00</td>
<td>2.0</td>
</tr>
<tr>
<td>Railroad, 1857–62</td>
<td>0.92</td>
<td>1.7</td>
</tr>
</tbody>
</table>
may be highly misleading, particularly because of the interplay that is possible between the values of \( b_1 \) and \( b_2 \). Different combinations of these two values are capable of ‘fitting’ the same body of data equally well. If we can scale down our demands on the gravity model, the likelihood will increase that trustworthy results will be achieved. One way to do this is to give one of the parameters a fixed value and then focus the model’s attention on the estimation of the remaining variable.

Many modern applications of the gravity model simply assume \( b_1 \) to be equal to 1. Since our parameter estimates for mid-nineteenth-century railroad travel found \( b_1 \) to exceed 0.9, and its average value in the analysis of trekschuit travel was exactly 1.0 the simplifying step of setting \( b_1 \) equal to 1 seems defensible. We can then repeat the procedures outlined above with the difference that we now seek only that value for \( b_2 \) which minimizes the sum of squares of the residuals. Table 9.7 shows the resulting values of \( b_2 \), results that remain essentially unchanged when the procedure is expanded from routes 1, 2, 3a, 3b, 4, 5, 10, and 11 to routes 13, 16–17, and 19–20.

The cross-section analysis for the 1660s does not, in fact, yield a clear-cut result: distance exponents ranging from 2.0 to 2.2 all achieve the minimum sum of squares figure. In 1700–10 a \( b_2 \) value of 2.0 offers a somewhat better fit than the higher figures, while in the 1740s and again in the 1790s a value of 2.2 is clearly superior to the others. In comparison to the first estimation procedure these results fall within a narrower range, but they are similar in the direction of change that characterizes the four values of \( b_2 \).

Table 9.6. Actual average annual passenger volume on the routes analyzed in the gravity model (in thousands).

<table>
<thead>
<tr>
<th>Route number (^a)</th>
<th>Route</th>
<th>1660–70</th>
<th>1700–10</th>
<th>1740–50</th>
<th>1790–1800</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 + 11</td>
<td>Amsterdam–Haarlem</td>
<td>288</td>
<td>201</td>
<td>156</td>
<td>167</td>
</tr>
<tr>
<td>2 + 11</td>
<td>Haarlem–Leiden</td>
<td>136</td>
<td>83</td>
<td>60</td>
<td>79</td>
</tr>
<tr>
<td>3a</td>
<td>Leiden–The Hague</td>
<td>110</td>
<td>82</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>3b</td>
<td>Leiden–Delft</td>
<td>102</td>
<td>65</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>4</td>
<td>The Hague–Delft</td>
<td>144</td>
<td>96</td>
<td>45</td>
<td>n.a.</td>
</tr>
<tr>
<td>5</td>
<td>Delft–Rotterdam</td>
<td>n.a.</td>
<td>143</td>
<td>105</td>
<td>131</td>
</tr>
<tr>
<td>10</td>
<td>Amsterdam–Gouda</td>
<td>26</td>
<td>24</td>
<td>14</td>
<td>n.a.</td>
</tr>
<tr>
<td>13</td>
<td>Leiden–Utrecht</td>
<td>37</td>
<td>22</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>16–17</td>
<td>Amsterdam–Purmerend/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monnikendam</td>
<td>117</td>
<td>78</td>
<td>40</td>
<td>n.a.</td>
</tr>
<tr>
<td>21</td>
<td>Hoorn–Alkmaar</td>
<td>10</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>101</td>
<td>Hoorn–Enkhuizen</td>
<td>10</td>
<td>4</td>
<td>2.5</td>
<td>n.a.</td>
</tr>
<tr>
<td>105</td>
<td>Gouda–Rotterdam</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>30</td>
</tr>
</tbody>
</table>

\(^a\) For identification of route numbers, see Appendix.

Sources: See figures 9.2 through 9.6. n.a. = not available

290
The validity of this general range of distance exponent values is confirmed by two other efforts to apply the gravity model to intercity passenger travel in the Dutch Republic. Although the passenger volume on five of the seven Friesian trekvaart routes are known for the 1660s, I did not include this evidence with the just analyzed data for routes in Holland and seek to find one all-encompassing value for $b_2$. It seemed possible that the different character of the urban system in Friesland and the greater importance of the rural population as users of the trekschuiten could generate different gravity model parameter values. Moreover, our knowledge of urban population in Friesland before the mid-eighteenth century is even less well-founded than that for Holland.

In order to see if the travel flows in this less urbanized province confirm the general results achieved in Holland I applied the gravity model to the passenger data for the 1660s and the population figures of the suspect census of 1689 (with some adjustments). In order to take account of the probable importance of rural travelers, I added to the populations of the Friesian cities half of the population of the bordering rural jurisdictions (grietenijen). This exercise yielded an optimal distance exponent of 1.9. The correspondence achieved between the actual and estimated volume of passenger travel can be read from table 9.8.

The 'fit' is by no means breathtaking, but the estimates are not entirely at odds with the observed values. Moreover, in two cases where the fit is

<table>
<thead>
<tr>
<th>Route</th>
<th>Estimated</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harlingen–Franeker</td>
<td>33.2</td>
<td>20.3</td>
</tr>
<tr>
<td>Franeker–Leeuwarden</td>
<td>17.5</td>
<td>17.8</td>
</tr>
<tr>
<td>Harlingen–Leeuwarden</td>
<td>19.3</td>
<td>26.3</td>
</tr>
<tr>
<td>Workum–Bolsward</td>
<td>19.5</td>
<td>n.a.</td>
</tr>
<tr>
<td>Bolsward–Leeuwarden</td>
<td>13.4</td>
<td>14.0</td>
</tr>
<tr>
<td>Sneek–Leeuwarden</td>
<td>18.8</td>
<td>12.0</td>
</tr>
<tr>
<td>Leeuwarden–Dokkum</td>
<td>28.7</td>
<td>n.a.</td>
</tr>
<tr>
<td>Dokkum–Groningen</td>
<td>15.2</td>
<td>16.0</td>
</tr>
</tbody>
</table>

Sources: See figure 9.6. In addition, G.A. Groningen, O.A., no. 742r.
n.a. = not available.
bad, a plausible explanation is readily available. The ‘excessive’ travel on the Harlingen–Leeuwarden route can probably be accounted for by the function that Harlingen fulfilled at this time as the chief Friesian gateway to Holland. On the other hand, the less-than-predicted travel volume on the Franeker–Harlingen route, is explainable by the short distance between these two cities, 9 km, which made walking an effective competitor.

The slightly lower distance exponent in Friesland could be explained by the fact that in this less urbanized province fewer intervening opportunities existed to throttle long-distance travel. In Holland a traveler from Amsterdam to Delft (distance: 69 km) was someone whose needs or desires could not be fulfilled in Haarlem, Leiden, or The Hague (all cities closer and larger than Delft). In the north, by way of comparison, a traveler from Groningen to Leeuwarden (distance: 69 km) passed through nothing larger than Dokkum, an intervening opportunity of exceedingly modest proportions.

Another demonstration of the probable validity of a distance exponent with a value around 2 is provided by the analysis of intercity passenger-carrying capacity among the six cities in or near the IJssel river valley in the eastern provinces of Overijssel and Gelderland. The volume of passenger travel in this region is all but totally unknown, but the coach and trekschuit schedules are known and from them the passenger-carrying capacity can be reckoned. These estimates, based on the schedules in force in the 1770s, are presented in table 9.9. If a gravity model using the urban population data of 1795 and a distance exponent of 1 were used to estimate the volume of intercity passenger travel in this region, it would present a completely inadequate picture of the actual situation. Indeed, as table 9.9, column 3 shows, the demand estimate would be

<table>
<thead>
<tr>
<th>Route</th>
<th>Gross passenger-carrying capacity (Passengers per annum)</th>
<th>Index of estimated passenger-volume using three distance exponents ($b_3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Kampen–Zwolle</td>
<td>25,000</td>
<td>100</td>
</tr>
<tr>
<td>Zwolle–Deventer</td>
<td>10,000</td>
<td>40</td>
</tr>
<tr>
<td>Deventer–Zutphen</td>
<td>16,500</td>
<td>65</td>
</tr>
<tr>
<td>Zutphen–Arnhem</td>
<td>11,500</td>
<td>45</td>
</tr>
<tr>
<td>Arnhem–Nijmegen</td>
<td>25,000</td>
<td>100</td>
</tr>
</tbody>
</table>


TABLE 9.9. Actual passenger-carrying capacity and estimated passenger volume between the cities of the IJssel river valley, c. 1795.
literally the inverse of the true pattern. When a distance exponent of 2 is used, a closer approximation of the observed passenger-carrying capacity is achieved (column 4 of table 9.9). Given the crudity of the available data, an exact figure cannot reasonably be made, but the pattern of passenger-carrying capacity offered to the traveling public was most consistent with a value in the vicinity of 2.5.

In this region, trekschuiten provided the chief passenger service only at the northern and southern extremities (Kampen–Zwolle and Arnhem–Nijmegen), where demand was heaviest. In between, coaches provided the only service. Their higher costs are likely to have enhanced the deterrence effect of distance on the volume of travel, a fact reflected by the high distance exponent.

To summarize, the distance exponent that best reflects the observed behavior of trekschuit passengers (assuming the population exponent to be equal to 1) was in the range of 1.9 to 2.2. In Holland there existed a tendency for the exponent to increase, from 2.0 to 2.2, a tendency that exerted its greatest impact in the first half of the eighteenth century. The distance exponent of mid-nineteenth-century railroad passenger travel among the same cities was 1.7. This result meets our expectations based on the application of gravity models to modern circumstances.42 The behavior of travelers making use of new, faster modes of transportation is typically characterized by a reduction of the distance exponent, reflecting the fact the distance (in the form of time and cost) has become less of an obstacle to movement. The reduction of the distance exponent when the railroad – which was faster yet cost no more – replaced the trekschuit is consistent with this expectation. What is noteworthy here is how modest the reduction in the distance exponent value effected by the railroad actually was.

What did a distance exponent of 2 imply about the length of trips taken by seventeenth- and eighteenth-century travelers? Once the constant and distance exponents are known it is, of course, possible to plug them into the original gravity model equation and generate estimated population flows for each city pair that participates in the transport network under analysis. It must be remembered that, in contrast to the railroad example presented earlier, the matrix of \( I_{ij} \) values generated by such an exercise is hypothetical and cannot be directly checked. All that can be said for it is that it is more consistent with the observed passenger volumes on the various routes than any other matrix of values that the gravity model is capable of generating.

When the distance exponent is as high as 2.0 the number of passengers that travel further than the nearest city is very small. This fact can most efficiently be expressed in a distribution of the percentage of all trips which fell within various distance categories. In the 1660s the gravity model estimates that 53% of all trekschuit trips among the eight cities of central Holland were no more than 19 kilometers in length. Only
8% of all trips exceeded 60 kilometers. It should be recalled here that this transport system is bound; travelers to destinations to the south of Rotterdam, to take an example, surely existed, but our model is incapable of taking them into account. On the other hand, very short trips are also excluded. In the Holland–Utrecht region, travelers to and from intermediate stops have been ignored. Given their small importance in the total volume of travel this seemed warranted, but the number of trips (in contrast to the volume of passenger-kilometers) accounted for by such local travelers was bound to be substantial.

In figure 9.10 a graph of the estimated distance distribution of mid-seventeenth-century trekschuit travel is presented together with the actual distance distribution of trips made on the HYSM between Amsterdam and Rotterdam in 1861. In the original data, the only substantial difference between the two distributions is statistical rather than real: the railroad statistics included all short-distance (under 10 kilometer) trips while the trekvaart data did not. Once these trips are excluded from the two bodies of data, as they are in figure 9.10, the remaining distributions are remarkably similar.

Figure 9.10 Distribution of trips by distance: Holland–Utrecht trekvaarten, 1660–70; H.Y.S.M. railroad, 1861 (excluding trips of under 10 kilometers).

Sources: Verslag der Hollandsche IJzeren Spoorweg Maatschappij, 1861, p. 32; for explanation of estimated trekschuit distribution, see text.
Once a matrix of passenger flows among all the cities of central Holland is made for each time period, it is a simple matter to aggregate the relevant city pair flows into estimated passenger flows per route \[ I_{\text{route}} = \sum_{i=1}^{n} \sum_{j=1}^{n} (I_{ij}) \]. Here, finally, it is possible to compare the results of the gravity model to the actual observed passenger volumes. Just as in the railroad travel example, the analysis of the estimated and actual data is simplest with the help of scatter diagrams. Consider, for example, the travel patterns for 1700–10 and for 1740–50 (figures 9.11 and 9.12). In 1700–10 the gravity model, in which only urban population and distance estimate the demand for travel over a given route, does a reasonably good job of accounting for the observed travel pattern. None of the routes had passenger volumes that stood far below expectations, while three routes were conspicuous for being much busier than expected. They were routes 19–20, 13, and 5. In the case of the first, extending from Purmerend/Edam to Hoorn, it seems possible that the rural population to the north of Hoorn, the end point of the trekvaart network, generated a considerable demand that I have neglected by focusing attention exclusively on urban populations. The prediction for route 13, Leiden–Utrecht, is the most at variance with the facts, a distinction that it can claim in all four time periods. The reason could have something to do with the particularly great importance of Utrecht, but probably has as its chief explanation the same phenomenon that was identified for route 19–20. A large hinterland to the east of Utrecht generated a demand for travel to Leiden, The Hague and Delft which the gravity model ignored. The high volume of travel on the Delft–Rotterdam route, also evident in 1740–50, may be partly explained by the fact that travel to and from Schiedam, a city nearly adjacent to Rotterdam, had not been included; I suspect a more important factor to be that stronger than normal links existed between Rotterdam and the cities of Delft and The Hague.

By 1740–50 the gravity model is not able to explain as much of the observed pattern of travel as it could in the earlier periods. Not only does travel on routes 13 and 5 continue greatly to exceed expectations but now three routes, 3a, 3b, and 4, conspicuously fail to meet them. These routes form a triangle connecting Leiden, The Hague and Delft to each other. The Delft–The Hague route was particularly vulnerable to coach and pedestrian competition because of its short distance and the completion in 1693 of a paved road between them. Since no other technical factors can explain this deviation away, we are led to conclude that the gravity model has exposed a region which suffered a very profound economic decline in the first half of the eighteenth century.

The gravity model is capable of saying much more about the internal structure of the Dutch urban system and the alterations of that structure between the four time periods. In chapter XII, these issues will be
pursued further. Now, it is time to return to the original issue that led to this lengthy digression into the world of the gravity model; that is, how did changes in the size and distribution of Dutch urban population affect the aggregate demand for intercity travel?

As we have seen, the gravity model offers estimates of passenger volume by city pair. These can be aggregated into route estimates, and the route estimates, in turn, can be aggregated into estimates of total passenger volume over entire networks. In other words:

\[ I_{ij} = \frac{P_i P_j}{d_{ij}^{b_2}} \]

\[ I_{\text{route } x} = \sum_{i=1}^{n} \sum_{j=1}^{n} (I_{ij}) \]

\[ I_{\text{network}} = \sum_{x=1}^{8} (I_{\text{route } x} d_{\text{route } x}) \]

(where \( d_{\text{route } x} \) is the length of the route, permitting \( I_{\text{network}} \) to be expressed in passenger-kilometers). Constants can be applied to the gravity model at any stage of the analysis to translate the abstract numbers into actual passenger estimates (as we have done in the foregoing discussion of city pairs and route travel volumes). Table 9.10 presents the gravity model estimates of route travel volume (\( I_{\text{route } x} \)) in their abstract number form. This makes it possible to see at a glance the course of travel demand over the four periods as predicted by the gravity model under the assumption that only the size and distribution of urban population played a role. Once these numbers are aggregated into a network travel volume indicator, they can answer our initial question.

Table 9.10. Gravity model passenger volume estimates per route (raw numbers).

<table>
<thead>
<tr>
<th>Route number</th>
<th>Route</th>
<th>1660–70</th>
<th>1700–10</th>
<th>1740–50</th>
<th>1790–1800</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amsterdam–Haarlem</td>
<td>15.0</td>
<td>13.2</td>
<td>11.7</td>
<td>9.8</td>
</tr>
<tr>
<td>2</td>
<td>Haarlem–Leiden</td>
<td>6.4</td>
<td>5.7</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>3a</td>
<td>Leiden–The Hague</td>
<td>2.8</td>
<td>3.9</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>3b</td>
<td>Leiden–Delft</td>
<td>4.5</td>
<td>3.5</td>
<td>2.1</td>
<td>2.6</td>
</tr>
<tr>
<td>4</td>
<td>The Hague–Delft</td>
<td>4.0</td>
<td>5.4</td>
<td>6.1</td>
<td>7.2</td>
</tr>
<tr>
<td>5</td>
<td>Delft–Rotterdam</td>
<td>5.2</td>
<td>7.7</td>
<td>4.5</td>
<td>6.4</td>
</tr>
<tr>
<td>9</td>
<td>Amsterdam–Utrecht</td>
<td>1.6</td>
<td>1.6</td>
<td>1.5</td>
<td>1.6</td>
</tr>
<tr>
<td>10</td>
<td>Amsterdam–Gouda</td>
<td>1.0</td>
<td>1.1</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>12</td>
<td>Leiden–Gouda</td>
<td>0.5</td>
<td>0.5</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>13</td>
<td>Leiden–Utrecht</td>
<td>0.4</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>105</td>
<td>Gouda–Rotterdam</td>
<td>1.3</td>
<td>1.2</td>
<td>1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>106</td>
<td>Gouda–Dordrecht</td>
<td>0.5</td>
<td>0.5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>205</td>
<td>Rotterdam–Dordrecht</td>
<td>1.2</td>
<td>1.4</td>
<td>0.9</td>
<td>1.2</td>
</tr>
</tbody>
</table>

For identification of route numbers, see Appendix.
If the demand for intercity passenger travel had been affected only by the size and distribution of urban population, it would have changed as follows (taking 1660–70 as the base period): 1660–70, 100; 1700–10, 96; 1740–50, 79.5; 1790–1800, 79. While the total population of the eight cities in our network fell by only 5% between the 1660s and the 1740s, the population-induced fall in travel volume was in fact much
greater—over 20%. Thus, population change did account for a significant portion of the decline in total passenger volume displayed in column 1 of table 9.3. Column 6 of the same table presents my estimate of the course of passenger volume if all things had remained as they were in the base period except for the variables handled by the gravity model: population and its distribution. Since the total decline in demand (from 1660–70 to 1790–1800) amounted to 49%, this single variable can explain 43 percent of the observed decline in passenger travel. Its explanatory power is greatest in the period 1700–10 to 1740–50.

IX.4.7. The role of price and population in explaining the demand for intercity passenger transportation

We have now identified the impact on intercity passenger travel of two variables: price and population. Together they account for a portion of the observed changes in passenger travel that can most clearly be identified with the use of a graph. Figure 9.13 displays for various time intervals the total shift made by the demand curve for intercity passenger transportation and identifies the portions of that accounted for by the two variables. Figure 9.13a displays the shift that occurred between 1660–70 and 1700–10.

In the 1660s demand stood at point A. In 1700 it stood at point B (13.5 million pass. km at a price of 110 [1660–70 = 100]). Given a demand curve characterized by a price elasticity of –1 (assumed for all demand curves in this figure), the price-adjusted demand in 1700 would have stood at point C. The price-caused decline in demand is thus identified by the bracketed distance P_r. The changed distribution of urban population drove the demand curve of 1660 leftward to the position of the demand curve D_1700'. The bracketed distance P_o is, correspondingly, that portion of the decline in demand accounted for by population change. There remains unexplained the distance between the demand curves D_1700' and D_1700, i.e., the bracketed distance I. This is the 'residual' value that represents the difference between column 5 and column 6 in table 9.3.

In figure 9.13b this same procedure is followed to identify the contributions of the two variables in the time interval 1700–10 to 1740–50. The demand curve for the initial period, D_1700, is identical to the curve thus identified in figure 9.a, except that point B in figure a has become point A in figure b. The observed passenger volume of the 1740s is identified by point B on the demand curve D_1740, and, once again, C identifies the price-adjusted demand point for that period. Note that in this case, with prices adjusted to the 1700–10 period, the price variable adds to, rather than reduces, the to-be-explained leftward shift of the demand curve. The extra amount to be explained is identified by the bracketed distance P_r. The population variable goes a long way to account for the shift of the demand curve in this time interval, as is shown by the position of花生
demand curve $D_{1740}'$. But there remains unexplained the distance between points C and D, the bracketed distance I.

In figure 9.13c the very minor changes in the second half of the eighteenth century are identified. The large real price decline of this period results in a price-adjusted demand point being identified that is a full million passenger-kilometers less than the actually observed point B. Since the 1740–50 demand (point A) had been 9 million passenger-kilometers, the real leftward shift of the demand curve was the short distance AC, which is entirely accounted for by the population variable. This has the effect of making the demand curve $D_{1790}'$ correspond exactly to $D_{1790}$, and, of course, make points D and C equal as well. Consequently, there is no unexplained residual in the second half of the eighteenth century. (In fact, if 1800–06 had been used as the fourth period of this analysis, there would have existed a positive residual: the demand then exceeded by 10% the level predicted by this model.46)

The remaining figures, 9.13d and e, can both be read in the same manner as has been explained for figures a, b, and c.

IX.5. THE RESIDUAL AND THE PER CAPITA INCOME OF THE DUTCH REPUBLIC

All our exertions on behalf of the two variables price and population notwithstanding, a substantial unexplained residual remains. This residual is identified as the bracketed distance I in figures 9.13a through e. In table 9.3 its absolute value in millions of pass.-km can be read from column 7 while column 8 expresses the residual as a percentage of the total base-period passenger volume. It tells us that the unexplained decline of passenger volume between 1660–70 and 1700–10 was nearly 20% of the 1660–70 passenger volume. In the following 40 years the unexplained decline amounted to over 22% of the 1700–10 passenger volume. In the second half of the eighteenth century there is no unexplained residual. Over the entire period 1660–1800 a decline amounting to 33% of the initial passenger volume remains to be accounted for.

The residual values identify that portion of the changes in passenger demand that can be ascribed to all the variables not explicitly dealt with in this analysis. In my opinion, the most important of these remaining variables was per capita income, but obviously, the confidence with which one can make this association depends on the extent to which the importance of other possible variables can be shown to be relatively small.

The possible role of intermodal competition can safely be ignored. All the available evidence reviewed in the investigation of the trekschuit’s role in the total – public and private – transportation at the beginning of this chapter suggests that a shift away from the trekschuit to the diligence began to assume significant dimensions no earlier than the end of the
eighteenth century. Since trekschuit traffic rose in the second half of the eighteenth century, this variable could only change the residual for this period from O to a small positive value. It cannot affect the identification of a large unexplained residual for the interval between the 1660s and 1740s.

The possible role of structural change in the Dutch economy is a second variable that could have accounted for a portion of the residual.
Figure 9.13a–e. Graphic representation of the influence of the variables price and population on the shifts in demand for intercity passenger transportation in Holland and Utrecht, 1660–70 to 1790–1800.

Identification of symbols:
A Observed demand level in base period
B Observed demand level in end period
C Price-controlled demand level in end period
D Population-controlled demand level in end period
Pr Change in demand explained by relative price change
Po Change in demand explained by change in urban population and population distribution
I Residual change in demand (attributed primarily to changes in per capita income)

Source: See table 9.3.
To the extent that structural change altered the distribution of urban population and that this reduced the demand for business travel among the cities, its effect will have been captured by the gravity model, and, consequently, will not appear in the residual. But it is conceivable that, within each city, there occurred a simultaneous decline of communications-intensive industries and a rise of economic activities characterized by a much smaller need for personal contact with people in the other cities of Holland. Such a structural change would cause the constant of the gravity model to decline, without necessarily implying a decline in per capita income.

The third possible factor is a change in income distribution. Even though per capita income might remain constant, it could possibly be redistributed to the disadvantage of income groups characterized by a high income elasticity of demand for trekschuit travel and to the advantage of groups whose income elasticity of demand was much lower. Eighteenth-century contemporaries sometimes spoke of the development of a chasm between the very rich and the very poor, caused by the destruction of a middle class of skilled workers and small merchants. From what we know of the broad social range of trekschuit use, such a growth of inequality could probably have been a significant cause of reduced trekschuit use only if a truly large transfer of income flowed into the hands of only the very richest persons. Such a redistribution would, by itself, have had such an impact on the demand for most goods that it would have displayed most of the characteristics of an income decline.

It is, thus, not impossible that the second and third of the just discussed variables could account for a portion of the identified residuals. But in both cases only extreme situations could have exerted a major influence. Consequently, it does not seem reasonable to believe that they can drive per capita income from its place as the most important remaining explanatory variable.

If we temporarily assume, for simplicity's sake, that change in urban per capita income is the sole variable behind the residual values, what do these residuals actually tell us about the incomes of urban Dutchmen? The problem here is to translate an income-caused shift in the demand curve (D1700' to D1700, etc. in figures 9.13a through e) into an actual income change. To solve this problem we need to know the income elasticity of demand for trekschuit service (ni). This concept tells us how consumers' demand for trekschuit transportation would respond to a 1% rise or decline in real income. Since the income elasticity of demand is likely to vary with income classes, a comprehensive value of ni can be used only so long as income distribution is held constant.

This elasticity cannot be directly observed, but there is no reason to believe that demand was inelastic to income change. A portion of trekschuit travel was for leisure of family purposes; this must be regarded
as a luxury and thus sensitive to the level of real income. The demand for business travel usually assumes a more stable character than leisure travel but in the modern economy it, too, is sensitive to the overall level of economic activity, which in turn, affects income. All in all, it seems reasonable to believe that the elasticity considerably exceeded -1. That is, that a 1% decline in income caused the demand for trekschuit travel to diminish by over 1%. If for instance \( m \) equalled -2, the 33% income-caused decline in demand that occurred between 1670 and 1740 would reflect a 16.5% decline in per capita income.

The many uncertainties that cleave to the calculations of the residual, the identification of income change as the explanation for the residual, and the discovery of the true value of the income elasticity of demand for trekschuit transportation make it irresponsible to attach great importance to any precise estimate of the actual income decline experienced by the Dutch economy. But even though great precision cannot be achieved, this analysis of the trends in the demand for trekschuit transportation is capable of supporting a number of important conclusions about the long-term evolution of the Dutch economy.

1. Urban per capita income began to decline significantly in the course of the 1670s. This decline was persistent and lasted for some 70 years, reaching its low point in the 1740s. The 1690s provided a respite to this process and divide the era of decline into two parts, of which the second was the more intense.

2. The exact amount of income decline in the period 1670–1740 cannot be determined from the trekschuit data alone. But the size of the decline in trekschuit demand that plausibly can be attributed to a fall in per capita income is such that even very cautious estimates yield compelling evidence that the decline was absolute and substantial.

3. There is no evidence to uphold a belief in further income decline after the 1740s. It is, in fact, not at all impossible that per capita income staged a modest recovery in the second half of the eighteenth century.

The results achieved by this analysis of long-term trends in intercity passenger travel strikingly contradict the traditional account of Dutch economic development and its periodization. They are, on the other hand, consistent with the recent findings of Van der Woude and Faber. But our conclusions need not rest on long-term analysis alone. In the following three chapters the same time series data will be subjected to further stages of time series analysis with the aim of understanding better the changing structure and direction of change of the Dutch economy.
The second step in the analysis of a time series, after plotting the long-term trends, is the identification and analysis of the cyclical and residual variations. (If the time series did not originally consist of annual data, the second step would be the analysis of seasonal variations. This is not the case in the present study, but seasonal variations are nonetheless important and will be investigated in the following chapter.) The purpose of this chapter is to uncover possible regularities in the short-term cycles of demand - separating the truly cyclical from the residual or random variations - and to discover the economic and other factors that can explain all or part of these short-term variations.

X.1. Did the pre-industrial economy experience business cycles?

The presence of regular cycles in the pre-industrial economy remains a controversial issue. The existence of true business cycles is usually reserved for the era of industrial capitalism beginning in England in the late eighteenth century (Schumpeter dates the ‘first’ Kondratieff from 1787) and in the Netherlands much later (De Jonge claims not to observe a full-fledged, modern industrial business cycle until 1907).\(^1\) Fluctuations existed earlier, of course, but only with the emergence of an economy dominated by fixed capital investment did an economically determined cyclical pattern begin to exert a more-or-less compelling pressure on entire economies and, ultimately, on the international economy. Most economic historians, when describing the pre-industrial economy, prefer to speak of harvest cycles and of isolated crises. The state of the harvests, the disrupting effects of wars, and, in the eighteenth century, the occasional eruption of financial panics (such as in 1720, 1763, and 1772–73) together generated a superficial pattern. But this pattern, it is argued, was not cyclical; it was random in the sense of being in large part the product of forces exogenous to the economic system such as diplomacy, weather, and mob psychology.

At least one historian of the pre-industrial Dutch economy has taken exception to this belief. N. W. Posthumus held that a rough periodicity, averaging seven years in duration, existed in the ups and downs of the textile production series that he constructed as part of his monumental study of the Leiden textile industry.\(^2\) He went on to verify that the annual variations in Leiden’s excise tax collections corresponded closely with the variations in textile production, a correspondence that Posthumus believed added credence to his conclusion that business cycles existed
in the pre-industrial economy. Few economists or historians have found Posthumus' evidence compelling. The records of one industry in one city are, after all, not sufficient to show that pre-industrial business cycles existed in the economy of the Dutch Republic.³

But French historians, from Ernest Labrousse in the 1930s to Baehrel, Goubert, Chaunu, and Braudel in more recent works, have repeatedly focused attention on short-term fluctuations and medium-term swings in their investigations of conjoncture and longue durée. The cyclical regularities that these authors believe to have found differ one from another. Indeed, the whole subject of conjoncture suffers from confusion arising from the individualistic approaches of the scholars: one speaks of 'juglar' cycles, another of 'interdecenial' cycles, still another of 'demi-kondratieffs' and so forth. Fernand Braudel, in his attempt to summarize postwar work on this subject, expresses a belief in the existence of cycles in the pre-industrial economy. But, he notes that they were not regular. Or, to be more precise, he argues that several types of cycles alternated in dominating economic life. The cyclical patterns differed from modern business cycles, he conceded, but at the same time he felt justified in applying modern business cycle terminology (Kitchin, Juglar, Kondratieff cycles) to the pre-industrial economy.⁴

This is not the place to attempt a definitive resolution of the issue raised by Posthumus and the French historians, but the analysis of cyclical variations in the trekschuit passengers series will bring to light a body of data that can be of considerable importance to this issue, and for two reasons. First, the broad base of demand for intercity transportation gives us reason to believe that the trekschuit passenger series sensitively reflect general economic conditions. Second, we possess 21 time series that each offer continuous annual observations for at least 50 years. They are scattered through four provinces and touch on 11 cities of over 10,000 inhabitants. This makes it possible to identify the extent to which the urban and regional economies connected by the trekvaart network shared a common cyclical pattern.

In order to avoid some of the confusion that surrounds this subject, it is necessary to distinguish at the outset between business cycles proper (short-term fluctuations generated by such factors as inventory size, investment behavior, and capital formation in producers' goods) and what Anglo-American economists have dubbed 'long-swings', cycles of approximately 20 years that are generated by demographic variables and population-sensitive capital formation, particularly residential construction. In another place I hope to examine the evidence for the existence of long swings in the seventeenth and eighteenth centuries. Here the focus will be kept on the short-term fluctuations.
X.2. **The cycles of demand for intercity passenger transportation, 1648–1817**

We can begin by examining the cyclical variations of several individual routes. The first step, of course, is to remove the trend from these series. Although there are various ways to do this, the best is generally thought to be the fitting of a least-squares regression line to the time series. The regression line calculations and break point identifications made for the foregoing analysis of long-term trends in the demand for trekschuit transportation can be used for this purpose. Figure 10.1 displays the detrended series for routes 1 and 2. They are closely associated, for the obvious reason that a large percentage of the travelers between Haarlem and Leiden had Amsterdam as their origin or destination.

By comparison, routes 3 and 13, whose cyclical variations are presented in figure 10.2 are somewhat less closely associated with each other. But while each route's fluctuations display some noteworthy unique features, their similarity – the fact that they usually all reach their peaks and troughs in the same or an adjacent year – is their dominant characteristic. This correspondence among the trekvaart routes of Holland and Utrecht permits us to simplify the analysis of cyclical variation by focusing attention on the aggregate series.

The analysis of cyclical variation which follows is based on four overlapping aggregate series that together span the period 1648–1817. They are series C (1648–1676), A (1665–1752), B (1740–1793) and B* (1740–60, 1787–1817). Tables 10.1a through d identify the peak and trough years (upper and lower turning points) of the cycles in these aggregate series. Note that minor peaks and troughs have been placed in parentheses and that the duration of the cycles (measured from peak to peak) is presented in the third column for both the minor cycles and for the cycles that appear when the peaks and troughs in parentheses are ignored.

<table>
<thead>
<tr>
<th>Peak</th>
<th>Trough</th>
<th>Years between peaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1649</td>
<td>1652</td>
<td>5</td>
</tr>
<tr>
<td>1654</td>
<td>1655</td>
<td>7</td>
</tr>
<tr>
<td>1661</td>
<td>1665–67</td>
<td>7</td>
</tr>
<tr>
<td>1668</td>
<td>(1670)</td>
<td>10</td>
</tr>
<tr>
<td>1671</td>
<td>1672</td>
<td>3</td>
</tr>
<tr>
<td>1674</td>
<td>306</td>
<td></td>
</tr>
</tbody>
</table>
Until about 1710 the identification of peak and trough years in the detrended aggregate series is straightforward. A definite, indeed, pronounced cyclical pattern is evident. Thus, between 1648 and 1674 the economy experienced three cycles. From a peak in 1649 it swung downward until 1652. Since the peak of 1654 was of minor importance the trough of 1652 can be regarded as continuing through 1655. Thereafter a gradual recovery took place reaching its high point in 1661. The second cycle began with a gradual downswing until 1665-67. The following year, 1668, showed a pronounced recovery from the war year levels of 1665-67, but since the two years following 1668 were not flourishing, it seems best to regard 1671 as the next real peak year. The following year, the disastrous year 1672, shows a sharp decline, but its temporary nature is clearly indicated by the fact that demand snapped back quickly to the high level of 1671. We have treated 1671-1674 as a separate cycle, but it is obviously of a different sort than the preceding cycles.

These cycles will seem familiar to anyone with even the briefest acquaintance with Dutch political history. The troughs of the first two cycles correspond to the periods in which the Dutch Republic was engaged in naval wars with England. The First Anglo-Dutch war of 1652-54 and the second Anglo-Dutch war of 1665-67 were both characterized by English attempts to blockade the Dutch ports, which, in turn, caused important sectors of the Dutch economy to grind temporarily to a halt.

The fleeting character of the Third Anglo-Dutch or French War's impact on our statistics may bring puzzlement to some readers. Since in this war the English had no success in enforcing a long-lasting blockade, the chief disruptive effect was inflicted by the French invasion, and the invasion's impact varied for each route. The routes to Utrecht were brought to a standstill for the duration of the French occupation of that city. In June, 1672 the Leiden to Utrecht barges terminate near Woerden (Nieuwerbrugge). In the following winter when the French General Luxembourg makes use of the freezing weather to breach temporarily Holland's water barrier, the barges proceed no further than Alphen aan den Rijn. By June of 1673 passengers can once again be carried as far as Bodegraven, an opportunity to which many thousands of travelers avail themselves, but only after 24 November, when French troops have retreated, is through service to Utrecht restored. Despite the onset of winter, thousands of travelers crowd onto the Utrecht-bound barges in the last 37 days of the year. But at the same time that travel directly to Utrecht is impossible, the number of passengers boarding the Leiden to Gouda trekschuiten more than doubles. Apparently Gouda assumed a new importance during the French invasion. Perhaps it offered a route through the French lines. This could also account for the fact that traffic on the Amsterdam-Gouda route, declined less than any other route in 1672 despite the fact that it passed very close to enemy lines. But in the
following year the avoidance of this route by travelers is clear to see. The
night barge between Amsterdam and Leiden, which served no strategic
role, simply ceased operation altogether. Although its route did not pass
through enemy lines, its business clientele obviously saw no need to risk
using this route when a safer route (via Haarlem) was available.

Behind the lines, on the heavily traveled routes connecting Amsterdam
with Rotterdam via Haarlem, Leiden and The Hague, the war’s impact
on trekschuit travel can be divided into two periods. From the beginning
of the invasion in June until the end of the year people did not venture
out on unnecessary intercity trips. The decline in passenger volume be­
tween 1671 and 1672 ranged from 22 percent on the Amsterdam–
Haarlem route to 16 percent on the Haarlem–Leiden route, but since
most of this decline took place in the second half of the year, this implies
that some 30 to 40 percent fewer trips were made than in the comparable
period of 1671. The spring of 1673 brought a new situation. For reasons
that are not altogether clear the population that feared to venture from
their homes in 1672 crowded into the trekschuiten in 1673. The increase
in demand was sufficiently sharp to make 1673 as a whole one of the peak
years in the history of the trekvaart industry.

In Friesland the records of trekschuit passengers betray no sign that the
country was at war. In Groningen, which suffered an invasion by troops
of the Bishop of Münster, the route to Winschoten shows nothing abnor­
mal in 1672, but in the following year travel volume attained an all-time
high point. Presumably this, too, is related to the war, but the absence
of monthly data makes it hard to know whether it was the prosecution
of the war or its aftermath that occasioned such intense use of the trek-
schuiten.

Between 1674 and 1710 all of the aggregate series are in agreement in
identifying six cycles in the demand for trekschuit transportation.

<table>
<thead>
<tr>
<th>Peak</th>
<th>Trough</th>
<th>Years between peaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1674</td>
<td>1679</td>
<td>8</td>
</tr>
<tr>
<td>1682</td>
<td>1684</td>
<td>4-5</td>
</tr>
<tr>
<td>1686-87</td>
<td>1691</td>
<td>7-6</td>
</tr>
<tr>
<td>1693</td>
<td>1695</td>
<td>6</td>
</tr>
<tr>
<td>1699</td>
<td>1704</td>
<td>8</td>
</tr>
<tr>
<td>1707</td>
<td>1708-09</td>
<td>3</td>
</tr>
<tr>
<td>1710</td>
<td></td>
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</tbody>
</table>

Table 10.1b. Peak and trough years in the variations of demand for trekschuit trans­
portation, 1674–1710.
In contrast to the period 1648–1674, this period witnessed a major long-term decline in demand; it is interesting to note that the permanent decline was almost entirely concentrated in two short but pronounced downswings, 1674–1679 and 1686/87–1691. Since there are no problems in distinguishing between minor and major cycles in this period, the above table speaks for itself. The last cycle, only three years in length, is certainly a minor ripple in comparison to the preceding cycles, but one could be persuaded that it is of virtually symbolic importance. From the long cycles of great amplitude that characterized the period 1648–74, the demand for trekschuit transportation proceeded through progressively weaker cycles ending with the little palpitation of 1707–1710. In the 30 years that follow 1710 one must contrive to identify real cycles in the passenger volume series.

Before proceeding to the decades after 1710 a few observations are in order about the timing and character of these six cycles. The influence of dramatic political events is no longer so evident in these post–1674 cycles, but it is not altogether absent. The fluctuations of the late 1670s and 1680s cannot readily be accounted for by recourse to political history but it seems likely that the sharp downturn recorded by all the trekvaart series between 1675 and 1679 identifies a period that would repay detailed study. We, with the benefit of hindsight can see it as the inauguration of a secular trend, but contemporaries also sensed that something was happening. Dutch merchants complained that the English enjoyed decisive commercial advantages in the years between the Second Peace of Westminster (1674, when peace was made with England ending her involvement in the Anglo-French coalition against the Republic) and the Peace of Rijswijk (1678, when peace was finally concluded with France). In the intervening years England enjoyed the advantages of a neutral while the Republic remained at war. At the same time the domestic economy was struck by a sharp decline in agricultural prices compounded by the levying of extraordinary land taxes to restore the dikes after the floods of 1675. The ensuing agricultural crisis is reflected in the plummeting of rents in these years. In contrast to other short-term crises, this one was definitive; none of the following upswings proved capable of making up more than a fraction of the losses of this period.

It can also be pointed out that the severe decline of the following cycle is likely to have been exacerbated by the outbreak of the Nine Years’ War (or War of the League of Augsburg) two years earlier. Likewise, the improvement of relations with the Scandinavian countries after 1692 probably helps to account for the peak year of 1693. What cannot so readily be explained, however, is why the upswing 1691–93 was such a decisive and dramatic economic revival. Finally, it is probably no accident that the peak of 1699 occurred in the hiatus in the European wars that lasted from 1697 to 1702. It can also be pointed out that the severe decline of the following cycle is likely to have been exacerbated by the outbreak of the Nine Years’ War (or War of the League of Augsburg) two years earlier. Likewise, the improvement of relations with the Scandinavian countries after 1692 probably helps to account for the peak year of 1693. What cannot so readily be explained, however, is why the upswing 1691–93 was such a decisive and dramatic economic revival. Finally, it is probably no accident that the peak of 1699 occurred in the hiatus in the European wars that lasted from 1697 to 1702.

The passenger volume figures for the first half of the eighteenth century

310
display a precipitous decline of frightening proportions, but for most of this period the de-trended time series display an almost serene stability. Calmly and without fuss the demand for intercity passenger transportation (and for many other things) melted away. The cycles — if the palpitations around the trend line can rightfully be called cycles — are mostly very short and of extremely modest amplitude. The most reasonable periodization for the years between 1710 and 1735 is presented in Table 10.1c. After 1719 it is necessary to identify two cyclical patterns, one for the routes around Amsterdam (routes 1, 2, and 16–20) and another for most of the remaining routes in Holland–Utrecht region (most notably, routes 3, 5, 11, 13).

Except on several routes reaching outward from Amsterdam, no break on the downward course of demand could maintain itself for more than a year. Consequently, most of the cycles are very short and consist of several years of decline followed by a one-year respite. On the routes around Amsterdam the overall decline in this period was less great in large part because the cycle from the trough of 1719 to 1726 consisted of six years of growth or stability and one year of decline rather than the

Table 10.1c. Peak and trough years in the variations of demand for trekschuit transportation, 1710–1735.

<table>
<thead>
<tr>
<th>Peak</th>
<th>Trough</th>
<th>Years between peaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1710</td>
<td>1712</td>
<td>3–4</td>
</tr>
<tr>
<td>1713–14</td>
<td>1716</td>
<td>4–3</td>
</tr>
<tr>
<td>1717</td>
<td>1719</td>
<td>3</td>
</tr>
<tr>
<td>1720</td>
<td>1726</td>
<td>7</td>
</tr>
<tr>
<td>1727</td>
<td>1728</td>
<td>3</td>
</tr>
<tr>
<td>1730</td>
<td>1731–32</td>
<td>3</td>
</tr>
<tr>
<td>1733</td>
<td>1734</td>
<td>2</td>
</tr>
<tr>
<td>1735</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Type two (routes 1, 2, 16–20)</strong></td>
<td></td>
</tr>
<tr>
<td>1717-</td>
<td>1719</td>
<td>8</td>
</tr>
<tr>
<td>1725</td>
<td>1726</td>
<td>2</td>
</tr>
<tr>
<td>1727</td>
<td>1728</td>
<td>2–3</td>
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<td>1729–30</td>
<td>1731–32</td>
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<tr>
<td>1733</td>
<td>1734</td>
<td>2</td>
</tr>
<tr>
<td>1735</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* For identification of route numbers, see Appendix.
reverse. Also, the decline from 1729–30 to 1731–32 was minor on these routes while it was a major downswing on most other routes.

Beginning with 1735 the cyclical fluctuations once again assume a greater length and a more pronounced amplitude. Unfortunately our data base for the 1760–1787 period is small, making correct identification of the cycles in this period problematical.

1735 marks the beginning of the sharpest and most generally felt downswing of the eighteenth century. The fall in demand persisted for ten years, broken only by a one-year revival in 1741. But the level of demand in 1741 appears to break the downward trend only because of the extremely low passenger volume recorded for 1740, which can in large part be ascribed to the severe winter of that year. Since the fluctuation of 1740–41 was more the result of supply problems (no trekschuit service for 80 days because of the severe winter) than demand failure, it seems reasonable to treat the period 1735 to 1744–46 as a single downswing.

The low point reached in the three years 1744–46 was not only the trough of a cycle, it was the turning point of a long-term trend that began in the 1670s. The upswing of 1746–49 is, therefore, of special interest. After 1749, which marks the end of a 14 year peak-to-peak cycle, a short

\[
\begin{array}{|c|c|c|}
\hline
\text{Peak} & \text{Trough} & \text{Years between peaks} \\
1735 & 1744–44 & 14 \\
1749 & 1751 & 3 \\
1752 & 1755 & 10 \\
1762 & (1763) & 2 \\
(1764) & 1765 & 5 \\
1769 & 1771 & 3 \\
(1772) & 1774 & 3 \\
1775 & 1776 & 3 \\
1778 & 1780 & 5 \\
1783 & 1784 & 7 \\
1790 & 1795 & 7 \\
1797 & 1799 & 4–6 \\
1801–03 & 1804 & 5–3 \\
1806 & 1813 & 11 \\
1817 & & \\
\hline
\end{array}
\]

Table 10.1d. Peak and trough years in the variations of demand for trekschuit transportation, 1735–1817.

312
three-year fluctuation occurs, followed by another long 10-year cycle. The length of this cycle is largely the result of a long delay in the beginning of a clear upturn after the trough of 1755 had been reached, a frustrated recovery that can be blamed on the economic impact of the Seven Years War, which began in 1756. From 1762 until 1780 the cyclical pattern seems to return to the 1710–35 pattern of very short fluctuations which can hardly be called cycles at all. Moreover, just as in 1710–35, the various routes sometimes diverge from the pattern shown by the aggregate series. It is just in these years, however, that the data on which this analysis of cycles is based are weakest.

A strong, unambiguous cyclical pattern is again visible around 1780; the war crisis of that year is the obvious low point of a peak-to-peak cycle that begins in 1778 and ends in 1783. 1784, the last year of the Fourth Anglo-Dutch War forms the next trough, and is followed by a long, gradual upswing. 1795, the year of the French invasion that brought the fall of the Dutch Republic, forms the trough of a five-year downswing. Thereafter, regular cycles with stronger upswings than downswings, characterize the demand for trekshuit service until 1806. The establishment in that year of the Kingdom of Holland and Napoleon’s inauguration of the Continental System at the end of 1806 have an unmistakable impact: slowly at first, but with increasing force after 1809, passenger volume sinks away until a low point is reached in 1813, the last year of French domination. The downswing of 1806–13 has no parallel in the entire 169-year period being analyzed here. The liberation of the country from French control brings with it an upswing in the demand for trekshuit travel until 1817, but it does not have sufficient force to make good all the damage inflicted in the disastrous years from 1806 to 1813.

The 169-year period 1648–1817 can be divided into 33, or, if the minor cycles are excluded, 26 peak-to-peak cycles. They varied in length from 2 to 14 years, with a mean of 5.1 years for all, or 6.5 years when the minor cycles are excluded. It should be noted that the many short fluctuations of 1710–35 weigh heavily in these means. When they are excluded the mean peak-to-peak interval for the 144 years 1648–1710, 1735–1817 becomes 5.5 years, or when the minor cycles are excluded, 7.2 years. Table 10.2 displays the distribution of the cycles by their duration: here their extreme heterogeneity, a characteristic measured by their standard deviation, can readily be appreciated.

Before proceeding to analyze these fluctuations it is appropriate to note here the usually close correspondence that exists between these cycles and those charted by T. S. Ashton for the eighteenth-century English economy. Since his identifications of the peaks and troughs rest on a broadly-based assessment of many types of evidence, the similarities in the two cyclical patterns should give us reason to place some confidence in the trekvaart records as a source of general economic conditions.
A comparison of the fluctuations charted above with Ashton's analysis of economic fluctuations in eighteenth-century England yield the following results. From 1704 to 1734 the correspondence is close: the peaks and troughs are, with only one exception, either the same year or an adjacent year, but one short cycle in our data is subsumed into a longer cycle by Ashton. From 1734 to 1749 (1751 for Ashton) Ashton identifies $3\frac{1}{2}$ cycles where we identify but $1\frac{1}{2}$. In both the long downswing of 1735-44 and the upswing of 1746-49 Ashton identifies minor turning points. He, too, calls attention to the severity of the 1744-45 depression. From 1751 to 1784 the correspondence between the two studies is again close: the peaks and troughs fall in the same or in an adjacent year. Once again, two short cycles in our data are subsumed in longer cycles by Ashton. From 1784 to 1800 the correspondence is weak. Ashton's dates are often the reverse of ours. Altogether he identifies 20 (trough to trough) cycles from 1702 to 1800 where we identify 21.

Ashton's tentatively expressed belief that the business fluctuations he identified were not accidents (i.e., that one can speak of real business cycles) has recently received support from an analysis of interest rate fluctuations in the London and Amsterdam money markets made by Robert Eagley and V. Kerry Smith. Their spectral analysis of monthly interest rate quotations for the 58-year period 1731-1789 identified
pronounced periodic cycles of 10-years duration as well as much shorter cycles of 12 and 2.5 months. 'To the extent that monetary phenomena governed or were geared to real fluctuations in the eighteenth-century economy', they concluded, 'regular business cycle elements were present in the English economy before the industrial revolution'.

My own spectral analysis of the annual trekvaart travel volumes from 1633 to 1820 identifies significant periodic cyclical components of 2.4 and 2.9 years (frequencies of .42 and .35) and somewhat weaker peaks at 6.2 and 12.5 years. When the cyclical effects of the weather on the time series are removed (following procedures described below on p. 319, and for the shorter period 1658-1757), the short 2.4-year cycle disappears entirely and the 6.2-year cycle becomes less pronounced. What then remains are two significant frequencies corresponding to cycles of 2.8 and 9.5 years. In view of the just described distribution of cycle durations, this bimodal distribution is not surprising, and the 9.5-year cycle seems to be consistent with Eagley and Smith's results. But one must still question whether these results are sufficient to warrant the strong conclusions drawn by Eagley and Smith.

Another of Eagley and Smith's findings is perhaps of greater significance to the present enterprise, and that is that the London and Amsterdam money market indicators were highly correlated (with Amsterdam the dominant center). Moreover, the correlation was generally higher than that between London and the other centers within Great Britain itself.

The quantitative evidence marshalled by Phyllis Deane and W. A. Cole in their study *British Economic Growth, 1688–1959* lends further support to our finding that British and Dutch economic fluctuations displayed a great deal of parallel movement. Of particular interest is the importance they attach to the mid-1740s as a turning point:

The origins [of the acceleration of the rate of growth] must be sought in the remarkably pervasive if sometimes unobtrusive stimuli which seem to have influenced practically every sector of the industrial economy in the 1740s. The new trend line established after 1745 led to something quite different in England than in the Republic, but in both — and perhaps in other countries as well — the discontinuity in long-term rates of change is striking.

X.3. THE INFLUENCE OF RANDOM VARIABLES

The fluctuations in the demand for intercity travel by trekschuit obviously were the product of many factors. Some variables exerted a role year in and year out in a more or less systematic way; others took the form of discrete events whose occurrence and impact on the trekvaart industry could not be anticipated. It is this second category of variables —
random variables — that anyone familiar with the history of *ancien régime* Europe would most likely regard as the easiest to identify. We know when plagues raged, wars broke out, and political crises and civil disturbances took place, and it seems reasonable to suppose that these events, on which historians have long devoted so much attention, should be reflected in our data.

Such an assumption would be amply confirmed by a glance at the records of trekschuit transportation in the Southern Netherlands. The annual number of passengers on the Brussels–Antwerp route in the 1690s was capable of varying by as much as 50% in a single year, all depending on the military situation. Likewise, in the 1740s, the records of the Ghent–Bruges route tell of constant war-related disruptions to trekschuit operations. In 1741 the entire service had to be suspended beginning on October 1 because of military action. In the summer of 1745 the barges were again kept at their docks by French troops. In 1748 the French insistence that all travelers first acquire a French passport, so reduced the volume of traffic that one of the two barges was taken out of service. The following year, on the other hand, was an exceptionally good one, thanks to the pilgrims traveling to Bruges in the Spring of 1749 to celebrate the 600-year jubilee of the Holy Blood.

The numerous war-caused disruptions to intercity communications observable in the Southern Netherlands may have been typical of many parts of Europe. At any rate, they are consistent with the image conveyed by many social histories of *ancien régime* Europe. It is all the more noteworthy therefore, that the fluctuations observable in the time series of intercity trekschuit passengers in the Dutch Republic do not conform to this image. On the contrary, the amplitude of the cycles described above almost never were so large as to suggest that the normal habits of the population had been disrupted. The generally greater stability and continuity of Holland's trekschuit operations is, by itself, evidence that the economy, both because of its complexity and the political position of the Republic, enjoyed a certain insulation from the sudden disruptions that afflicted neighboring Flanders. But while sharp discontinuities are notably absent from our data, this does not mean that the Dutch economy was unaffected by war. The cyclical pattern observed for the period 1648–1674 was, as noted earlier, dominated by the First and Second Anglo–Dutch Wars and the French invasion. After 1673, the cyclical pattern is rarely dominated by the direct impact of belligerent activity. Neither the War of the League of Augsburg nor the War of the Spanish Succession can be read so easily from the annual records of the Dutch trekvaart industry — which is not to say, of course, that these wars were without economic impact.

In the second half of the eighteenth century several cycles once again show a sensitivity to military activities. The Seven Years' War seems to have delayed the recovery from the depression of 1755; the outbreak of
the Fourth Anglo-Dutch War is clearly reflected in the low level of demand in that year, and the French invasion of 1795 also coincides with a cyclical low point. On the other hand, the Prussian invasion of 1787 apparently did not disrupt the course of economic life for very long, for the passenger volume figures show nothing out of the ordinary.

Even more surprising is the absence of any discernible impact on the traveling habits of the urban Dutchman exerted by outbreak of plague and other epidemic diseases. The outbreaks of plague in Amsterdam in 1635–36, 1655, and 1664 are each said to have killed close to a tenth of the city’s population. But neither the sudden fall of population nor the efforts of travelers to avoid cities where plague was known to rage seems to have had any large impact on the flows of passengers to Amsterdam.

In contrast to the discrete character of the incidence of such variables as war and epidemic, another random variable exerted its influence in every year: the weather. The freezing of the canals was the only event capable of interrupting with certainty the otherwise dependable operation of the trekschuiten.

On some routes the skippers operated alternative wagon services during the winter shutdowns, but these could offer only a small fraction of the capacity normally made available by the trekschuiten. Consequently the supply of trekchuit service available in any given year was a direct function of the severity of the winter. The more days there were of below freezing temperatures, the fewer barges made their appointed rounds.

The financial records of several trekvaarten record the number of barges that set out on their scheduled sailings every month, and on one route the bookkeepers carefully noted the actual days on which the trekvaart was forced to close. This was done month by month, year by year, from 1658 until 1839, with a break in 1758–1813. The usefulness of these observations for the history of climate is obvious, and has been exploited in an article published elsewhere. Here these data will be utilized to identify the impact of winter shutdowns on the actual volume of passengers carried.

Throughout the seventeenth and eighteenth centuries the average number of icebound days per winter on the trekvaarten of Holland was 28. Of course, this average did not preclude the occurrence of winters when ice never formed at all, or of winters when ice blocked navigation for nearly three full months. We are well-informed about the weather-caused fluctuations in the available supply of trekchuit service. It remains to determine how these winter season variations in supply affected the actual volume of passengers carried, and thus, the observed fluctuations around the long-term trend line.

One possibility is that the suspension of trekchuit service in the winter simply forced potential travelers to postpone their trips until the trekschuiten once again resumed the observance of their schedules. In such
a case winter temperature as such would not affect the annual passenger volume statistics at all. The sensitivity of annual demand to winter supply can be identified through regression analysis. The results of simple correlations of passenger volume (expressed as a percentage deviation from the 15-year moving average of passenger volume for that year) and the number of days the trekvaart was frozen for the century-long period 1658–1757 are presented in table 10.3.

Variations in the severity of winter weather explained about a quarter of the variance in annual passenger volume on the routes in Holland. On aggregate route A* (the sum of routes 1, 2, 3, 11, and 13) a winter without ice caused the passenger volume to rise, on average, 3.8% above normal (i.e. the 15-year average for that date); each icebound day reduces that figure by 0.15%, so that in an average winter of 28 icebound days, the deviation would be near 0. In a year with 70 days of ice the forced reduction of supply would have sufficed to keep passenger volume 6.7% below normal. Such years, incidentally, were not so rare as they have been in the recent past. In the period 1658–1757 at least 70 days of ice were recorded in 1663, 1672, 1679, 1681, 1695, 1697, 1709, 1716, and 1740.

The weather exerted an important short-term influence on the volume of trekschuit travel. If the variance in the number of passengers carried had been directly proportional to the variance in the number of days per year the trekschuiten were in operation, the loss of passengers would have been 0.27% per icebound day \((1/365 = .27)\). At first glance, then, the actual loss of 0.15% would suggest that almost half of all winter passengers when faced with the suspension of trekschuit service, simply postponed their trips until service was resumed. But this interpretation is incorrect. As the following chapter will make abundantly clear, the level of demand in winter months – particularly in the eighteenth century – was distinctly lower than in the summer months. Consequently,

<table>
<thead>
<tr>
<th>Route</th>
<th>( Y = a - bX )</th>
<th>( r^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.23 - .15X</td>
<td>.25</td>
</tr>
<tr>
<td></td>
<td>(4.52) (-5.60)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3.45 - .14X</td>
<td>.18</td>
</tr>
<tr>
<td></td>
<td>(3.12) (-4.41)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4.66 - .19X</td>
<td>.23</td>
</tr>
<tr>
<td></td>
<td>(3.69) (-5.24)</td>
<td></td>
</tr>
<tr>
<td>A*</td>
<td>3.83 - .15X</td>
<td>.34</td>
</tr>
<tr>
<td></td>
<td>(4.72) (-6.28)</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>8.47 - .32X</td>
<td>.25</td>
</tr>
<tr>
<td></td>
<td>(3.66) (-4.78)</td>
<td></td>
</tr>
</tbody>
</table>
the values in these regression equations are consistent with the generalization that the trips taken, or contemplated, in the winter months were regarded as necessary and unpostponable. When ice forced the suspension of trekschuit service, travelers either had to find other ways to reach their destinations or abandon their plans altogether. The absence of large bulges in the number of passengers in the first weeks of service following a long icebound period, is another, more direct, proof that few travelers were in a position to postpone their trips.

The regression equations describing the impact of winter weather on the volume of trekschuit travel make it possible to isolate the proportion of the total variance of the 'de-trended' time series that can be attributed to the influence of winter weather. By removing the influence of the random variable winter weather, the cyclical pattern is normalized for that variable. Such a normalized timeseries presents the data as they would have been if every winter had been ‘average’. If a purely economic cycle existed in the seventeenth- and eighteenth-century Dutch economy, the removal of the random influence of weather should make it more clearly visible. Table 10.4 presents the ‘de-weathered’ cycles for the period 1648-1762. Given the substantial direct impact exercised by the winter weather on the annual volume of passengers, it is perhaps surprising that the removal of the influence of winter weather does not substantially alter the basic cyclical pattern identified from the original deviations. Since this analysis of the weather variable is capable of identifying some short cycles as being caused chiefly by extreme winter temperatures, it has been possible to subsume a few minor cycles into longer-term cycles. Consequently, in the de-weathered data, 16 instead of 18 cycles carry the trekvaart industry form 1648 to 1762. These cycles are sharply divided between 6 cycles of from 11 to 14 years duration and 9 cycles of no more than 5 years duration. In between 5 and 11 years is just one (9-year) cycle. The chief difference between the original and de-weathered cycles can be summarized by the following six points:
1. The 1668-71 cycle is very minor, with its trough in 1669 instead of 1670.
2. The two peak-to-peak cycles 1682-86/87, 1686/87-1693 are really one cycle, since the 1686/87 peak, once de-weathered, is found to fall in 1685 and be very minor.
3. The three-year cycle 1707-1710 actually begins in 1706, and ends in 1709. Moreover, the 1706 peak is so minor that it can be regarded as part of the 1697-1709 cycle.
4. The 1719-1725 upswing is partly an illusion. The continued upswing after 1723 is the result of the very mild winter of the two following years (with 6 and 0 days of ice, respectively). The de-weathered upswing ends in 1723.
5. The 1740 trough, once the 73 days of freezing weather of that year are taken into account, loses most of its significance as a cyclical trough.
TABLE 10.4. Peak and trough years in the 'de-weathered' variations of demand for trek-schuit transportation, 1648–1762.

<table>
<thead>
<tr>
<th>Peak</th>
<th>Trough</th>
<th>Years between peaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1649</td>
<td>1652</td>
<td></td>
</tr>
<tr>
<td>(1654)</td>
<td>1655</td>
<td>5</td>
</tr>
<tr>
<td>1660</td>
<td>1667</td>
<td>6</td>
</tr>
<tr>
<td>(1668)</td>
<td>1669</td>
<td>8</td>
</tr>
<tr>
<td>1671</td>
<td>1672</td>
<td>11</td>
</tr>
<tr>
<td>1673</td>
<td>1679</td>
<td>3</td>
</tr>
<tr>
<td>1682</td>
<td>(1684)</td>
<td>9</td>
</tr>
<tr>
<td>(1685)</td>
<td>1690</td>
<td>11</td>
</tr>
<tr>
<td>1693</td>
<td>1695</td>
<td>8</td>
</tr>
<tr>
<td>1697</td>
<td>1704</td>
<td>4</td>
</tr>
<tr>
<td>(1706)</td>
<td>1707</td>
<td>9</td>
</tr>
<tr>
<td>1709</td>
<td>1711</td>
<td>12</td>
</tr>
<tr>
<td>1713</td>
<td>1715</td>
<td>3</td>
</tr>
<tr>
<td>1718</td>
<td>1719</td>
<td></td>
</tr>
<tr>
<td>1723</td>
<td>(1724)</td>
<td></td>
</tr>
<tr>
<td>(1725)</td>
<td>1726</td>
<td>2</td>
</tr>
<tr>
<td>1727</td>
<td>1728</td>
<td>4</td>
</tr>
<tr>
<td>1729</td>
<td>1731</td>
<td>2</td>
</tr>
<tr>
<td>1733</td>
<td>1734</td>
<td></td>
</tr>
<tr>
<td>1735</td>
<td>1744–45</td>
<td>2</td>
</tr>
<tr>
<td>1749</td>
<td>1751</td>
<td>3</td>
</tr>
<tr>
<td>(1752)</td>
<td>1755</td>
<td>13</td>
</tr>
<tr>
<td>1762</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Including minor cycles

<table>
<thead>
<tr>
<th></th>
<th>Original</th>
<th>De-weathered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cycles:</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Mean duration (in years):</td>
<td>5.1</td>
<td>5.2</td>
</tr>
<tr>
<td>Standard deviation (in years):</td>
<td>2.4</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Excluding minor cycles

<table>
<thead>
<tr>
<th></th>
<th>Original</th>
<th>De-weathered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cycles:</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>Mean duration (in years):</td>
<td>6.3</td>
<td>7.1</td>
</tr>
<tr>
<td>Standard deviation (in years):</td>
<td>3.5</td>
<td>4.1</td>
</tr>
</tbody>
</table>

320
There is all the more reason to regard 1735–1744 as a single downswing.

6. Several peaks and troughs are moved backwards or forwards by a year, as a comparison of table 10.4 with tables 10.1a–d shows.

X.4. THE INFLUENCE OF ECONOMIC VARIABLES

The analysis of a time series ordinarily attempts to separate the purely random from the truly cyclical components. The removal of variance attributable to such a classic random variable as weather conditions would therefore be regarded as an important step towards the discovery of the 'true' cyclical pattern. Correspondingly, the cycles of table 10.4 should be regarded as more accurate than those of tables 10.1a–d. But there is reason to hesitate in taking this step with the trekschuit data.

Annual variations in the severity of winters exerted a notable influence on the number of trekschuit passengers, but its influence on the economy as a whole, while probably less, was also far from negligible. Consequently, de-weathered data may give at least as misleading a picture of the economic cycles as the original variances. The likelihood of this possibility is strengthened by the results I achieved in trying to measure the extent to which the demand for trekschuit transportation was influenced by the short-term price fluctuations of the important breadgrain, rye.

Budget studies of pre-industrial households always find a large portion of total household income spent on bread. Since the demand for this basis of the European diet must have been inelastic, it seemed reasonable that the demand for such a relative luxury as trekschuit travel would be inversely related to the price of rye, the most widely consumed bread grain in Holland. That is, I expected to find that, in the short-run, the demand for trekschuit travel would be higher in years of low grain prices than in years of high grain prices.

In testing this hypothesis the initial results showed the opposite to be true. Multiple regression equations that sought to identify the amounts of the annual fluctuation in passenger volume (Y) explained by the two variables icebound days per year (X1) and rye prices expressed as a percentage deviation from the 15-year average (X2) always showed rye prices and passenger demand to be directly related. The relationship was never found to be particularly strong, but it was consistent and always statistically significant. The same direct relationship was shown in simple regressions of deviations in rye prices and the de-weathered deviations in passenger volume from the long-term trends. (See table 10.5.)

These results, showing increases in rye prices to have a small positive rather than negative impact on the demand for trekschuit travel, were unexpected. The puzzle would have remained were it not that, in the course of analyzing the economic impact of severe winters, a significant inverse correlation was found between rye prices and average winter
temperature; i.e., the colder the winter, the higher was the price of rye in the following year.\textsuperscript{16} We now know that cold winters were correlated with both reduced passenger travel (the result of the suspension of trek-schuit service) and higher rye prices, with the former being a more consistent and powerful correlation than the latter. The relationship between rye prices and passenger travel was bound to be distorted when studied in conjunction with the impact of winter temperature. The two independent variables, because of their direct correlation with each other (i.e. multicollinearity), yield unstable estimates of their coefficients. It is possible that some of the negative impact exerted by the price of rye is credited to the weather variable.

When rye prices (expressed as a percentage deviation from the 15-year moving average) are correlated to unadjusted passenger volumes (expressed in this case as a percentage deviation from the least-squares regression line), we can be more confident of uncovering the true relationship between the two variables. This does not mean, however, that the initially expected results are now achieved. The results are, in fact, more interesting than that.

Rye prices continue to be positively correlated to the passenger volume of aggregate series $A^*$, but this correlation is tiny, and no longer statistically significant. When regression equations are calculated for sub-periods of the time series, the reason for this ‘non-committal’ result is exposed. Until the beginning of the eighteenth century a notable positive correlation prevailed; thereafter, the correlation turned negative.

For aggregate route $A^*$ the equations were:

\begin{align*}
    &1675-1710 \quad Y = 5.86 + .18 X \\
    &1711-1752 \quad Y = 5.08 - .03 X
\end{align*}

For route 1 a much longer time series is available. Here too, the early eighteenth-century shift is evident.

\begin{table}[h]
\centering
\begin{tabular}{llllll}
\hline
Route & Years & Y = a_0 + a_1X_1 + a_2X_2 & r^2 \\
\hline
$A^*$ & 1675-1752 & Y = 4.012 - .156X_1 + .060X_2 & .41 \\
     & & (5.19) & (-6.85) & (3.04) \\
1 & 1658-1753 & Y = 4.380 - .133X_1 + .085X_2 & .36 \\
     & & (5.05) & (-6.28) & (4.07) \\
2 & 1662-1751 & Y = 3.776 - .145X_1 + .090X_2 & .27 \\
     & & (3.60) & (-4.86) & (3.36) \\
3 & 1658-1753 & Y = 5.000 - .196X_1 + .083X_2 & .29 \\
     & & (4.07) & (-5.64) & (2.66) \\
\hline
\end{tabular}
\caption{Regression analysis of two variables that influenced the annual variation of trek-schuit passenger volume.}
\end{table}

$Y$ = Percentage deviation of passenger volume from the least-squares regression value  
$X_1$ = Number of ice-bound days per year  
$X_2$ = Percentage deviation of rye prices from the 15-year moving average  

322
1633–1710 \[ Y = 1.30 + 1.62 X \]
1720–1760 \[ Y = .14 - .03 X \]
1787–1820 \[ Y = .46 - .03 X \]

The strength of the positive relationship in the seventeenth century can most clearly be expressed by applying a ‘difference of means test’ to the data. In the 78 years from 1633 to 1710 rye prices exceeded the 15-year moving average by at least 1.5% in 13 years. In these years the number of trekschuit passengers exceeded its regression line value by an average of 4%. In the 19 years that rye prices fell at least 1.5% short of their 15-year moving average, passenger volume averaged 3% below its regression line value. Were the mean deviations in passenger volume for these two groups of years (with extreme high and low rye prices, respectively) sufficiently far apart so that they cannot be regarded as the product of chance? This is the question answered by the difference of means test. In this case the answer is yes: the means are statistically different from each other at the 5% significance level. In the eighteenth century the means are less far apart, but their signs are opposite; then, years of high rye prices are characterized by passenger volumes 2.5% below average, while the years of low rye prices were associated with passenger travel volumes 1.5% above average. This difference is also significant at the 5% level.\(^{17}\)

How can we account for these peculiar short-term relationships between rye prices and the demand for trekschuit transportation? I wish to suggest that the initially hypothesized negative relationship existed, but did not act alone. Another – positive – relationship also existed. Figure 10.3 presents a possible – but not proven – identification of that positive relationship.

![Figure 10.3. Consumption frontiers for rye and trekschuit transportation.](image)
If we assume for a moment that consumers spent their income on only two goods, rye and trekschuit travel, then line AB identifies all possible ways in which a household could spend its income assuming a given income and given prices for rye and trekschuit transportation. They could buy OA of trekschuit transportation, OB of rye, or, more likely, some combination of the two. The consumer's indifference curves (not shown in figure 10.3) will identify that combination of the two goods that optimizes the consumer's utility. Now suppose that the price of rye increases, while income and the trekschuit tariff remain the same. AC now identifies the consumption possibility frontier. The shape of the indifference curve will determine how the consumer responds to this change. If his demand for rye is entirely inelastic, he will continue to purchase just as much rye as before. To achieve this objective in the altered circumstances, he will be forced to reduce his expenditure on trekschuit travel. This is an extreme case, of course, but as long as the elasticity of demand for rye is less than that for trekschuit travel (a reasonable assumption) the reduction in real income caused by the price increase will generate a greater decline in trekschuit travel than in rye consumption.

The short term shift from point X to point Y, which illustrates the extreme case of the just described phenomenon, is what I set out to measure in the regression analysis described above. But there was apparently a second factor at work. High rye prices were associated with larger than average grain shipments from the Baltic to Amsterdam, the grain entrepôt of Europe. A good year for the grain trade surely stimulated the shipping industry and the level of port employment, and these stimuli were then transmitted by a multiplier process through the entire economy. The magnitude of these effects can, at this point, only be imagined. But it is not impossible that they increased per capita income sufficiently to compensate for the price-induced decline in purchasing power.

Just such a hypothesized short-term increase in income is shown in figure 10.3 by the new consumption possibilities frontier A'C'. The prices of the two goods remain the same as in AC, but increased income makes it possible to buy more of both goods. Assuming, for simplicity, an inelastic demand for rye, the new consumption point is Z. The decline in trekschuit travel forced by the increased price of rye has been more than compensated for by the short-term rise in income. Figure 10.3 conforms with the observed seventeenth-century behavior of rye prices and trekschuit travel. Following this hypothesis a step further, we can suggest that the Amsterdam grain entrepôt's ability to generate increased incomes throughout Holland in years of high grain prices was weakened in the early eighteenth century. From then on A'C' usually stood much closer to AC than is shown in figure 10.3, and Z often found itself to the left of X.

It is known that the average annual volume of grain shipments from the Baltic was smaller in the eighteenth than in the seventeenth century and that Amsterdam's function as the distribution center for grain met
with new and effective competition. Our hypothesis is also consistent with the suggestion made by J. A. Faber, in his analysis of the declining size of the Dutch-Baltic grain trade, that the value of that trade to the Republic rested more in its employment function than in its function as a source of trading profit.\(^{18}\)

Further research into the domestic income-generating impact of the grain trade seems called for, but one preliminary indication of our model’s possible validity is provided by the changing strength of the correlation between fluctuations in trekschuit travel and the *convooien* tax revenues of the port of Amsterdam. The weaknesses of this source as a determinant of the trends of the Dutch economy were discussed in the preceding chapter, and it stands to reason that its use for an analysis of economic cycles must also be suspect. But, for what it is worth, a simple correlation was made of the *convooien* receipts of Amsterdam and the percentage deviation of passenger volume from its 15-year moving average on the Amsterdam-Haarlem trekvaart.\(^{19}\) The results showed a certain correlation from 1640 to 1675 (r = .48), an only slightly weaker correlation from 1675 to 1710, and a total absence of correlation in the period 1710–1760 (r = .02). It would be irresponsible to draw far-reaching conclusions from these results. They may prove only that one or both time series became increasingly inaccurate in the eighteenth century, but it is also possible that these results reinforce the conclusions of our analysis of rye prices: that the domestic income-generating impact of Amsterdam’s overseas trade tended to decline in the early eighteenth century.

X.5. Conclusions

The foregoing discussion makes clear that the cyclical pattern evident in the demand for trekschuit transportation yields to no simple explanation. The disruptive effects of wars and other random events are registered in these data, but they do not often dominate the fluctuations as they seem to, for instance, in the Southern Netherlands. Fluctuations of grain prices and the vagaries of the weather also exerted a discernible impact on the volume of trekschuit travel, but that impact was complex, and certainly cannot be comprehended in the context of a simple harvest cycle model. On the contrary, the economy of the Dutch Republic seems to have been in the unique position (in the seventeenth century at any rate) of being a net gainer from the events that brought grief to much of the rest of Europe. It must be emphasized that this net gain was very small, but the important point is that this was not an economy that was shunted by the whims of Ceres and Mars between years of plenty and years of famine. The cycles exhibit a degree of insulation from the effects of the most obvious random and harvest variables. But does this mean that true business-cycles existed?
The facts that the observed fluctuations do not yield readily to simple explanation and that they are often in close agreement with the fluctuations that have been charted (on the basis of varied evidence) for the English economy are signs that they represent more than purely random events. But these cycles lack the robustness and relative consistency of nineteenth- and twentieth-century business cycles. The absence of any central tendency in the duration of the cycles is the most curious of their characteristics. There were both many short cycles of 3 or 4 years, and many very long ones of 11, 12 and even 14 years. Consequently, the average length, 6 to 7 years, is a duration that almost never actually occurred.

Also curious are the two eighteenth-century periods, 1710–35 and, to a lesser extent, 1762–80, when the variations around the trend line settle down to petty palpitations. In these years the vigorous cyclical pattern of earlier decades seems to dissolve. This seems particularly significant. Business cycle theory holds that the more interdependent an economy the longer and stronger will be the chain of the interaction proceeding from the initial disturbance that effects the economy at the lower turning point. Correspondingly, the shortening of the duration, and weakening of the amplitude and even the discernibility of the cycles in the early eighteenth century would suggest that the Republic's economy was becoming less well integrated – that its various economic sectors and geographical regions were leading more autonomous lives than they had in the seventeenth century. Such an explanation lends support to the conclusions drawn in the preceding chapter regarding the extent and timing of economic decline. But, we do not yet know that it is the right explanation. Both this dampening of the cyclical pattern and the wide range of cyclical periods need more investigation before a definite answer can be given to the question as to what extent a true economic cycle (generated by inventory size, investment behavior, capital flows, etc.) existed in the pre-industrial economy.
XI.1. THE PROBLEM OF SEASONAL FLUCTUATIONS IN THE PRE-INDUSTRIAL ECONOMY

Among the characteristics of pre-industrial societies that immediately attract our attention and remind us of the great distance separating them from modern societies, is the pronounced seasonal rhythm, a rhythm to be found not only in economic life, but in social and religious life as well. In agricultural communities the existence of and reasons for this seasonality are sufficiently obvious that we need not dwell on them here. But non-agricultural activities of the most varied sorts also exhibited pronounced seasonal patterns. Many industries - for example, linen bleaching and peat digging - could operate only in the summer months; in the winter months harbor activities changed their character completely as the number of vessels setting sail fell to nearly zero. Of all the ships passing through the Danish Sound in an average seventeenth century year, less than 3% did so in the three winter months, and over 90% of the sailings were concentrated in the seven months from April to October. Further seasonal fluctuations were imposed on harbor activities by the timing of the arrival and departure of the East Indies fleets, the Russian fleets, and whaling and fishing fleets. The ‘jerky’ character of economic life also created peaks in the ‘transactions demand for money’ (to move harvests, pay seasonal laborers, equip outgoing fleets, etc.) which had a further effect on seasonal fluctuations. A consequence of these financial peaks was to make money physically scarce in certain seasons, which, in turn affected the volume of retail sales, and even the incidence of bankruptcies.

It is generally held that social and economic ‘modernization’ is characterized by the dampening of pronounced seasonal concentrations of a wide variety of phenomena - from marriages, conceptions, and deaths, to work. Here I wish to focus attention on the specific contribution that a dampening of seasonal fluctuations can make to economic growth, a source of growth that is not always given the recognition due to it.

Even in the absence of significant productivity growth, a pre-industrial economy was capable of greatly increasing output if the available productive factors could be released from enforced idleness. And one of the major sources of enforced idleness was to be found in the seasonal limitations that were imposed on many sectors of the economy. The Dutch economy must have felt this limitation acutely during its rapid growth in the first two-thirds of the seventeenth century. In chapter III I described the undependability and extra costs of travel that every
winter brought with it, and in chapter I I found year-round dependability to be the one characteristic of trekschuit transportation that contemporaries never failed to value highly. Compared to this, the money and time savings were of secondary importance. From our perspective, the trekschuit's vulnerability to winter frost—which forced the suspension of service for an average of one month per year—diminishes considerably the trekschuit's attractiveness as a reliable means of winter transportation. But to contemporaries there was nothing superior; it offered a major improvement over the existing modes of transportation.

It is in this context of a growing economy that feels a need to spread the performance of economic activities more evenly through the year that the seasonal fluctuations in the demand for trekschuit travel should be analyzed. Among the questions to which we seek answers are to what extent did the trekvaart in fact offer a regular year-round of transportation and to what extent did a year-round demand for intercity travel actually exist?

XI.2. THE MONTHLY DISTRIBUTION OF PASSENGER TRAVEL IN THE SEVENTEENTH CENTURY

To study seasonal fluctuations I have calculated the monthly passenger volume in ten-year averages for as many trekvaart routes as possible and expressed each month's figures as a percentage of the average annual number of passengers. Thus, if the ten-year average number of passengers traveling in the month of May were 10,000, and the ten-year annual average were 120,000, the share of passengers traveling in May would be 1/12th, or 8.3%. It should be noted that 1/12th, or 8.3% is also the even distribution point, that is, the share that every month would claim if the demand were evenly distributed through the year. Correspondingly, a month whose share exceeds this figure can be regarded as exhibiting a greater than average demand, and vice versa.

Although we have seasonal distributions for several routes, the Amsterdam–Haarlem route offers the fullest information. Therefore, the analysis will begin with this busiest of all trekvaarten and then proceed to the others.

Figures 11.1 and 11.2 display the monthly distributions of trekschuit passengers, trekschuit passengers per barge, and tollgate revenues for the decades 1644–53 and 1660–69, respectively. These figures reflect the fact that the monthly distribution of trekschuit passengers remained essentially unchanged over the first four decades of the Amsterdam–Haarlem route's operations, which began in 1632. The distribution is characterized by a gradual rise to peaks in July and September, followed by a gradual decline to the travel volumes of the three winter months of December, January, and February. Travel demand was not evenly
distributed, but apart from the three winter months, the differences among the months were not enormous; the monthly shares ranged from about 8 to about 11% of the average annual totals. In contrast, the three winter months together accounted for only 14% of annual travel volume. A large portion of the low observed winter demand was the consequence of the suspension of service during freezing weather and the less numerous scheduled departures. (The earliest and latest summer departures usually were suspended during the shorter days of winter.) A more accurate picture of the demand for intercity travel can be achieved by expressing the average monthly passenger volume in relationship to the actual average number of monthly trekschuit departures.

Figures 11.1 and 11.2 also display the monthly distribution of the 'load factor', the average number of passengers per trekschuit. This distribution is much more evenly spread than the distribution of passengers themselves. The average trekschuit load in the three winter months taken together ranged between 17.7 and 18.3 or only about 12% below the average load in the peak three month period – June, July, and August –
when loads ranged between 19.2 and 21.0 passengers. These results suggest that the small number of passengers in the winter months was much more a consequence of inadequate supply (due chiefly to icebound canals) than of inadequate demand. This conclusion is consistent with the results of the regression analysis of winter weather’s impact on passenger volume in the previous chapter and is further confirmed by the seasonal pattern of use made of the towpath that paralleled the canal.

The third curve of figures 11.1 and 11.2 shows the monthly distribution of tollgate receipts on the Amsterdam–Haarlem trekvaart. Throughout the first four decades of this route’s operation the most striking fact about the pattern of towpath use is that the three winter months account for more of the annual receipts than any other three-month period. The actual number of towpath users is not known, but under even the most generous assumptions towpath users could not fully have compensated for the reduced volume of trekschuit passengers. Towpath receipts in these decades were too small to accomplish this. But the tendency remains clear: when trekschuit service was suspended travelers took to the
road and walked or rode to their destinations. In short, there existed a demand for intercity transportation that was remarkably evenly distributed through the course of the year, and that was sufficiently compelling to force travelers to use uncomfortable alternatives to the trek-schuit on the coldest days of winter rather than stay home close to the hearth.

On most other routes in the mid-seventeenth century, the monthly distribution of passengers displays characteristics very similar to those of the Amsterdam–Haarlem route. Apart from small differences in the timing of the peak month, often attributable to the incidence of annual markets and kermises, the relatively even distribution of demand with a modest peak in the summer is found over and over again. Figure 11.3 presents the monthly distribution for the 1660s on routes 1, 2, and 3. Once one discounts the impact of the Amsterdam kermis in September, and the Leiden and Delft kermises in June, a good deal of the divergence among the three distributions is explained.

The monthly distribution of passenger demand on most trekvaart routes shows this same pattern, but not all. The routes that served agricultural areas and small cities dependent on the agricultural economy, were

![Figure 11.3. Average monthly distribution of trekschuit passengers on three routes, 1660–69.](image)

characterized by a very distinct pattern of travel demand. The Sneek-Leeuwarden route, in Friesland, offers the most complete data on this rural seasonal distribution. (See figure 11.4.) In place of a single summer peak, one observes here two: one in the early spring and a second in the late fall. In the summer months travelers became nearly as scarce as in the winter months. The economic dependence of Sneek on its butter market and its function as a service center for the surrounding countryside is clearly reflected by these data.

Not all routes in the rural northern provinces shared the same pattern, however. For example, the Harlingen–Leeuwarden distribution, also shown in figure 11.4, rose from its winter low point to a level in March, which, with only minor fluctuations, was maintained until November, when travel volume plunged downward for the three winter months. There is reason to believe that this extremely stable pattern is, in fact, a composite of two separate patterns, one urban, with a midsummer peak, and the second rural, with peaks in March and again in October and November. Fortunately, we do not have to content ourselves with speculation on this matter. Thanks to a dispute that broke out between the trekschuit skippers of Dokkum and Groningen soon after the trekvaart between their two cities was opened, we possess a detailed account of the monthly number of travelers between not only Groningen and Dokkum (where connections were made for Leeuwarden) but also between Groningen and all the intermediate villages along the route. By separating the travelers to and from the villages from through (inter-
urban) travelers and calculating separate monthly distributions for these two categories, the differences between rural and urban travel patterns can be observed. The one year for which this detailed information is available – 1658 – experienced a severe winter that closed the trekvaart for two full months. That makes impossible a comparison of winter travel demand in the rural and urban sectors, but for the rest of the year the differences are obvious enough (see figure 11.5). The villages generate a double-peaked demand pattern, with low demand in the summer months; the cities generate a single, summer-peaked pattern. Together, they create an overall pattern similar to that of the Harlingen-Leeuwarden route.

The east-west routes on the North Holland peninsula that connected together Enkhuizen, Hoorn, and Alkmaar also deserve separate mention. The influence of the rural economy is evident here too, although in the seventeenth century the influence of the sea-faring and fishing economies of the cities was still much in evidence. The combination of these influences generated a very irregular seasonal pattern (see figure 11.6) in which the peak months were April and August, when Alkmaar and Hoorn held large kermises, respectively. In contrast to these east-west routes, the north-south routes connecting Hoorn with Amsterdam showed none of this irregularity. Once March had begun, a steady level

![Figure 11.5. Monthly distribution of interurban and rural-urban travel on the Groningen-Dokkum trekvaart, 1658.](image)

Source: G.A. Groningen, O.A., no. 742r, 'Questie met de stad Doccum over de trekweg'.

% of annual passengers

- Groningen - Dokkum
- Groningen - villages

months of the year

333
of travel volume, with only a minor peak of demand at the Hoorn kermis time, persisted until the end of November.

The seasonal pattern of trekschuit transportation in the seventeenth century was by no means everywhere the same. But on the bulk of the routes, and on nearly all in urbanized central Holland, we have been able to identify an 'urban' demand pattern which was quite stable, reached a modest peak in the summer months, and was in part frustrated by supply shortages in the winter. This pattern is consistent with the propositions that the Republic's economic development created a pressure on available resources, that men sought to deal with this problem by keeping the economy functioning as much as possible on a year-round basis, and that the trekvaart network played an integral role in the achievement of this goal.

XI.3. CHANGES IN THE MONTHLY DISTRIBUTION OF PASSENGER TRAVEL

The monthly distribution of passenger travel among the major cities of Holland did not long continue to exhibit the characteristics which have just been described. Beginning in the 1670s, but with great force in the first 30 years of the eighteenth century, the seasonal pattern of
urban demand experienced a transformation that is as difficult to explain as it is important.

However difficult it may be to explain, it is not difficult to describe. The ten-yearly distributions of trekschuit travel on the Amsterdam-Haarlem route show clearly what was at hand. Figure 11.7, showing several of these distributions from 1650–59 to 1806–13, lets us see that the 1650–59 distribution was not significantly altered until the eighteenth century. Once this stable seventeenth-century pattern was disrupted it assumed, with great speed, a new form that reaches its peak in the 1730s. But the process of change was not quite as concentrated as figure 11.6 suggests. In the first place, the high winter load factors characteristic of the first four decades of operation began to show signs of weakness already in the 1670s. From then on the difference between winter and summer loads become progressively greater, as figure 11.8 shows. Secondly, at the same time that the trekschuiten began to run with light winter loads, the monthly distribution of towpath receipts lost its winter peak. (See figure 11.9.) After the 1660s the towpath’s function as an alternative means of transportation, to be used primarily when the trekschuiten could not depart, falls into desuetude. The pressure that in the 1630s through the 1660s had compelled winter travelers to brave the elements and push on to their destinations gradually lost its force.
average number of passengers per barge

months of the year

<table>
<thead>
<tr>
<th>1650-59</th>
<th>1680-89</th>
<th>1730-39</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: See figure 11.1.

Figure 11.8. Average monthly distribution of the number of passengers per barge on the Amsterdam-Haarlem trekvaart for selected decades, 1650-1739.

% of average annual tollgate revenues

months of the year

<table>
<thead>
<tr>
<th>1650-59</th>
<th>1680-89</th>
<th>1730-39</th>
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</table>

Source: See figure 11.1.

Figure 11.9. Average monthly distribution of tollgate revenues on the Amsterdam-Haarlem trekvaart in selected decades, 1650-1739.
The transformation of the seasonal distribution of passenger travel can be most comprehensively displayed with the help of a seasonal analysis chart (figure 11.10). For each month the percentage of annual travelers who traveled in that month is plotted for each ten-year period in consecutive order. The chart shows at a glance the months in which travel increasingly became concentrated and the months which travelers increasingly sought to avoid.

The trends of all three winter months were downward, but January and February in particular show great decade-to-decade variations. This is partly explainable by long-term variation in the severity of the winters. In some decades the average annual number of icebound days exceeded 30 while in others it did not reach 15. If we control for the effect of fluctuations in the average winter temperature, the following picture emerges for the period 1633–1759: until 1669 the weather-controlled percentage of travelers who used the trekschuit in the three winter months remained very close to 14.1%. Thereafter came a sudden downward shift. From the 1670s until the 1720s the weather-controlled percentage stays close to 12.6. The 1730s brings with it a second downward shift such that in the last 30 years of this period less than 10.5% of all passengers traveled in the months of December, January, and February.

The unadjusted figures for the winter months underestimate the true decline of winter travel because of the fact that winters in the first half of the eighteenth century were much milder than those of the seventeenth century. The decline is interesting precisely because a rather high demand for winter travel had been such a conspicuous characteristic of Dutch urban society in the mid-seventeenth century, an era of unusually frequent severe winters.

The winter months were not alone in becoming increasingly unpopular with Dutch travelers. The seasonal analysis chart also identifies the spring and fall months of March, April, October, and November as losers. If we group them together, their share of annual travel shows a strikingly steady downward trend that begins already in the 1640s. From in excess of 33% of all travel in the decades before 1660, these months on either side of winter accounted for considerably less than 30% after 1720.

Intercity passenger travel became increasingly concentrated in the remaining five months of the year, May through September, with June, July, and August being the greatest gainer. Until the 1670s this concentration process is not evident. From then until 1700–09 travel in these months is of somewhat greater importance, but only after 1710 does the concentration process intensify. The 1730s form a conspicuous peak in this process, but even when this decade is ignored, the concentration process is impressive. By the 1750s about 60% of all trekschuit passengers travel in the five months from May to September. At the same time the percentage of tollgate receipts collected in the summer also increased. While the three summer months of June, July, and August accounted for
Figure 11.10. Seasonal analysis charts of passenger travel on the Amsterdam–Haarlem trekvaart per decade, 1633–1759.

Each dot represents the average value for a decade. From left to right: 1633–42, 1644–53, 1650–59 ... 1750–59.

Source: See figure 11.1.
less than 30% of receipts until the late 1680s, they accounted for 37% in the 1750s.

Changes in bookkeeping practices introduced in 1760 deny us the possibility of following the course of monthly fluctuations on the Amsterdam–Haarlem route from then until 1806. Then the monthly distribution showed, if anything, a slightly greater concentration of travel in the five summer months than had been evident in the mid-eighteenth century. Indeed, one can argue that the concentration process that began in the late seventeenth century did not reach its peak until the 1840s. When the railroad replaced the trekschuit on the Amsterdam–Haarlem route in 1839, a true year-round mode of transportation had finally been introduced. Not only did the railroad continue to function in freezing weather, but it also made winter travel more bearable by shortening the length of time that travelers had to spend exposed to the elements. It is, therefore, particularly surprising to find that the monthly distribution of railroad passengers in 1840–41 showed a greater concentration of travel in the summer months than had any of the trekschuit distributions (see figure 11.11).

This long-term transformation of the monthly distribution of trekschuit

![Figure 11.11. Average monthly distribution of passenger travel on the Amsterdam–Haarlem route by railroad (1840–41) and by trekschuit (1750–59, 1806–13).](image)

travel was not confined to the Amsterdam–Haarlem route; it characterized urban travel patterns throughout the Republic. The general tendency for intercity travel to be concentrated in the summer months is clearly observable in figure 11.12. The monthly distributions of seven routes were plotted for ten-year periods around 1670 and again around 1740. For each of these periods the upper and lower envelopes of all the distributions taken together were then identified, and are shown by the heavy lines in the figure. Figure 11.12 serves to demonstrate the universality of the transformation sketched for the Amsterdam–Haarlem trekvaart. The most peaked seventeenth-century distribution is here shown to have been more evenly distributed than the least peaked mid-eighteenth-century distribution.

The rural travel pattern, which we can follow through the seventeenth and eighteenth centuries only on the Sneek–Leeuwarden route, shows none of the permutations identified in the urban travel pattern. (See figure 11.13.) The double-peaked monthly distribution of travel between Sneek and Leeuwarden remained essentially unchanged from 1665 to 1761. In the final third of the eighteenth century this long-standing pattern was finally broken. By the 1790s the March/April peak had lost some of its importance and a third (July/August) peak had emerged in the distribution.

% of average annual passenger volume

![Graph showing monthly passenger volume distribution](image)

**Figure 11.12.** Upper and lower boundaries of the composites of average monthly distributions of trekschuit passengers on seven routes, 1660–85 and 1720–59.
The new rhythm of travel on the Sneek–Leeuwarden route bears no particular relationship to the transformation identified in the urban pattern. It does, however, correspond to the late eighteenth-century patterns of other routes that served agricultural areas and small cities. (See figure 11.14.) The Edam/Purmerend–Hoorn routes, where, in the seventeenth century, demand had been very evenly distributed from March to November, showed already by the 1730s a minor peak in May, a second peak, the greatest of all, in the Hoorn kermis month of August, and a third peak in October. In the same period the coach route connecting Hoorn and Enkhuizen displayed an intense form of this same three-peaked pattern. Far from the North Holland peninsula, on the Vianen–Gorinchem route, a three-peaked pattern also emerged in the late eighteenth century. Just as in Friesland, a two-peaked pattern existed in the 1750s, although in this case the peaks came in April and August rather than in March and October. By the 1790s we find a minor peak in May followed by a more pronounced July peak and an equally great November peak.
XI.4. EXPLANATIONS

The development in the eighteenth century of similar seasonal travel patterns on routes in widely scattered parts of the trekvaart network, on routes, moreover, serving areas with highly dissimilar economies, is an intriguing phenomenon. I have been unable to penetrate its mysteries. It seems likely, however, that the explanation is to be found in the character of the local marketing and distribution systems, and, perhaps, the hiring dates for farm servants.

Altogether different is the probable significance of the transformation we have charted in the urban travel pattern. All of the trekvaart routes connecting the major cities of Central Holland and Utrecht were swept along by this transformation of the seasonal rhythm of intercity travel. The transformation began in the late seventeenth century and did not reach its culmination until the nineteenth century, but the first three decades of the eighteenth century accounted for the bulk of the total change in travelers' behavior. The transformation can be summarized as follows: in the mid-seventeenth century the demand for intercity
travel maintained itself on a relatively even level throughout the year. It was, in fact, the need felt by a growing economy for year-round communications that had helped justify the construction of a trekvaart network to contemporaries. By the mid-eighteenth century the distribution of travel - both in the trekschuit and on the towpath - showed a much greater sensitivity to the seasons than it had a century earlier. On the Amsterdam–Haarlem route trekschuit and towpath travel in the three winter months, which in the 1660s had exceeded 50% of the volume of travel in the peak three-month period (June, July, and August), stood by the 1750s at no more than 33% of the peak period. To put it another way, the fall in the demand for intercity travel per trekschuit between the 1660s and the 1750s was not evenly distributed among the months of the year. The barges setting off in the three winter months during the 1750s carried only 49% as many passengers per barge as they had in the 1660s. The barges departing in the spring and fall months of March, April, October, and November carried only 59% as many passengers, while in the five months from May to September the barges continued to carry 72% as many passengers per barge as they had in the 1660s. In short, eighteenth-century travelers showed a marked preference for making their trips in the summer months: they no longer showed much appreciation for that characteristic of the trekschuit that their seventeenth-century ancestors had found so indispensible.

The explanation for this profound change in the travel behavior of urban Dutchmen is not readily apparent. In part because of our inability to specify the relative importance of the various purposes for which people made use of the trekschuiten we are unable to judge definitively the validity of various plausible hypotheses.

One conceivable argument explains the changing pattern of travel demand as the result of the rising relative importance of 'leisure' travel. Presumably, family visits, outings, etc., were made overwhelmingly in the summer months. Thus, as travel for business purposes - supposedly distributed more evenly through the year - declined in relative importance, the concentration of travel in the summer months would increase. We do not know very much about the relative importance of these two basic travel motivations, but there are reasons to suspect that this argument is not correct. It implies that business travel either declined even more rapidly than the overall decline in the travel volume, or that business travel made increasing use of alternative modes of transportation. The first proposition cannot be proved or disproved, but it seems unreasonable to believe that a complete collapse of business travel could go hand in hand with the large-scale development of leisure travel. The belief in a switch of business travelers away from the trekschuiten can be rejected with greater certainty. During the decades that the seasonal distribution changed the most, no evidence exists that a new mode of transportation was attracting the business traveler. On the contrary, the
toll receipts on the towpaths were not only generally declining, they too were showing the same summer concentration as the trekschuiten.

A second hypothesis is that structural changes in the economy were such that industries with a more pronounced seasonal character came to the fore while industries characterized by year-round operations declined. Our problem here is to identify such industries. Did Amsterdam’s financial activities – of growing importance in the eighteenth century – have a more seasonal character than Leiden and Haarlem’s textile industries – both of which were decaying in the eighteenth century?

The absence of evidence that can support these approaches to the explanation of the new seasonal distribution has encouraged me to place my confidence in a third hypothesis. It must be emphasized at the outset that this third approach enjoys no more direct confirmation than the others. It is, on the other hand, compatible with what we know about the eighteenth-century state of the Republic’s economy and the seventeenth-century desire for year-round communications. The transformation of the seasonal distribution of passenger transportation can be viewed as a type of ‘internal contraction’. Johan de Vries, in his study of the economic decline of the Dutch Republic in the eighteenth century observed a tendency to concentrate economic activities in the strongest center of a generally weak economy. For this reason Amsterdam, the strong center, was able to book economic and demographic gains in the face of – or rather because of – economic decay elsewhere. Internal contraction as a spatial phenomenon will be discussed later, but here I wish to argue that internal contraction could also function as a temporal phenomenon. As an economy declines it develops excess capacity. The productive equipment that is first made idle is the least efficient equipment. Similarly, the time in which one first becomes idle is that portion of the year in which productivity is the lowest and operating costs are highest – the winter months. In the pre-industrial economy operations in the winter months can be viewed as a sort of production frontier: when the economy is booming and one is straining to keep pace with demand, the suppression of seasonal unemployment is a means to achieve increased production. The absence of technological developments that can increase productivity makes this means all the more important. But the production growth is achieved at a cost, and when demand is soft and one takes steps to contract the scope of one’s economic activities, the relatively expensive and uncomfortable wintertime operations are likely to be the first to go.

This concept of internal contraction as a temporal phenomenon has yet to be supported with direct evidence from the Dutch economy. If it proves to be an accurate identification of economic behavior, the seasonal distribution of intercity travel can serve as a valuable indicator of the extent to which resources were being utilized fully. In the case at hand, the consecutive ten-year distributions describe a mid-seventeenth-century
urban economy straining to extract more output from the available resources, and then traces the economy to its ‘relaxed’ mid-eighteenth-century posture, characterized by a widespread under-utilization of resources. This under-utilization may well have become even more severe by the mid-nineteenth century, for then the seasonal distribution of intercity travel (by then on the railroads) had reached its extreme point of inequality. It may be no accident that just then a government report described the extent of winter unemployment and its consequences in the following shocking terms:

A great obstacle to the steady development of industry and crafts is the almost total standstill to which work comes in the winter months. In the spring and the first summer weeks there are almost no workers to be found who are in a state to satisfy the demand [because of malnutrition?]. The employers are often forced to attract labor from outside [abroad?]. These workers, who are mostly unmarried, stay on once they have settled in a large municipality, and compete with the local inhabitants for that small amount of winter work that has to be done. For both groups this is very undesirable situation.

XI.5. DAILY FLUCTUATIONS

At the risk of trying the reader’s patience I wish to draw attention to one last periodic fluctuation in the travel behavior of seventeenth- and eighteenth-century Dutchmen: the daily fluctuations. My interest in examining the rhythm of trekschuit travel within the course of a week was stimulated by the discovery that Sundays were no different from other days on the trekvaarten: almost all trekvaart ordinances stipulated the same schedules for Sunday as for the other days of the week. Did this in fact imply that seventeenth- and eighteenth-century Dutchmen set off on intercity trips as frequently on the Sabbath as on any other day of the week?

One need not believe that this religion-saturated society succeeded in imposing strict Sabbath observance still to be surprised by the prospect of 6500 urban Dutchmen sitting in trekschuiten on a typical mid-seventeenth century Sunday? Did this really happen? The account books of most trekvaarten present nothing more detailed than monthly figures, but the records kept by the commissioners and the skippers (which formed the basis for the monthly and annual accounts) offer data on a daily, even hourly basis. These records have only rarely been preserved, and are often difficult to use, but for the double route from Leiden to Delft and The Hague they are available for most years from the 1650s to the end of the eighteenth century. The influence (or absence of influence) of Sabbath observance on trekschuit travel can thus be identified over a 150-year period. Such a long series can also contribute to the answer of another out-
standing question: the relative importance of leisure versus business travel. Assuming that Sunday travelers were primarily leisure travelers, a time series tracing the relative importance of Sunday travel over a long time period could add detail to our picture of trekschuit users and their travel motives.

Because these calculations are exceedingly time-consuming, Sunday travel on the Leiden—Delft and Leiden—The Hague routes has been isolated for only eight years between 1659 and 1790. The results are summarized in table 11.1, which expresses the number of Sunday travelers as a percentage of all travelers. If trekschuit users distributed their trips among the seven days of the week (i.e. if they were indifferent to travel on Sundays), 14.3% of all trips would have fallen on each day of the week, including Sunday. The table shows that the incidence of Sunday travel never varied far from this ‘indifference’ level. If the table had begun with 1677 the incidence of Sunday travel would have shown a slow, steady increase which might be interpreted as an indication of secularisation, but the extent of the change is, in fact, very small, and in the case of the Leiden—Delft route no greater than the decline in Sunday travel between 1659 and 1677. Our conclusion must be, therefore, that throughout the seventeenth and eighteenth centuries Sunday on the trekvaart was no different from any other day, and that no strong trend is apparent to support the view that leisure travel became substantially more important in the eighteenth century than it had been in the seventeenth.

TABLE 11.1. Percentage of passengers traveling on Sundays in selected years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Leiden—Delft</th>
<th>Leiden—The Hague</th>
</tr>
</thead>
<tbody>
<tr>
<td>1659</td>
<td>15.3</td>
<td>13.7</td>
</tr>
<tr>
<td>1677</td>
<td>12.9</td>
<td>12.1</td>
</tr>
<tr>
<td>1709</td>
<td>12.9</td>
<td>13.4</td>
</tr>
<tr>
<td>1720</td>
<td>13.3</td>
<td>14.2</td>
</tr>
<tr>
<td>1730</td>
<td>13.4</td>
<td>14.2</td>
</tr>
<tr>
<td>1770</td>
<td>14.0</td>
<td>15.7</td>
</tr>
<tr>
<td>1780</td>
<td>15.2</td>
<td>15.5</td>
</tr>
<tr>
<td>1790</td>
<td>15.1</td>
<td>15.6</td>
</tr>
</tbody>
</table>

CHAPTER XII

THE STRUCTURE OF THE URBAN SYSTEM

The quantitative data assembled for this study have thus far been subjected to a time series analysis to identify trends, cyclical fluctuations, and shorter-term seasonal and daily fluctuations. Because the data consist of a relatively large number of separate time series, they can also be used to describe the character of the network that generated them. Until now we have focused on the changes in the rate of flow and in pulsations on the individual routes and for the network as a whole. Now we will consider the division of the total ‘flow’ of passengers among the routes of the network and changes in that division.

The extent to which the cities of central Holland – the modern day ‘Randstad’ – functioned as a single urban system is a subject that has been touched upon earlier in this study (see, particularly, chapter II), but here I aim to provide a summary of the overall evolution of this urban system as it was reflected in the flows of passenger traffic between the member cities.

XII.1. 1632–1656: AUTONOMOUS REGIONAL SYSTEMS

The first boom in trekvaart construction in the 1630s and 40s concentrated on the establishment of links serving short-distance traffic between regional capitals and nearby satellite towns. As we have seen in chapter II, four regional trekvaart networks came into existence in this period. This does not mean that long-distance travel between the regions did not exist, since the beurtveren maintained sailboat connections between most cities. But, apparently, long-distance travel had not assumed such a volume that it warranted the investment of hundreds of thousands of guilders in new trekvaarten. At that date only short-distance travel was capable of attracting capital on such a scale: a single urban region had not yet come into existence.

XII.2. 1656–1665: THE ACHIEVEMENT OF A SINGLE SYSTEM

The second boom in trekvaart construction, launched in the mid-1650s, forged together the Republic’s four regional trekvaart networks into a single transportation system. In the Holland–Utrecht region this was achieved by the construction of three routes whose viability hinged almost entirely on the existence of a large demand for travel beyond the cities that they directly connected: these were the Haarlem–Leiden,
Amsterdam—Gouda, and Leiden—Utrecht trekvaarten.

The growth of Amsterdam from a city of about 100,000 inhabitants in the 1620s to a city of nearly 200,000 in the 1660s obviously did much to increase the demand for long-distance travel, but Amsterdam’s growth by itself does not suffice to explain the development at hand. The cities of South Holland – particularly The Hague and Rotterdam – were also growing in this period and their growth seems to have been characterized by a growing interdependence with Amsterdam rather than a growing competitiveness with her. This combination of general urban growth and the specific rise of strong ties of interdependence between cities at opposite ends of the urban system accounts for the intense interest in trekvaart routes catering to long-distance traffic in the 1650s and the completion – despite imposing political obstacles – of a well-integrated passenger transportation system by the mid-1660s.

The gravity model used in chapter IX can offer an insight into the impact of urban population growth in this period on the decisions to go ahead with the construction of these routes. The total population of the cities of central Holland and Utrecht grew by 50 percent between the census of 1622 and the 1660s. But, just as the demand for intercity passenger travel declined more rapidly than urban population after the 1660s, it must have grown much more rapidly in the earlier decades. If we assume for a moment that the trekvaart network had existed in 1622, and that (just as in the 1660s) a distance exponent of 2.0 had characterized the traffic flows, the gravity model would predict a 100% increase in the demand for intercity passenger travel – double the rate of population growth. Since, in fact, the trekvaart network did not yet exist in 1622, and since economic growth is also likely to have contributed to the demand for intercity travel, we can readily believe that the decision to continue with the construction of trekvaarten took place in an environment of rapid growth in the demand for travel.

XII.3. 1660–1700: THE URBAN SYSTEM AT ITS PRIME

From the trekvaart network’s completion until the beginning of the eighteenth century the cities of Holland and Utrecht functioned in the context of a true urban system. The scatter diagram of the actual passenger volume on various routes compared to the gravity model’s estimated passenger volume identifies certain city pairs with above average and others with below average interaction. (See figure 9.11.) But, the most important message conveyed by the gravity model results in this period is that the traffic on most routes bears some relation to the volume predicted on the basis of city population and distance. The good fit achieved by the model is an indication that none of the cities was conspicuously isolated or overwhelmingly dominant. The existence of a
well-integrated urban system is only imperfectly demonstrated by the fact that the distance exponent of the gravity model is lower in 1660 and 1700 than it is later in the eighteenth century. More telling is the keen interest shown by trekvaart officials in the co-ordination of schedules on the various routes to provide convenient services for long-distance travelers. Examples of these connecting schedules were provided in chapter III. Another device to facilitate long-distance travel was the coordination of morning schedules with the arrival of night barges.

A glimpse into the nature of the market for these services is provided by the records of the Amsterdam—Gouda route. When the Gouda—Rotterdam road was paved in 1680, coaches covering the 21 kilometer distance in two hours connected at Gouda with the overnight barges to and from Amsterdam. Suddenly, travelers between Amsterdam and Rotterdam found the Gouda route an attractive alternative to the route via Haarlem, Leiden, etc. Immediately, the number of passengers on the Amsterdam—Gouda route jumped by an annual average of 8000 over the preceding decade.

The relative importance of long-distance travel in the second half of the seventeenth century may well have increased. We have no direct evidence to isolate the number of passengers traveling between, say, Amsterdam and Rotterdam. But we can get a hint of the evolution of such traffic by examining the number of passengers arriving at the gateway cities of Leiden and Gouda. Travelers from North Holland, Amsterdam and Haarlem to South Holland cities such as The Hague, Rotterdam, and Dordrecht, had to pass through these two gateways. From the north these gateways were served by trekvaart routes 2, 10, and 11. If we total the passengers on these routes and compare them with the overall volume of travel on all routes in central Holland (as recorded in table 9.3, column 1) we find that while total volume fell by 31% between the 1660s and the first decade of the eighteenth century, travel volume on these three routes fell by only 23%. Indeed, the number of passengers carried on routes 10 and 11 — predominantly long-distance overnight travelers — did not decline at all. These were the only routes in the entire Republic where volume was as high in 1700 as it had been in the 1660s.

XII.4. 1700—1750: THE URBAN SYSTEM IN DISSOLUTION

The trekvaart statistics for the first half of the eighteenth century show a system in dissolution. It became increasingly more difficult to speak of a coherent, interrelated network as the fortunes of the individual routes came to diverge strikingly from one another. This process of dissolution has already been introduced in chapter IX, where we found the gravity model to assume a higher distance exponent between 1700—10 and 1740—50. In addition, the model was able to explain less of the devia-
tion in passenger volume among the various routes than had been achieved in 1700-10. Communications with certain cities, most notably Delft, Leiden, and The Hague, fell far below the expected level, while communications with other cities far exceeded expectations. In general two trends seem to have been at work: long-distance travel was becoming relatively less important, and Amsterdam was asserting its dominance over what remained of an urban system. With regard to the first point we can look again at the volume of traffic through the gateway cities of Leiden and Gouda. While such traffic had increased in relation to the overall volume of traffic between the 1660s and 1700s, its experience in the following 40 years was just the reverse. Moreover, the percentage of travelers reaching Leiden who proceeded to Delft and Rotterdam must have fallen even more, for the Leiden-Delft route declined more in this period than any other route in the Dutch Republic.

The greater than average decline of travel between Amsterdam and Rotterdam cannot be verified with direct evidence, but the relative decline of gateway traffic, the withering of the Delft-Leiden route, and the suspension of night barge service on the Haarlem-Leiden-Delft route in 1729, all point in this direction.

The relative decline of long-distance travel is indicated more directly by the passenger data of the Amsterdam-Hoorn trekvaart. Since the trekvaarten connecting these cities were divided for operational reasons into five separate mini-routes, it is possible to identify the number of passengers departing Amsterdam, those arriving at Hoorn, and the net number leaving the trekschuiten at the intermediate points of Monnikendam, Edam, and Purmerend. (This last little city was more important than its size alone would suggest because it functioned as a departure point for travelers to Alkmaar.) From 1667 until 1703 the number of passengers on the segments of this route ending in Hoorn stood at a steady 48 to 52% of the passengers on the segments of this route ending at Amsterdam. By the 1740s this percentage had fallen to the 37-40% range.

The second trend evident in this period of declining passenger volume is the increasing concentration of the remaining traffic of the network as a whole on the routes that connect directly with Amsterdam. This phenomenon has just been described for the Amsterdam-Hoorn route, but it was in fact a general phenomenon. The sharp increase in the population exponent between 1700s and 1740s that was derived in the first application of the gravity model to the trekschuit data in chapter IX is a comprehensive indicator of this development. If we calculate the passenger-kilometers produced by routes 1, 7, 8, 10, 11, 16, and 17—all of which have Amsterdam as an end point—and compare that figure to the passenger-kilometers produced by the remaining routes of the Holland-Utrecht region, (figures are available for routes 2, 3, 4, 5, 13, 18, 19, and 20) the striking fact emerges that the first group declines by
29% between 1700-10 and 1740-50 while the second group declines by 44%. (This result is achieved despite the fact that two of the Amsterdam routes [10 and 11] suffer badly in this period from the collapse of long-distance travel.)

XII.5. 1750-1800: THE DEVELOPMENT OF A DUAL-CENTERED URBAN SYSTEM

By the mid-eighteenth century the dissolution of the urban system had reached its nadir, and the primacy of Amsterdam had attained its high point. Thereafter the only new development was the evolution of Rotterdam as a central city in its own right. While its growth in the seventeenth century had taken place in the context of close association with Amsterdam - to judge from the flow of passenger traffic between the two cities - Rotterdam's late eighteenth-century growth occurred in rivalry with or at any rate in the absence of strong associations with Amsterdam. The volume of passengers on the Rotterdam-Delft (and thus to The Hague) route rose by some 30% in the second half of the eighteenth century, but none of this traffic growth was registered on the routes connecting Rotterdam with the cities to the North. Instead one sees in these decades the establishment of new passenger routes connecting Rotterdam to such cities as Brielle, Maassluis, Antwerp, and Nijmegen.³

A precise date when one can begin describing the Netherlands as split into two urban regions, one centered on Amsterdam and the other on Rotterdam, cannot be identified, but the pattern of passenger travel on the HYSM railroad in the 1850s (see chapter IX) clearly reflects the existence of such a split.

XII.6. THE STRUCTURE OF THE URBAN SYSTEM AS SHOWN THROUGH MIGRATION STATISTICS

We can conclude this reconnaissance of the structure of the Holland-Utrecht urban system in the seventeenth and eighteenth centuries by comparing our often indirect evidence with the pattern of migration to Amsterdam that can be read from the migration data published by Dr. Simon Hart.⁴ Under the assumption that the cities from which many of Amsterdam's migrants came were also cities whose other associations with Amsterdam were strong, and vice versa, this migration evidence, available for 25-year periods throughout the seventeenth and eighteenth centuries can help identify the evolution of Amsterdam's pattern of relationships with the other cities of the Holland-Utrecht region. The data published by Dr. Hart show that Amsterdam attracted migrants from every corner of the Republic, from neighboring countries, and
from Scandinavia. The present study will confine itself to the 11 largest cities of the Holland–Utrecht region.

The pattern of migration, just as the pattern of passenger travel, can be studied in the context of a gravity model. The number of migrants from a given city to Amsterdam obviously bore some relationship to the population of the city in question and its distance from Amsterdam. (The population of Amsterdam, since it is common to all the relationships, can be left out of this model. The model in this form is actually a 'potential' model rather than a true gravity model.) The distance exponent in this case is likely to be much lower than was found when the gravity model was applied to passenger transportation. The burden of travel costs and travel time in relation to the results is obviously much less in the case of migration than in the case of a brief trip. In effect, time and cost offer less resistance to the migrant than to the short-term traveler.

In cross-section analysis a distance exponent of 1 yields a substantially higher correlation coefficient than either 1.5 or 2. This parameter value is then applied to the equation

\[ M_i = \frac{P_i}{d_i^b} \]

or, in logarithmic form

\[ \ln M_i = \ln P_i - b \ln d_i, \]

where \( M_i \) = the number of migrants to Amsterdam from city \( i \)
\( b \) = the distance exponent
\( d_i \) = the distance from Amsterdam to city \( i \)
\( P_i \) = the population of city \( i \).

Table 12.1 presents the results of this analysis for the three periods 1651–75, 1726–50, and 1776–1800. For each city I have calculated a ratio of the actual number of migrants in the 25-year period (\( M_i \)) and the estimated number of the migration model (\( \hat{M}_i \)). In the table this value (\( M_i/\hat{M}_i \)) is expressed as a percentage of the average ratio for all 11 cities: \( \frac{\sum_{i=1}^{11} (M_i/\hat{M}_i)}{11} \). This ratio shows at a glance those cities whose migration to Amsterdam exceeded and those whose fell short of the average (which takes the value of 1.0).

A clear-cut pattern of strong and weak relationships emerges from the application of a migration model to this evidence. The cities of the North Holland peninsula all exhibited weaker than average relationships with Amsterdam, a relationship which only became weaker yet in the course of the eighteenth century. In 1651–75 the eight cities to the south of Amsterdam were divided into four with strong and four with weak relationships with Amsterdam. The Hague, the seat of government, sent migrants to Amsterdam at twice the expected rate. This was a durable relationship that persisted throughout the eighteenth century. In 1651–75 the eight cities to the south of Amsterdam were divided into four with strong and four with weak relationships with Amsterdam. The Hague, the seat of government, sent migrants to Amsterdam at twice the expected rate. This was a durable relationship that persisted throughout the eighteenth century. Utrecht, for reasons that are not so evident, also sent migrants to Amsterdam at far above the average rate in all three of the periods of this exercise. The
absence of annual statistics for the Amsterdam–Utrecht trekvaart has made it impossible to say very much about the role of Utrecht in the Dutch urban system. But, as I have observed elsewhere in this study, every glimpse afforded us by the evidence shows Utrecht to be of inordinate importance.7

The remaining cities from which an above average number of migrants were attracted to Amsterdam in the mid-seventeenth century were Rotterdam and Dordrecht. But in their cases the eighteenth century brought changes. By the 1726–50 period their relationships were only modestly above the average, and at the end of the century Amsterdam no longer attracted many migrants from these cities. This evolution of migration is in conformity with the indirect evidence we have pieced together concerning the evolution of long-distance trekschuit transportation between these port cities: the seventeenth-century growth of Rotterdam was complementary to Amsterdam and generated a large demand for travel between the two cities, while the late eighteenth-century growth of Rotterdam was more independent, and raised Rotterdam to the status of a rival urban center.

The four remaining cities have in common the fact that Amsterdam never succeeded in attracting from them large numbers of migrants (holding constant their size and distance from Amsterdam). They were the industrial cities of Holland: Haarlem, Leiden, Delft, and Gouda. Their specifically industrial character probably played a role in making Amsterdam an unattractive place to seek one's fortune. The migration evidence in this case may not correspond well with the flow of passengers between Amsterdam and these cities. But it is worth noting that the mid-nineteenth-century volume of railroad passengers between Amsterdam and three of these cities was also conspicuously weaker than predicted by the gravity model.8

| Table 12.1. Marriage migration to Amsterdam: ratio of the actual number of migrants to the number estimated by the migration model. |
|---|---|---|---|
|   | 1651–1675 | 1726–1750 | 1776–1800 |
| Haarlem | .60 | .40 | .63 |
| Leiden | .69 | 1.06 | 1.00 |
| The Hague | 2.02 | 1.78 | 1.95 |
| Delft | 1.06 | .77 | .79 |
| Rotterdam | 1.73 | 1.39 | .89 |
| Dordrecht | 2.03 | 1.32 | .79 |
| Gouda | .71 | .47 | .50 |
| Utrecht | 2.06 | 1.78 | 1.56 |
| Hoorn | .57 | .56 | .52 |
| Enkhuizen | .85 | .77 | .63 |
| Alkmaar | .98 | .63 | .65 |

XII.7. Summary

The seventeenth- and eighteenth-century evolution of the Dutch urban system passed through several stages that each found its reflection in the changing pattern of demand for intercity passenger transportation. In the early seventeenth century one cannot yet speak of an urban system. The economy of each large city still showed a high degree of autonomy. In the field of transportation this autonomy expressed itself in the establishment of beurtveren and market boats to serve the city markets, and in the construction of short-distance trekvaarten to draw nearby satellite towns closer to the regional center. In these respects the Dutch cities functioned just as cities elsewhere in Europe.

The development of the Dutch economy in the first half of the seventeenth century had the unique geographical result of forging the several relatively autonomous municipal economies into a single urban system. The intense demand for communications between these now interdependent cities took expression in the construction of the trekvaart network, a technology which acted to reinforce the integration of the urban system. This achievement, with cultural and social as well as economic ramifications, has not passed unnoticed in earlier historical studies of the Dutch Republic and lives today in the unique form of Holland's metropolitan region, the Randstad.9 It should be noted, however, that a flourishing, integrated urban system was as perishable as it was unique. In the first half of the eighteenth century the level of contact maintained between the member cities diminished, while one city, Amsterdam, drew to itself much of the activity that had previously been carried out throughout the urban system. In the second half of the eighteenth and early nineteenth centuries this partially dissolved urban system was further transformed by the rise of Rotterdam as a second central city. Not until the twentieth century could one again describe the cities of Holland and Utrecht as members of a single urban system.
CHAPTER XIII

OVERVIEW

The hardy traveler whose mid-seventeenth-century voyage from Dunkirk to Groningen served as an introduction to the unique passenger transportation system of the Low Countries has long been forgotten. This study has pursued, perhaps too relentlessly, the goal of reducing a living institution — with its skippers, jockeys, helpers, toll collectors, ditchdiggers, stable boys, and municipal commissioners — to a succession of tables, graphs, models, and equations. This path has been followed in order to gain a rare and valuable type of insight into a pre-industrial economy. But I am prepared to concede that another kind of insight is thereby neglected. It is the insight into the unique society of the Dutch Republic that one could acquire by stepping aboard a trekschuit for a five or six hour trip, and making the acquaintance of a Leiden University student traveling home at the end of a term; a beurs-bound Gouda merchant trying to sleep on the straw-covered benches of the night barge to Amsterdam; a North Holland sailor en route to Amsterdam, there to embark on a ship to the East Indies; a clerk of the VOC traveling to Hoorn to handle bookkeeping problems associated with the equipping of the September fleet; a Gorinchem girl on her way to enter household service in the townhouse of an Utrecht nobleman; a German peasant who, after picking up casual work on the way, walks to Naarden, where he begs a ride on the trekschuit on the last lap of his migration to Amsterdam; a party of Portuguese Jews who board a trekschuit for Naarden in order to attend the burial of a friend at the Jewish cemetery at Muiderberg; a minor municipal official of Amsterdam whose curiosity to see a stranded whale compels him to board the trekschuit to Haarlem on the first leg of his trip to Zandvoort; a Delft baker’s apprentice and his servant girl fiancée who board the trekschuit for a day at the Hague kermis; a Haarlem rentier who reserves the entire roef to travel with his family to Utrecht, to make his annual visit to his brother-in-law; a young Englishman on the grand tour making the rounds of all the Dutch cities to visit the churches and wonder at the town halls; a Groningen bricklayer who boards an early morning trekschuit to Zuiderbroek to work on the repair of the municipally-owned sluices; or a Anabaptist preacher who sets out to assume the functions of a sick colleague in Harlingen.

Precisely because the trekvaart network assumed such a central place in Dutch society, and fulfilled its varied functions in a technologically and organizationally stable environment for so long, I have felt encouraged to treat it from several perspectives. Because the types of questions asked and techniques applied in the quest to squeeze answers out of the historical data have been so varied, it is desirable to close this study with an over-
view of the chief findings of the three parts into which it has been divided.

The foremost purpose of Part I was to sketch the character of passenger transportation in the pre-railroad age, and to call attention to the unique characteristics of the trekvlaart network within that context. Seen from this perspective, the history of the trekvlaart network raises a series of interesting questions whose answers can contribute to a better understanding of Dutch urban society in the Golden Age. Why, to begin with, did mid-seventeenth-century urban Dutchmen so intensely desire an improvement in passenger transportation? And, how was it possible that such a well-designed, highly-connected network could come into being in the total absence of central direction?

An explanation of 'desire' can never hope to satisfy entirely, but our investigation found the most frequently recurring theme in the writings of contemporaries to be the need for dependability. A degree of insulation from the effects of weather, tides, and seasons, and an ability to estimate one's travel costs to the last penny were the most appreciated characteristics of the trekschuit. Economic growth seemed to impose on seventeenth-century Dutchmen elements of a Weberian rationalization of life that included a new appreciation for the modern concept of time as a commodity. It seems likely that it was not, as is sometimes supposed, the Industrial Revolution, *per se*, that imposed these new forms of rationalization on society. Prior eras of economic growth educated contemporaries to the fact that regularity and punctuality offered important economic benefits. Society moved in this direction not because a new technology demanded it and made it unavoidable, but because this form of rationalization, in and of itself, was a source of economic growth.

How a nation of nearly autonomous cities could build a true network is a second important question. The network's construction history was not without its delays and needless costs, but a network was built, and this finds a large part of its explanation in the coming-into-being in the course of the first half of the seventeenth century of a true urban system. The society enjoyed the benefits of multiple initiative-takers, and, in a competitive environment, their selfish initiatives could achieve the end result of a true, integrated transportation network.

This result was unplanned, but not unimportant, for the growing interdependence of the Dutch cities required the creation of a transportation system very different from the beurteveer services which served each city as an isolated economic entity.

The organization of space made possible by the trekvlaart network further stimulated the consolidation of an urban system; moreover, the structural features of the network, as they existed for nearly 200 years, help to explain several unique characteristics of Dutch society. A 'time frame' was created which, by its stability, permitted the development of 'modern' notions of time, distance, and the role of these two concepts in economic life. The comparatively low cost of intercity transportation
endowed the regions served by the trekvaart network with a physical mobility that probably existed nowhere else before the railway age. Moreover, that mobility extended down the social ladder even to the poor. Finally, the social implications of the trekschuit derive not only from the provision of mobility to a mass public, but also from the bringing together in a single space for long periods of time a socially varied group of people.

In Part II, the trekvaart network was examined from the perspectives of business history. The questions asked here flowed from the observation that the construction and maintenance of trekvaarten and the operation of trekschuiten brought together a combination of characteristics that are generally regarded as highly unusual before the development of the first 'big business', the railroads. That is, the trekvaart network was conspicuous in a pre-industrial economy for its large requirement for fixed capital investment, its need for a large, relatively specialized labor force, its need to supervise and coordinate activities spread over a large geographical area, and its production and sale of a service that catered to a mass market.

What economic concepts and organizational forms did seventeenth-century Dutchmen seek to apply to an economic activity with such characteristics? Can their conduct be called capitalist? Did they succeed in fully exploiting the capabilities of the technology entrusted to their care? What were the financial results of the trekvaart industry and to whom did the profits accrue? These questions do not exhaust the issues that were dealt with in Part II, but, by way of summary, I will concentrate here on the central finding that the organizational forms, bookkeeping practices, and managerial policies applied to the trekvaart industry suited neither the needs of the technology nor the stated aims of the owners and operators (the cities). Despite the importance of capital to the creation of the trekvaart industry, its operation cannot be described as capitalist, and, the rationalizing influence that trekschuit service had on the society notwithstanding, its operation often appears to have been highly irrational. The trekvaart-owning cities turned to long-existing institutions - municipal administration and guilds - to administer and operate the trekschuit service. These proved unable to function with the market responsiveness, operational flexibility, and sensitivity to the function of capital investment that the technology required for its successful exploitation. We have here a case of a technology that did not get the organizational form that it required. The consequences of this failure became particularly apparent as the industry declined in the eighteenth century.

A consequence of the organizational forms applied and the economic attitudes with which the trekvaart industry was managed, was the obfuscation of its true financial position. Since the administrators kept no capital accounts, they could not follow the profitability of their cities' investment of, all together, nearly five million guilders. In retrospect it is
possible to calculate route profitability, and several routes were reason-
ably profitable, at least in the seventeenth century. But more interesting
than this fact is the consequence of the division of responsibility of the
financial results between the capital-investing cities and the skippers’
guilds that provided the trekschuit service. Many of the guilds enjoyed,
so long as the demand for trekschuit service remained strong, extremely
high profits. Consequently, the trekschuit skippers formed a group of part
businessmen-part manual workers whose annual incomes in decades of
prosperity could approach those of occupational groups with much higher
social status. On the other hand, in decades of economic decay, their
annual incomes were barely distinguishable from those of their own hired
hands. Worse still, they were caught between their financial responsibility
for the skippers’ guilds on the one hand and the municipal regulations that
prescribed their conduct and, in large measure, their costs of operation, on
the other. The windfall profits which that position could give them in good
years could easily turn into unbearable losses when demand declined.
From this situation only the municipal governments could offer relief.

The organizational weaknesses and policy errors that hobbed the
ability of the trekvaart technology to contribute fully to the economic
well-being of Dutch society can be attributed in part to the peculiar form
of municipal government in the Dutch Republic. But it would be an error
to stop here; the peculiar features of a pre-industrial mass transportation
network should not be permitted to obscure the fact that the history of the
trekvaart industry illuminates general problems of transportation policy-
making in a regulated setting. Finding the right organizational form and
the right scale of operation has also bedeviled railway, road, and airline
operations in many countries, and regulators have had persistent problems
in identifying real rather than imagined needs and serving the traveling
public rather than the convenience of the operators and other special
interests. The trekvaart industry suffered from types of mismanagement
that have been common ever since. They can be found anew – and for that
reason with less excuse – in the policies governing, among others, Dutch
local bus operations, the Belgian national airline, and the United States
railroad system.

In part III I analyzed the quantitative data regarding passenger travel
on the Dutch trekvaart network. After reviewing the passenger volume
data brought together in figures 9.1 through 9.6, no reader will wish to
quarrel with the statement that the trekvaart industry experienced a
profound decline between the 1670s and 1740s. But the purpose of Part III
is not to study the fortunes of an industry. Rather, it is to identify and
analyze the trends, cycles, and structures of an entire urban economy.
The existing literature on the state of the Dutch Republic’s economy
in the seventeenth and eighteenth centuries does not speak with a single
voice on the question of growth and decline. In fact, only the recent
works of Van der Woude and Faber are compatible with the conclusions
reached here. It seems advisable, therefore, to review the findings of the just-completed quantitative study and bring them together into a single picture of the Dutch urban economy between the mid-seventeenth and mid-nineteenth centuries.

The first task of Part III was to justify the use of trekvaart statistics as a general indicator of economic activity. To do this it had to be shown that the industry was sufficiently large to register conditions in many sectors of the economy, and that the demand for trekschuit service was not highly sensitive to factors specific to the industry (such as competition with other modes of transportation). The available evidence justifies our confidence that the distortions embedded in the trekschuit statistics are not serious, and that fewer problems adhere to its use as an indicator of economic activity than to the other quantitative evidence on which economic historians have hitherto been forced to rely.

The central finding of this quantitative study is a sharp economic decline that sets in during the 1670s and reaches a low point in the mid-1740s. Before the 1670s the economy had been growing—albeit in the context of pronounced cycles—and from the 1740s until 1806 one can speak of modest growth or, at worst, stagnation. The decline of 1675–1745 can in fact be divided into two segments with the brief revival of the 1690s acting as the breaking point. While the first period of decline occurred in the context of a sharp cyclical movement and was felt with similar severity by nearly all important routes, the eighteenth-century decline was persistent, without pronounced cycles, and did not assume as extreme a form around Amsterdam as it did elsewhere.

The decline in per capita income identified in the analysis of chapter IX was about the same in the two periods, but there is reason to believe the second period was the more severe, or perhaps one should say, the more definitive in its effects. In the first 50 years of the eighteenth century the ability of the gravity model to explain variations in the volume of travel among the various trekvaart routes and the relative importance of long-distance travel both decline. These I interpret as symptoms of the dissolution of the well-integrated urban system that had been characteristic of the mid-seventeenth-century economy. At the same time the seasonal distribution of passenger travel became highly concentrated in the summer months. The disappearance of relatively steady, year-round demand for intercity communications, another hallmark of the mid-seventeenth century, I interpret as a symptom of an economy suffering from a high degree of under-utilized capacity. The decline of the economy in the first half of the eighteenth century is characterized by temporal and spatial internal contraction. Just as the strongest urban economy, that of Amsterdam, tended to draw what was left of the Republic’s economic strength to itself, so the optimal months for communications tended to draw to themselves the remaining demand for intercity transportation. Finally, the changing character of the annual fluctuations
in travel volume also hint at economic decline. Business cycle analysts hold that fluctuations of small amplitude and short duration—such as became common in the early eighteenth century—are symptomatic of a lack of integration among the sectors of an economy.

In summary, the impressive thing about the quantitative evidence analyzed here is how it displays symptoms of decline in all its dimensions—in the analysis of trends, cycles, seasonal patterns, and network structure. In all of these respects the first half of the eighteenth century stands out as the period of the most intense decay.

These findings do not permit us to speak of mere relative decline, of an economy standing still while others pass her by. My effort to identify that portion of the decline of trekschuit travel explained by a reduced per capita income could not attain a level of precision sufficient to justify actually estimating the amount by which income declined. But the extent of decline to be explained is sufficiently large to warrant the conclusions that the real income loss was probably substantial. From what we know of wage rates and prices in the period 1670–1740 the real earnings of the fully-employed almost certainly rose in this period. Therefore, it seems highly likely that the decline in real per capita incomes took the form of unemployment and (for the many piece-rate workers, such as the trekschuit crew members) underemployment. It also follows that the growth of unemployment exceeded the rate of real income decline.

The Republic continued to be a rich country long after it had ceased being a prosperous country. The capital stock that had been accumulated in the seventeenth century continued to exist and to furnish income to its owners. But it did not furnish employment. For those sectors of the economy that made intensive use of urban labor, and for the laborers themselves, the period 1675–1745 brought a decay of such proportions that it transformed many of the most basic structural features of the Republic’s economy and society.

The fact that the Dutch economy fell into a decline shortly after the completion of the trekvaart system does not, of course, imply the existence of a causal relationship. On the contrary, I have sought to treat the volume of trekschuit travel as a reflection of more general economic conditions. Nonetheless, the fact of conjuncture does suggest the desirability of critically re-examining the transport-centered theories of economic growth that frequently find favor in economic development policy-making and that are commonly invoked to account for the past growth of western economies. Specifically, the Dutch experience should make one question the amount by which canal construction in eighteenth-century Britain could have contributed to her rapid economic growth. It does seem likely that the canal system affected the level of economic performance (even after its decline, the level of Dutch GNP probably remained above most other European economies); whether the existence of a canal system could affect the rate of economic growth (i.e., could set in motion a process
of long-term growth) is another, much more dubious proposition.

A second important result of this quantitative analysis is the identification of the 1740s as a turning point in the Republic's economic fortunes. The increase in the volume of intercity travel that was recorded on nearly every route in the second half of the eighteenth century was not large enough to warrant the conclusion that real per capita incomes rose. But there was, at any rate, no further decline. Here, again, the cyclical and structural characteristics confirm the conclusions drawn from the study of the long-term trend. Since most studies of the eighteenth-century Dutch economy identify serious decline as beginning sometimes after 1740 or not until after the outbreak of the disastrous Fourth Anglo-Dutch War in 1780, our findings deserve emphasis. The traditional historical linkage of the political collapse of the Republic with its economic collapse is in need of revision. This does not mean, of course, that the Dutch economy's difficulties were behind her after the 1740s. The post-1750 stagnation shown by our figures stands in sharp contrast to the vigorous new growth being experienced in much of the rest of Europe. In this period the concept of relative decline is likely to be of use in examining the political and economic problems of an immobilized society in a newly dynamic world.

One final finding of this study – presented in chapter VIII – is that this immobilization persisted until well into the nineteenth century. The coming of the railroad did not radically alter the long-established travel patterns of the trekvaart network. On the contrary, in the Netherlands probably more than anywhere else in Europe one can speak of a structural continuity from the eighteenth century until after the mid-nineteenth century. Using two formulations of the concept of 'social saving', I estimated the trekvaart network's contribution to gross regional product in 1670 and that of the railroad (in its capacity as a passenger carrier) around 1850. The results showed railroad social saving to have been exceedingly modest and less than trekvaart social saving had been two centuries earlier. We have here a clear illustration of the problems of technological obsolescence and structural inertia that confront 'pioneer' economies. The final contribution of the trekvaart network to the Dutch economy was, in effect, to weaken the railroad's ability to modernize the economic structure and stimulate new patterns of urban development.
# APPENDIX

Key to the identification of passenger transportation routes in the Dutch Republic

<table>
<thead>
<tr>
<th>Route number</th>
<th>Cities connected</th>
<th>Principal coach routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amsterdam-Haarlem</td>
<td>Hoorn-Enkhuizen *</td>
</tr>
<tr>
<td>2</td>
<td>Haarlem-Leiden</td>
<td>Hoorn-Medemblik</td>
</tr>
<tr>
<td>3</td>
<td>Leiden-The Hague/Delft</td>
<td>Amsterdam-The Hague *</td>
</tr>
<tr>
<td>3a</td>
<td>Leiden-The Hague</td>
<td>Gouda-Rotterdam *</td>
</tr>
<tr>
<td>3b</td>
<td>Leiden-Delft</td>
<td>Gouda-Dordrecht *</td>
</tr>
<tr>
<td>4</td>
<td>The Hague-Delft</td>
<td>Rotterdam-Dordrecht *</td>
</tr>
<tr>
<td>5</td>
<td>Delft-Rotterdam</td>
<td>Rotterdam-Maassluis</td>
</tr>
<tr>
<td>6</td>
<td>Delft-Maassluis</td>
<td>Middelburg-Vlissingen *</td>
</tr>
<tr>
<td>7</td>
<td>Amsterdam-Naarden</td>
<td>Naarden-Amersfoort-Groningen *</td>
</tr>
<tr>
<td>8</td>
<td>Amsterdam-Weesp *</td>
<td>Amsterdam-Arnhem *</td>
</tr>
<tr>
<td>9</td>
<td>Amsterdam-Utrecht</td>
<td>Naarden-Amersfoort-Deventer *</td>
</tr>
<tr>
<td>10</td>
<td>Amsterdam-Gouda</td>
<td>Utrecht-Amersfoort-Deventer *</td>
</tr>
<tr>
<td>11</td>
<td>Amsterdam-Leiden</td>
<td>Utrecht-Arnhem *</td>
</tr>
<tr>
<td>12</td>
<td>Leiden-Gouda</td>
<td>Utrecht-Nijmegen *</td>
</tr>
<tr>
<td>13</td>
<td>Leiden-Utrecht</td>
<td>Utrecht-Den Bosch *</td>
</tr>
<tr>
<td>14</td>
<td>Utrecht-Vreeswijk (De Vlaart)</td>
<td>Den Bosch-Maastricht *</td>
</tr>
<tr>
<td>15</td>
<td>Vianen—Gorinchem</td>
<td>Den Bosch-Nijmegen *</td>
</tr>
<tr>
<td>16</td>
<td>Amsterdam-Monnikendam</td>
<td>Den Bosch-Gouda *</td>
</tr>
<tr>
<td>17</td>
<td>Amsterdam-Purmerend</td>
<td>Den Bosch-Breda</td>
</tr>
<tr>
<td>18</td>
<td>Monnikendam-Edam</td>
<td>Gorinchem-Breda</td>
</tr>
<tr>
<td>19</td>
<td>Edam—Hoorn</td>
<td>Breda-Antwerp *</td>
</tr>
<tr>
<td>20</td>
<td>Purmerend—Hoorn</td>
<td>Rotterdam-Antwerp *</td>
</tr>
<tr>
<td>21</td>
<td>Hoorn-Alkmaar</td>
<td>Lemmer-Groningen *</td>
</tr>
<tr>
<td>22</td>
<td>Alkmaar-Zijpe</td>
<td>Groningen-Nieuwe Schans</td>
</tr>
<tr>
<td>23</td>
<td>Leeuwarden—Harlingen</td>
<td>Zwolle-Deventer *</td>
</tr>
<tr>
<td>24</td>
<td>Leeuwarden-Bolsward</td>
<td>Deventer-Zutphen *</td>
</tr>
<tr>
<td>25</td>
<td>Bolsward-Workum</td>
<td>Deventer-Arnhem *</td>
</tr>
<tr>
<td>26</td>
<td>Leeuwarden-Sneek</td>
<td>Zutphen-Arnhem *</td>
</tr>
<tr>
<td>27</td>
<td>Leeuwarden-Dokkum</td>
<td>Zwolle-Arnhem *</td>
</tr>
<tr>
<td>28</td>
<td>Dokkum-Groningen</td>
<td>Harderwijk-Deventer *</td>
</tr>
<tr>
<td>29</td>
<td>Groningen-Ulrum</td>
<td>Rotterdam-Nijmegen *</td>
</tr>
<tr>
<td>30</td>
<td>Groningen-Warffum</td>
<td>Harderwijk-Zutphen *</td>
</tr>
<tr>
<td>31</td>
<td>Groningen-Uithuizen</td>
<td>Zwolle-Sneek *</td>
</tr>
<tr>
<td>32</td>
<td>Groningen-Winschoten</td>
<td>Arnhem-Harderwijk *</td>
</tr>
<tr>
<td>33</td>
<td>Winschoten—Nieuwe Schans</td>
<td>Zwolle-Harderwijk *</td>
</tr>
<tr>
<td>34</td>
<td>Groningen-Delfzij</td>
<td>Nijmegen-Venlo</td>
</tr>
<tr>
<td>35</td>
<td>Kampen-Hasselt</td>
<td>Tiel-Utrecht *</td>
</tr>
<tr>
<td>36</td>
<td>Kampen-Zwolle</td>
<td>Groningen-Coevorden</td>
</tr>
<tr>
<td>37</td>
<td>Arnhem-Nijmegen</td>
<td></td>
</tr>
</tbody>
</table>

* signifies that the coach route began operation in the 17th century

362
Principal sailing vessel routes

Zuider Zee and North Holland

<table>
<thead>
<tr>
<th>Route</th>
<th>Location</th>
<th>Route</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>201</td>
<td>Amsterdam-Alkmaar</td>
<td>217</td>
<td>Rotterdam-Brielle</td>
</tr>
<tr>
<td>202</td>
<td>Amsterdam-Zaandam</td>
<td>218</td>
<td>Rotterdam-Dordrecht</td>
</tr>
<tr>
<td>203</td>
<td>Amsterdam-Enkhuizen</td>
<td>219</td>
<td>Rotterdam-Vianen</td>
</tr>
<tr>
<td>204</td>
<td>Amsterdam-Harlingen</td>
<td>220</td>
<td>Dordrecht-Gorinchem</td>
</tr>
<tr>
<td>205</td>
<td>Amsterdam-Workum</td>
<td>221</td>
<td>Dordrecht-Geertruidenberg</td>
</tr>
<tr>
<td>206</td>
<td>Amsterdam-Staveren</td>
<td>222</td>
<td>Dordrecht-Moerdijk</td>
</tr>
<tr>
<td>207</td>
<td>Amsterdam-Lemmer-Sneek</td>
<td>223</td>
<td>Dordrecht-Willemstad</td>
</tr>
<tr>
<td>208</td>
<td>Enkhuizen-Lemmer-Sneek</td>
<td>224</td>
<td>Dordrecht-Bergen op Zoom</td>
</tr>
<tr>
<td>209</td>
<td>Amsterdam-Zwolle</td>
<td>225</td>
<td>Dordrecht-Antwerp</td>
</tr>
<tr>
<td>210</td>
<td>Amsterdam-Kampen</td>
<td>226</td>
<td>Dordrecht-Veere</td>
</tr>
<tr>
<td>211</td>
<td>Kampen-Deventer</td>
<td>227</td>
<td>Rotterdam-Middelburg</td>
</tr>
<tr>
<td>212</td>
<td>Kampen-Elburg</td>
<td>228</td>
<td>Rotterdam-Antwerp</td>
</tr>
<tr>
<td>213</td>
<td>Kampen-Sneek</td>
<td>229</td>
<td>Vlissingen-Breskens</td>
</tr>
<tr>
<td>214</td>
<td>Amsterdam-Harderwijk</td>
<td>230</td>
<td>Vlissingen-Sas van Gent</td>
</tr>
<tr>
<td>215</td>
<td>Amsterdam-Amersfoort</td>
<td>231</td>
<td>Rotterdam-Nijmegen</td>
</tr>
<tr>
<td>216</td>
<td>Lemmer-Groningen</td>
<td>232</td>
<td>Rotterdam-Utrecht</td>
</tr>
</tbody>
</table>

Delta and South Holland

Aggregate series

The following routes are included in the aggregate series:

A 1, 2, 3, 11, 13, 32
A' 1, 2, 3, 11, 12, 16, 18, 19, 32
A* 1, 2, 3, 11, 13
B 3, 11, 13, 32
B' 1, 2, 13
C 1, 3, 4, 6
D 1, 2, 3, 4, 8, 10, 11, 13, 16, 18, 19, 32

Computer tapes containing the data of annual passenger volume on each trekvaart route have been deposited in the Afdeling Agrarische Geschiedenis, Landbouwhogeschool, Wageningen, and the Economisch-Historische Bibliotheek in Amsterdam.
LIST OF TABLES

2.1. Matrices of the Holland–Utrecht and Friesland–Groningen networks ... 68
2.2. Summation matrices of the Holland–Utrecht and Friesland–Groningen networks ... 70
2.3. Dimensions of trekschuiten ... 78
3.1. Schedule of trekschuit service from Rotterdam and Maassluis to Alkmaar and Enkhuizen in the second half of the seventeenth century ... 94
3.2. Schedule of trekschuit and coach services from Dordrecht and Rotterdam to Utrecht, Leiden, and Amsterdam in the late seventeenth century ... 96
3.3. Schedule of trekschuit service from eastern Groningen to Harlingen, Workum, and Sneek in the seventeenth and eighteenth centuries ... 96
3.4. Capacity of scheduled passenger transportation services, second half of seventeenth century ... 97
3.5. Geographical distribution of passenger transportation capacity ... 98
3.6. Winter season changes in the schedules and fares of coach and sailing vessel services ... 103
3.7. Urban population accessible within one day’s travel from four selected cities (population estimates of c. 1660) ... 105
3.8. Beurtveer fares ... 108
3.9. Trekschuit tariffs in the Holland–Utrecht region, 1660–1830 ... 108
4.1. Construction expenses of the Haarlem-Leiden trekvaart, 1657–58 ... 128
4.2. Trekvaart construction costs ... 130
4.3. Average annual trekvaart maintenance expenditures ... 135
4.4. Expenditures of the Amsterdam commissioners of the Amsterdam-Haarlem trekvaart, 1685–1800 ... 136
4.5. Distribution of expenditures on three trekvaarten ... 137
4.6. Daily summer wage rates of common outdoor labor ... 142
4.7. Surplus of trekvaart revenues over current expenses, expressed as a percentage of invested capital, per ten-year period ... 149
5.1. Labor and physical assets employed in the production of trekschuit service ... 162
5.2. Skippers’ and helpers’ (knechts) pay on six South Holland trekvaarten ... 164
5.3. Annual horsepower expenditures of the Haarlem and Leiden skippers’ guilds, 1721–1818 ... 166
5.4. Estimated total expenditures and revenues of the Holland–Utrecht trekschuit skippers, 1650–1800 ... 174
6.1. Load factors of trekvaart routes in the 1660s and 1670s ... 192
7.1. Comparative costs of three modes of transportation between Amsterdam and Utrecht in 1821 ... 212
8.1. Average annual resource use of the trekvaart network ... 220
8.2. Social saving (direct resource saving) estimate, 1665–1675 ... 222
8.3. Social saving (consumers’ surplus) estimate, 1665–1675 ... 228
8.4. Implicit value of time for coach passengers in 1821–1830 ... 229
8.5. Railroad social saving on the Amsterdam–Haarlem route, 1840–42 ... 238
8.6. Railroad social saving on the HYSM, 1848–53 ... 239
8.7. Estimates of railroad social saving ... 244
9.1. Estimates of total passenger volume carried on the trekvaart network in three periods ... 252
9.2. Percentage change in trekschuit passengers by route, 1669–75 to 1742–48 and 1742–48 to c. 1800 ... 261
9.3. Estimates of price, population, and residual factors in the changing demand for intercity passenger transportation ... 276
9.4. Estimates of urban population, 1622–1795 ... 279
364
2.1. Passengers carried on the Amsterdam-Haarlem trekvaart, per month, 1632-1634
2.2. The Holland-Utrecht and Friesland-Groningen trekvaart networks presented as a graph
2.3. Profile of the Haarlem-Leiden trekvaart
3.1. Travel to and from intermediate stops on the Groningen-Dokkum trekvaart, May, 1658
3.2. Passengers carried by the Leiden skippers on the Leiden-The Hague route, per week, in 1668, 1682, and 1704
5.1. Production function of trekshuit service
5.2. Productivity of trekshuit crews
5.3. Purchase prices of horses acquired by the Haarlem skippers' guild of the Haarlem-Leiden trekvaart, 1780-1818
5.4. Operating expenses of the Haarlem skippers' guild of the Haarlem-Leiden trekvaart, 1780-1818
5.5. Major operating expenses per barge-kilometer on the Haarlem-Leiden trekvaart, 1723-1730 and 1780-1818
5.6. Estimated total revenues and expenses of the Holland-Utrecht skippers' guilds, 1650-1800
5.7. Estimated total surplus of the Holland-Utrecht skippers' guilds, 1650-1800
5.8. Total revenues, expenditures, and surpluses of the Haarlem-Leiden skippers' guilds, 1723-1730, 1759, and 1780-1818
5.9. Total annual income (wages plus distributed guild surplus) per member of the Leiden and Haarlem skippers' guilds, 1723-1730 and 1780-1818
6.1. Average costs of the Haarlem skippers' guild, 1660-1780
6.2. Substitution among travel modes in relation to the real price of trekshuit transportation. Amsterdam-Haarlem trekvaart, 1632-1759
6.3. Average costs and assumed demand curve on the Haarlem-Leiden trekvaart, c.1670
6.4. Cost curves faced by the skippers on the Haarlem-Leiden trekvaart, c. 1670
7.1. Break-even graphs for the Haarlem-Leiden trekvaart, c. 1670-c. 1780
7.2. Average costs and assumed demand curve on the Haarlem-Leiden trekvaart, c. 1700
7.3. Cost curves faced by the skippers and assumed demand curve on the Haarlem-Leiden trekvaart, c. 1745
8.1. The measurement of social saving (consumers' surplus) from the trekshuit service when coaches are the competing mode of transportation
8.2. A model of the penalties of the pioneer theory
9.1. Annual trekshuit travel volumes of aggregate routes A through D, and estimates of total volume in three periods
9.2. Annual passenger volume on four trekvaarten, 1632-1820
9.3. Annual passenger volume on four trekvaarten, 1658-1820
9.4. Annual passenger volume on the North Holland trekvaarten, 1664-1752
9.5. Annual passenger volume on trekvaarten extending eastward from Amsterdam, and toll revenues from roads and waterways between Amsterdam, Utrecht, and the eastern provinces, 1675-1825
9.6. Annual passenger volume on trekvaarten in Friesland and Groningen, 1651-1809
9.7. City pais (Iij's) among the six largest cities of Holland
9.8. Scatter diagram of actual and estimated intercity travel between fifteen city pairs served by the H.Y.S.M., 1857-61

366
9.9. Dominant associations among the six largest cities of Holland in 1855 and 1864 .................................................. 285
9.10. Distribution of trips by distance: Holland–Utrecht trekvaarten, 1660–70; H.Y.S.M. railroad, 1861 ........................................ 294
9.11. Scatter diagram of actual and estimated intercity travel by trekschuit, 1700–10 ($b_2 = 2.0$) ........................................ 297
9.12. Scatter diagram of actual and estimated intercity travel by trekschuit, 1740–50 ($b_2 = 2.2$) ........................................ 297
9.13. Graphic representation of the influence of the variables price and population on the shifts in demand for intercity passenger transportation in Holland and Utrecht, 1660–70 to 1790–1800 ........................................ 300
10.3. Consumption frontiers for rye and trekschuit transportation ........................................ 323
11.1. Average monthly distribution of trekschuit passengers, passengers per barge, and tollgate revenues on the Amsterdam–Haarlem trekvaart, 1644–53 ........................................ 329
11.2. Average monthly distribution of trekschuit passengers, passengers per barge, and tollgate revenues on the Amsterdam–Haarlem trekvaart, 1660–69 ........................................ 330
11.3. Average monthly distribution of trekschuit passengers on three routes, 1660–69 ........................................ 331
11.4. Average monthly distribution of trekschuit passengers on three Friesian routes in the mid-seventeenth century ........................................ 332
11.5. Monthly distribution of interurban and rural-urban travel on the Groningen–Dokkum trekvaart, 1658 ........................................ 333
11.6. Average monthly distribution of trekschuit passengers on two North Holland routes in the seventeenth century ........................................ 334
11.7. Average monthly distribution of trekschuit passengers on the Amsterdam–Haarlem trekvaart for selected decades, 1650–1813 ........................................ 335
11.8. Average monthly distribution of the number of passengers per barge on the Amsterdam–Haarlem trekvaart for selected decades, 1650–1739 ........................................ 336
11.9. Average monthly distribution of tollgate revenues on the Amsterdam–Haarlem trekvaart in selected decades, 1650–1739 ........................................ 336
11.10. Seasonal analysis charts of passenger travel on the Amsterdam–Haarlem trekvaart per decade, 1633–1759 ........................................ 338
11.11. Average monthly distribution of passenger travel on the Amsterdam–Haarlem route by railroad (1840–41) and by trekschuit (1750–59, 1806–13) ........................................ 339
11.12. Upper and lower boundaries of the composites of average monthly distributions of trekschuit passengers on seven routes, 1660–85 and 1720–59 ........................................ 340
11.13. Average monthly distribution of trekschuit passengers on the Sneek–Leeuwarden trekvaart, 1675–1808 ........................................ 341
11.14. Average monthly distribution of passenger travel on three rural routes in the eighteenth century ........................................ 342

367
LIST OF MAPS

2.1. The four trekvaart networks in 1650 ................................. 60
2.2. The trekvaart network after 1665 ........................................ 65
2.3. Three examples of beurtveer networks
   a. Two South Holland beurtveer networks: Gorinchem and Haastrecht
   b. The beurtveer network of Leeuwarden .................................. 84
2.4. Coach and sailing vessel services in the Dutch Republic in the mid-eighteenth century ................................. 88
8.1. The Netherlands' railway network as of 31 December 1855 .................... 233
9.1. Location of tollgates whose annual receipts have been collected for this study 266
LIST OF FREQUENTLY USED DUTCH WORDS

Beurtschip A sailing vessel used to carry freight and passengers between fixed points on a regular schedule. The schedule, fares, and other aspects of the service were fixed by agreements made between the governments of the places served. Comparable to a packet boat.

Beurtover A service between two points performed by beurtschepen (see beurtschip). It draws its name from the fact that the skippers who collectively maintained the service shared the work by taking turns (Beurt = turn, as in ‘everyone in his turn’).

Beurtschipper The captain, or skipper, of a vessel sailing in a beurtover.

Bode A messenger and errand runner, typically for a government official or agency.

Gabelle The portion of a trekschuit fare reserved for the city to compensate it for the cost of the canal and towpath; a toll.

Jaagpad The towpath of a trekvaart; interchangeable with trekpad.

Jager The rider of the horse that pulls the trekschuit; anglicized as jockey.

Kajuit The most luxurious accommodations on a vessel, particularly on a packet boat.

Kermis An annual fair, with a carnival atmosphere, lasting usually for a week or more.

Knecht The skipper’s assistant on the trekschuit; more generally a male servant. Anglicized as helper.

Kooi A compartment with bunks or berths on a sailing vessel.

Last A volume measurement commonly used in Baltic shipping and the grain trade. The Amsterdam last was 3003.6 liters, or, when measuring rye, 2000 kilograms, or about two tons.

Marktschip A market boat. A type of beurtover specially designed to give farmers and merchants in nearby towns and villages access to a larger city’s principal markets.

Octrooi A patent, or charter granted by the provincial government. In this study, a charter conferring the right of eminent domain and other legal privileges needed to dig a new canal.

Passagiegeld A tax levied by the provincial governments on interprovincial transportation as well as on most intraprovincial trekschuit transportation.

Roef The first class compartment of the trekschuit.

Rút The hold, or second class compartment of the trekschuit.

Schipper The captain, or skipper, of a vessel.

Schouw A ferry.

Schuit Any barge, or scow.

Staten The parliamentary assemblies of the provinces and of the Republic.

Tent Another name for the ruim, the second class compartment of the trekschuit.

Trekpad The towpath of a trekvaart.

Trekschuit A passenger-carrying barge pulled by one or more horses. The English sometimes called such vessels draw barges or fly boats, but since neither term achieved the status of common usage, the terms trekschuit and passenger barge are used interchangeably in this study.

Trekvaart A waterway, usually a canal, possessing a towpath along at least one of its banks.

Vaart Any navigable waterway.

Vinder The business manager of a skippers’ guild. Someone, often one of the skippers, empowered to buy and sell horses, buy fodder, lease pastures, provide for the maintenance and repair of guild assets, etc.

Voet A distance measurement, comparable to the English foot. An Amsterdamse voet = 28.3 cm.

Volksschuit A nineteenth-century name for the trekschuit, signifying its use primarily by common people.
ARCHIVES

The following list gives the names of the archives consulted for this study, followed by the abbreviated and anglicized designation used in the footnotes. If no separate collections are listed below the name of an archive, only the oud archief (abbreviated as O.A.) was used.

Gemeentearchief Alkmaar (G.A. Alkmaar)
  keuren en ordonnanties
Gemeentearchief Amsterdam (G.A. Amsterdam)
  Archief van Burgemeesters, IV., Veren
  Notariële archieven
  Particuliere archieven, no. 11, Postwagens Amsterdam-'s-Gravenhage
  no. 16, Wegen en vaarten
Gemeentearchief Antwerpen (G.A. Antwerp)
Gemeentearchief Arnhem (G.A. Arnhem)
Gemeentearchief Bolsward (G.A. Bolsward)
Gemeentearchief Brugge (G.A. Bruges)
Gemeentearchief Brussel (G.A. Brussels)
  Canal et Senne
Gemeentearchief Delft (G.A. Delft)
  1e afdeling
Gemeentearchief Dokkum (G.A. Dokkum)
Gemeentearchief Dordrecht (G.A. Dordrecht)
  Ordonnanties
Gemeentearchief Enkhuizen (G.A. Enkhuizen)
Gemeentearchief Gorinchem (G.A. Gorinchem)
Gemeentearchief Gouda (G.A. Gouda)
Gemeentearchief 's-Gravenhage (G.A. The Hague)
Gemeentearchief Groningen (G.A. Groningen)
Gemeentearchief Haarlem (G.A. Haarlem)
  Archief Franse tijd
  Commissarissen der binnenvaarten
  Enschede inventaris
  Stukken betreffende de trekvaarten en veerdiensten
Gemeentearchief Harlingen (G.A. Harlingen)
Gemeentearchief Hoorn (G.A. Hoorn)
Gemeentearchief Kampen (G.A. Kampen)
  Commissarissen van de trekvaart
Gemeentearchief Leeuwarden (G.A. Leeuwarden)
Gemeentearchief Leiden (G.A. Leiden)
  Secretarie archief
  Trekvaarten en veerdiensten
Gemeentearchief Medemblik (G.A. Medemblik)
Gemeentearchief Naarden (G.A. Naarden)
  Nieuw archief
Gemeentearchief Nijmegen (G.A. Nijmegen)
Gemeentearchief Purmerend (G.A. Purmerend)
Gemeentearchief Rotterdam (G.A. Rotterdam)
  Bescheiden betreffende de scheepvaart
Gemeentearchief Schoonhoven (G.A. Schoonhoven)
Gemeentearchief Sneek (G.A. Sneek)
Gemeentearchief Staveren (G.A. Staveren)
Gemeentearchief Utrecht (G.A. Utrecht)
Archief 1577-1795
Archief 1815-1851
Secretarie archief
Gemeentearchief Weesp (G.A. Weesp)
Gemeentearchief Workum (G.A. Workum)
Algemeen Rijksarchief 's-Gravenhage (A.R.A. The Hague)
Wetgevende colleges
Rijksarchief in de provincie Friesland (R.A. Leeuwarden)
Hof van Friesland
Rekenkamer archief
Rijksarchief in de provincie Noord Holland (R.A. Haarlem)
Zes Noord-Hollandse steden
Rijksarchief in de provincie Oost Vlaanderen (R.A. Ghent)
Rijksarchief in de provincie Utrecht (R.A. Utrecht)
Staten van Utrecht
Provinciale Waterstaat van Noord Holland
Nederlandse Spoorwegen
NOTES

CHAPTER I


2. G. A. Dordrecht, Ordonnanties, II, no. 3; XL, no. 17, 'Ordonnantie... op het be­varen van 't ordinaris veer van de zelve stad op de stad Antwerpen,' 7 Maart 1693.


9. Fynes Moryson, *An Itinerary*, 4 vols. (Glasgow, 1907), 1: 86. Perhaps we should be slower to generalize from Moryson's experience, for René Descartes, on at least one occasion, found traveling in Dutch waters (the Wadden Zee, apparently) disagree­able in the extreme. For an account of his discomfort see T. de Quincy, 'Murder Considered as a Fine Art,' in *Collected Works*, vol. 13 (London, 1897).

10. H. Brugmans, 'Middelen van verkeer,' *Uit onzen bloeitijd*, vol. 2, no. 3 (1909), 11; 'Reiskosten in ’t midden der 16e eeuw,' *De oude tijd* (1871), 76; Moryson, 1: 89–114.


13. Moryson, 1: 89–114. These high fares have been excluded from the calculation of average fares presented on p. 12.


24. G.A. Leiden, Trekvaarten en jaagpaden, no. 1, Leiden–Delft/The Hague register,
Notes to pp. 55–63

3 September 1666; G.A. Rotterdam, Bescheyden betreffende de scheepvaart, no. 32, 22 April 1673.


**Chapter II**

1. G.A. Brussels, XII. Canal et Senne, no. 246, ‘Conditien van den Vere.’


16. G. A. Dordrecht, ‘Octrooi voor het legging van een straatweg van Alblasserkerk af tot het veer van Papendrecht toe,’ 1683. This permission to construct a paved road was not acted upon.

17. Dordrecht, a city of about 20,000 inhabitants, was linked to the trekvaart network by two routes. Substituting for the never-built Dordrecht-Gouda trekvaart was a coach service with a twice-daily peak season frequency (G. A. Dordrecht, Ordonnantes, II, nos. 17, 18). More important were the connections to Rotterdam. The impracticality of trekvaart technology in this region dictated the continued use of sailing vessels. These vessels, whose keels had to measure at least 28 feet and whose capacity had to be at least 16 lasts, departed from each city four times daily. The drawbacks to this service were the constantly shifting departure times (dependent upon the tides) and the fact that sailing to Rotterdam often took much longer than sailing to Dordrecht. The undependability of this service could be avoided, at a cost, by using the second Rotterdam–Dordrecht connection, a four-times per day coach service. These two modes of transportation taken together permitted a high-volume, reasonably dependable link to be forged between Dordrecht and the trekvaart network of Holland and Utrecht (G. A. Rotterdam, O.A., no. 854–920; G. A. Dordrecht, Ordonnantes, XLI, no. 50).

Zaandam and the contiguous industrial villages stretching along the banks of the river Zaan had an aggregate population in excess of 20,000 in the mid-seventeenth century rising to 28,000 a century later. This important population center specialized in industrial activities that were closely associated with the economy of Amsterdam. The importance of communications between the two centers is reflected by the careful attention paid to making the sailing vessel service connecting them as dependable as possible. The regulations governing the service, which offered hourly departures from sunup to sundown, required the 36 skippers to maintain three types of vessels, each suited to different weather conditions. They also established a scale of fares designed to compensate the skippers for the danger and expense of maintaining a year-round, all-weather service. To judge from the scheduled passenger transportation services, the Zaan villages were isolated from the nearby cities of North Holland and functioned as a sort of enclave of the Amsterdam economy. This is surely an exaggeration of reality, but the absence of other scheduled service next to the high-volume link to Amsterdam is striking (G. A. Amsterdam, Archief Burgemeesters, Port. IV, Veren, Z. 1–4, ‘Ordonnante van 1631’).

18. Utrecht rebuilt two waterways into trekvaarten: the Kromme Rijn to Wijk bij Duurstede and the Hollandse IJssel to Montfoort and Oudewater. Neither is included in this study since they were of only local importance and sustained no regularly scheduled services of any frequency. The only reference to service on the Oudewater route that I have found (dating from 1824) speaks of a once-per-week barge (R. A. Utrecht, Staten van Utrecht, Kamerdn van het zandpad van De Meern naar Montfoort en Oudewater: Kamerard van het zandpad naar Wijk; G. A. Utrecht, archief 1815–1851, no. 1280).

Schoonhoven was regularly served by sailing vessels plying the river Lek between Rotterdam and Vianen and points further east. It also seems to have been connected to Gouda. A travel guide of 1778 mentions a tri-weekly trekschuit which presumably made use of the meandering river Vlist. No other sources refer to this service, but in 1781 a coach service was established on this route. Once again, the absence of later, confirmatory sources calls into question the longevity of this service. (Nugent, *Grand Tour*; G. A. Schoonhoven, O.A., no. 965.)

Until 1721 Medemblik seems to have been accessible by public conveyance only by sea. In that year a daily coach service to Hoorn was inaugurated. Its functioning
Notes to pp. 66–85

depended on the passability of the dike-top path over which the coach ran after leaving the paved road from Hoorn to Enkhuizen. Many travel guides failed to mention its existence. (G.A. Enkhuizen, O.A., no. 247.)


20. In a formal analysis the powering of the matrix continues until all zeros are eliminated. This ultimate matrix, the ‘solution matrix’, identifies the maximum number of steps needed to make accessible every point of the network. The power to which the matrix must be raised is equal to the ‘diameter’ of the graph. The diameter is the number of steps in the shortest path between the two most widely separated nodes. In the example used here powering has not been continued to the solution matrix. Abler, Adams, and Gould, pp. 262–263.


22. Van Mieris, 2:471; Kooiman, p. 175.

23. Originally, the trekvaart from Leiden to Delft was obstructed at Leidschendam by a dam. Over the objections of the three cities with toll-collecting privileges on inland navigation (Gouda, Haarlem, and Dordrecht) a narrow sluice was built in 1648. In 1682 it was widened, again over strenuous objection. Only in 1877, when the province of Holland took over the canal, were the locks upgraded to permit the canal to function as an important artery for freight transportation. H. C. Hazewinkel, Geschiedenis van Rotterdam, 3 vols. (Amsterdam, 1940) 2: 87.


25. Junior Coriat, Another Traveller, or cursory remarks and critical observations made upon a journey through part of the Netherlands in the latter end of the year 1766, 2 vols. (London, 1767), 1: 29–30.


32. Most ordinances that established the operating procedures on the trekschuiten specify this sort of manoeuvre. An alternative was to require barges traveling in one direction to stop and drop their lines into the water so that the approaching barge could glide over it. See, for example G.A. Delft, Ie afdeling, no. 1911, ‘Ordonnantie op het Maassluyse veer en trek-pad,’ 9 October 1715, art. 27; G.A. Groningen, ‘Ordonnantie op de trek- en wagenweg ende veer-schepen,’ 1754, art. 23. Also, Benjamin Silliman, A Journal of Travels in England, Holland and Scotland, 2 vols. (New Haven, 1820) 2: 292.

33. Smeaton, p. 33.

34. Ibid., p. 45.


37. G.A. Amsterdam, Archief Burgemeesters, Port. IV, Veren, Z. 1–4, ‘Ordonnantie van 1631.’

38. The analogy is made in D.Y.N. Ypma, ‘Van zeilende beurtman tot eigenrijder. Amsterdam–Friesland vice versa,’ It Beaken 37 (1975), 204.

39. This description of the chief Zuider Zee services is drawn from travel guides and supplemented by municipal ordinances. The most complete travel guides are Jan ten Hoorn, Reisboek de veremigde Nederlandsche Provincien (first ed., Amsterdam, 1679; second ed., Amsterdam, 1689; third ed., Amsterdam, 1700); Jan ten Hoorn,
Reis-boek door Amsterdam (Amsterdam 1679); Nieuwe geographische Nederlandse Reis-en Zak-Atlas (Amsterdam, 1773); Thomas Nugent, The Grand Tour, 4 vols., (third ed., London, 1778); Aanwijzer van meest alle heurtschepen, jaag- en marktschuiten, die van alle steden der Bataafse Republiek meest dagelijks afvaren op de volgende steden en plaatsen (Amsterdam, n.d. [circa 1800]); Koninklijk Almanak voor den Jare 1807 (The Hague, 1807); Reisboek door het Königrijk der Nederlanden (Amsterdam, 1821); 's-Gravenhaagsche Stads-Almanak voor het jaar 1830 (The Hague, 1830).

For the rise of Lemmer see Tegenwoordige Staat van Friesland, 4 vols. (Amsterdam, 1785-1789), 3: 537; Ypma, pp. 207-208.

R. A. Leeuwarden, Rekenkamer archief, no. 21, ‘Passagiegeld, afrekeningen van de collecteurs.’

Idem.


For travel guide sources to the Delta region see note 39, above. In addition see G.A. Dordrecht, Ordonnanties, IV, no. 30; XLI, no. 50; XL, no. 17, for ordinances to various points in Holland, Brabant, Zeeland, and Flanders; G.A. Rotterdam, O.A., no. 894-920; Nederlandsche Jaarboeken 9 (1755), 726-728; Wegwijzer der stad Gent en van voorgeburen en van Oost-Vlaanderen (Ghent, 1770, and following years).


Ten Hoorn, Reisboek door de Nederlandsche Provinciën (1689 ed.); Nederlandsche Jaarboeken 10 (1756), 1049. There is some dispute concerning the opening date of this service. The earliest ordinance dates from 1731. One source holds this to be a revision of a 1706 ordinance.


Coriat, 1: 168; Marshall, 1: 170; A Description of Holland, p. 410; Silliman, 3: 22. Since eighteenth century English coaching services were the most advanced in Europe, criticism from that quarter is not unexpected. More telling, perhaps, is the dissatisfaction with Dutch services expressed by German travelers. In 1830 an anonymous German remarked that ‘In den holländischen Provinzen sind die Diligencen so wie alles Räderwerk in Holland wahre Rumpelkasten... Der Kutschenbau scheint in Holland wenigstens um anderhalf Jahrhunderte zurück zu seyn. Die Landkutschen haben daselbst noch verdeckte von Pappendeckel oder Wachskleinwan, und sehen tuchstäblich noch so aus, wie die kutschen in den Jahrmarkten von Breugel und Tenniers.’ Bemerkungen über das Niederländische Postwesen, Archiv der Postwissenschaft 1 (1830), 17.

Bremisches Staats Calender auf das Jahr Christi MDCCLXXI, (1771).

Hazewinkel, 3: 494; Nugent, 1: 205.

CHAPTER III

6. G.A. Amsterdam, Part. archief no. 16, Wegen en vaarten, no. 10, *Ordonnantie van 1772* [renewal of 1658 ordinance].
7. *Nederlandsche Jaarboeken* 10 (1756), pp. 947–949; G.A. Rotterdam, Bescheiden betreffende de scheepvaart, no. 32 (1689); G.A. Rotterdam, ‘Nieuwe ordonnantie op ‟t schuyt-veer tuschen de steden Delft en Rotterdam,’ 16 October 1654; G.A. Delft, Ie afdeling, no. 1060, ‘Ordonnantie concernerende particulierlijk de jaeg-schippers varende van deze stad Rotterdam op Delft,’ 1730; G.A. Weesp, ‘Reglement voor de veerschepen varende tussen de steden Amsterdam en Weesp.’ 15 December 1807. Travel across the Zuider Zee in years of intense cold was made possible by the use of ice sleds. This emergency replacement for sailing vessels on the infrequent occasions when ice covered the Zuider Zee, was carefully regulated by the cities of Staveren and Enkhuizen. G.A. Staveren, O.A., nos. 188, 189, ‘IJslopers van Enkhuizen en Staveren,’ 1654, 1760.
10. Silliman, 2: 291, 293.
11. Ibid., p. 293.
14. A more precise measurement of accessibility is provided by the geographical concept of ‘potential’. However, the cruder measure used here has the advantage of having a direct, practical applicability.
15. For the character of communications in the pre-telegraphic age, see Allan Pred, *Urban Growth and the circulation of information in the United States system of cities, 1790–1840* (Cambridge, Mass., 1973). The distinction made here between an urban hierarchy and an urban system needs a word of explanation. Classical central-place theory seems inapplicable to the Low Countries. The urban hierarchies identified by Christaller and Lösch, and described more recently in the studies of Skinner and 377
Rozman require, it would appear, political and economic regimes very different from those found in the Dutch Republic. Here one finds a large number of cities, of varying sizes, exercising a range of functions bringing them into contact with many places besides those immediately above them on the central-place hierarchy. Their long-distance trading and mercantile economies resisted, as it were, the discipline of an administratively and politically imposed hierarchization. In the place of sub-ordination (for which a transport service such as that provided by the beurtveer sailing-boats would have been well-suited) came interdependence in the context of an urban system (which the trekvaart network tended to support). See W. Christaller, *Die zentralen Orte in Süddeutschland* (Jena, 1933); August Lösch, *The Economics of Location* (New York, 1967); Gilbert Rozman, *Urban Networks in Ch'ing China and Tokugawa Japan* (Princeton, 1973); G. W. Skinner, *Marketing and Social Structure in Rural China,* *Journal of Asian Studies* 24 (1964–65), 3–44, 193–228, 363–400. For criticism of central-place theory see James E. Vance, Jr., *The Merchant's World, the Geography of Wholesaling* (Englewood Cliffs, N. J., 1970), pp. 158–167.


22. G.A. Utrecht, archief 1815–1851, no. 1300, 'Staat der postwagendiensten,' 1824; no. 1280, 'Staat der schepen en schuiten,' 1824; A.R.A. The Hague, Wetgevende colleges, no. 507; Thomas Nugent, The Grand Tour, 4 vols., (third edition, London, 1778); Koninklijke Almanak voor den Jare 1807 (The Hague, 1807). In addition, ordinances and resolutions drawn from a large number of municipal archives have been used to chart these fares.


25. Almanach voor het negen en thienste jaer der Fransche Republiek, passim.


27. The Pachterskohier of 1742 shows the following situation: 229 families, or 0.5% of all families in Amsterdam, enjoyed a yearly taxable income in excess of 10,000 guilders. At the same time only 148 households, nearly all with taxable incomes exceeding 10,000 guilders, were assessed for the ownership of 4 or more horses. These figures are supplied by B. E. De Muinck in his study of the financial affairs of a prominent regent family, Een regentenhuishouding omstreeks 1700 (The Hague, 1965), pp. 74–76. The subject of this study, one of Holland's wealthiest men, never seems to have set foot in a trekschuit. But the same was by no means true for Jacob Bicker Raye, a member of a prominent Amsterdam family, and municipal office holder. The diary of this financially very comfortably situated man covers the middle decades of the eighteenth century and makes frequent mention of trekschuit trips. Fr. Beijerinck and M. G. de Boer, eds., Het dagboek van Jacob Bicker Raye (Amsterdam, n.d.).


30. Ibid., 1688.


32. G.A. Haarlem, 'Reglement op de commissaris,' 1694, quoted in ibid., p. 95.


38. Quoted in *ibid.*, p. 18.


47. G.A. Gouda, O.A., no. 633, ‘Rekeningen van de ontvangsten en uitgaven wegens het jaagpad.’

48. G.A. Groningen, no. 742r, ‘Questie met de stad Dokkum over de trekweg.’

49. R.A. Haarlem, Zes Noord-Hollandse steden, Doos 78, ‘Correspondentie betreffende de straatweg.’


55. *Nederlandsche Jaarboeken* 6 (1752), 473-474. *Harrijesdaag*, the first Monday after 15 August, was a day of more or less dissolute revelry celebrated by the petit bourgeois of Amsterdam and Haarlem.

56. Light is shed on this issue in the large-scale study of migration to Amsterdam recently completed by Simon Hart in *Geschrift en getal* (Dordrecht, 1976). Some of his migration data are utilized in chapter XII, below.

**Chapter IV**

1. For evidence on prevailing wage rates see pp. 139-143. The estimate of 770 laborers is based on the assumption that the 100,000 man-days of labor were distributed equally over the 90 working days between 25 April and 1 November. It is, of course, likely that the labor force exceeded this number at the peak of activity.

2. It is interesting to note that in these same months the Amsterdam–Gouda trekvaart was being dug. It is not impossible that some 3000 men were digging canals in central Holland during the summer of 1657. The task was approached by dividing the surveyed route into parken. On both the Kampen–Zwolle/Hassele and Alkmaar–Hoorn routes the records speak of 100 roede (378 meter) parken. On the latter route it was specified that the digging of each park would be the responsibility of a contractor and 50 workers.


7. G.A. Dokkum, O.A., no. 201, 'Geldleningen.'


9. G.A. Naarden, O.A., C. III. 8; H. Poolman, 'Commissarissen over de trekvaarten tusschen Diemerbrug en Muiden en tusschen Muiden en Naarden,' *Tussen Vecht en Eem* 1 (1971), 193; L. Jansen and S. C. van Diest, *Geschiedenis van Muiden* (Muiden, 1953), pp. 69–70 (Muiden borrowed 15,000 guilders from the Huiszittenmeesters der Nieuwewijde in Amsterdam; most of the rest came from the sale of land held by Muiden institutions); G.A. Sneek, O.A., no. 392. In Utrecht some 8% loans of 1628 were refinanced a few years later with 5% loans from the city's churches and charitable institutions. G.A. Utrecht, Secretarie archief, no. 1266.


11. The description that follows is based on the specifications of commissioners' duties as spelled out in a large number of ordinances, among them: G.A. Delft, 1e afdeling, no. 1911, 'Ordonnantie op het Maas-sluytsche veer en trek-pad,' 9 October 1715; 'Nieuwe ordonnantie op 't Schuyt-veer tusschen de steden Delf ende Rotterdam,' 16 October 1654; G.A. Amsterdam, Archief Burgemeesters, Port. IV, Veren, UZ. N2, 'Ampliatie op de ordonnantie voor de beurtschippers op Utrecht,' 23 December 1744; G.A. Groningen, 'Ordonnantie... op de trek- en wagenweg... tusschen Groningen en Winschoten,' 1754; 'Ordonnantie van de ordinaris veer-schepen nae Uthuisen, Ulrum, Mensingeweuer, en Warffum.'

12. An analysis of the volume of private transportation is presented in chapter IX.


20. G.A. Weesp, O.A., unnumbered appendices to trekvaart financial statements for scattered years, 1690–1751.


23. From the many citations the following are illustrative: on the Rotterdam–Gouda road the daily pay in 1760 of the street paver was 25 st. in summer and 21 st. in winter; his hod carrier (opperman) earned 16 st. in summer and 14 in winter. (G.A. Gouda, O.A., nos. 4190-4193, ‘Bijlagen tot de rekeningen.’) In 1745 Weesp paid the men dredging the trekvaart 24 st. per day in summer and 18 st. in the winter. (G.A. Weesp, unnumbered appendix to trekvaart financial statements.) In 1667–68 Edam paid canal maintenance workers 22 st. per day in the summer, 20 st. in the spring and fall, and 16 st. in the winter. (R.A. Haarlem, Zes Noord-Hollandse steden, doos 57, Edam kasboek.) Masons on the Leiden–Delft route did not suffer such a sharp winter wage reduction; their pay only fell from 24 to 22 st. (G.A. Leiden, Trekvaarten en jaagpaden, no. 60, Leiden–Delft/The Hague, 1659.)

23a. Sources:
Leiden: G.A. Leiden, Trekvaarten en jaagpaden, no. 60, Bijlagen tot de rekeningen.
Purmerend: G.A. Purmerend, O.A., no. 247, Rekeningen, Vijf-steden trekvaart. These workers received a 2 stuiver per day supplement to their 18 stuiver wage. The supplement was called 'drinkbier' (intended to replace the actual provision of beer?) and is sometimes encountered under this or similar names in other records, particularly in Leiden.
Hoorn–Alkmaar: G.A. Hoorn, O.A., nos. 610 (1910) and 611 (2589); G.A. Alkmaar, O.A., no. 1882, 'Hoornse vaart.'
Montoort: R.A. Utrecht, Staten van Utrecht, no. 928, Bijlage tot de rekening van den kamerwaard van het zandpad van De Meern naar Montfoort en Oudewater.
Drachten: G.A. Smallingerland, O.A., no. 33, Rekeningboek voor de gecomiteerde tot de slaating van 't Dragt; no. 34, Rekeningboek van de gecomiteerde tot de Kletstervaart.
Groningen: G.A. Groningen, O.A., no. 332b, Bijlagen tot de Stadsrekeningen.
Kampen: G.A. Kampen, Trekvaart archief, no. 3.
Notes to pp. 146–159

32. G.A. Haarlem, kast 7, loket 14, bundel 11, no. 4, fol. 434, 16 May 1729.
34. G.A. Haarlem, Stukken betreffende de trekvaarten..., nos. 21–26, 'Rekeningen, Amsterdam zijde.'
35. G.A. Gorinchem, O.A., no. 2179. The early records of the Nieuwersluis–Hinderdam and Gouda–Amsterdam routes also make some reference to outlays for borrowed capital, but, they, too, keep this up for only a short time. Since the accounts of some trekvaart administrations are no longer available, it is not impossible that this practice was, in fact, somewhat more widespread. Nonetheless, the fact that such major cities as Amsterdam, Haarlem, Leiden, and Delft, did not keep capital accounts is telling evidence about the limitations of bookkeeping in the early modern period.

Chapter V

1. See, for example, G.A. Leiden, Trekvaarten en jaagpaden, no. 1, Leiden–Delft/The Hague register, 23 Februari 1638, 9 Maart 1638.
2. G.A. Amsterdam, Part. archief no. 16, Wegen en vaarten, no. 19. Although the details varied, the same system applied to most trekschuit guilds and beurtveren. See G.A. Arnhem, O.A., no. 3260, 'Ordonnantie van de vaert in de Griff...,' 1682; Nieuwe Nederlandse Jaarboeken 13 (1778), 132-141; H. van Zijl, 'Het Durgerdammer veer,' Ons Amsterdam 20 (1968), 154–159.
3. G.A. Amsterdam, Part. archief no. 16, Wegen en vaarten, no. 19; Hermanus Noorderkerk, HANDOOSTEN OFTE PRIVILEGIEN... DER STAD AMSTELREDAM, 3 vols. (Amsterdam, 1748), ordinances of 1677 and 1763.
4. G.A. Rotterdam, 'Nieuwe orondantie van 't schuyt-veer tuschen de steden Delf ende Rotterdam,' 16 October 1654; Keuren en ordonnanties, no. 32, 22 April 1673.
6. G.A. Delft, 1e afdeling, no. 1060, 'Ordonnantie concernerende particulierlijk die jaeg-schippers varende van deze stad Rotterdam op Delf,' 9 September 1730.
7. G.A. Staveren, O.A., no. 188, 'Ordonnantien... van 't veer van hier naar Amsterdam, Enkhuizen,...,' 28 September 1633.
8. R.A. Leeuwarden, Hof van Friesland, bijdragen van de civiele sententies, no. 595-20, 'Ordonnantie van de grootschippersgilde van Bolsward.'
9. G.A. Haarlem, Trekvaarten en veerdiensten, nos. 1–12, Amsterdam–Haarlem registers, 1751; kast 24, no. 45 (1097), 'Rekening... die de vinders en schippers van de treksschuylten van Haarlem op Leiden...'

15. The *reis* supplement on 21 trekvaart routes ranged from 27 to 65 percent of the basic fare. The supplements on the most heavily traveled central-Holland routes clustered in the 40–60 percent range.

16. G.A. Haarlem, kast 24, no. 45 (1097), 'Vinders en schippers rekening.'

17. G.A. Haarlem, 'Trekschuiten en veerdiensten, nos. 1–12, Amsterdam–Haarlem registers, 1751. The same document lists the workers employed by the boat wharf that built and maintained the trekschuiten and the sailing vessels used to carry freight on the buitenvoor to Amsterdam. Eleven workers are mentioned: 1 foreman (*baas*), 2 journeymen, 1 apprentice, and 1 boy, who together handled the carpentry, plus 6 special craftsmen: a sailmaker, smith, smithmaker, blockmaker, ropemaker, and painter. Surely the responsibilities of this crew extended beyond the vessels of the Amsterdam–Haarlem skippers (!). I have not included any of them in the calculations of the maintenance labor force.

18. G.A. Delft, 1e afdeling, no. 1060, 'Ordonnantie concernerende de jaeg-schippers,' 9 September 1730, specifies that the jockey (*jager*) may not be under 8 years of age. G.A. Haarlem, kast 7, loket 14, bundel 11, no. 4, 'Klacht van de schippers op Leiden...,' 1728.


22. A *last* is equal to about 3000 liters and, when measuring grain, about 2000 kilograms (4400 pounds). In 1757 the Bolsward skippers estimated that a horse was fed one *lopen* of oats per week. Since a *lopen* equals 83.3 liters of grain, this level of feeding, if maintained year-round, amounted to 4332 liters per year. (G.A. Bolsward, O.A., no. 567.)


24. For example, the Haarlem skippers' guild on the Leiden–Haarlem route earned f658.12 from their horse operations. f227.16 was earned by renting to outsiders portions of the land kept for the feeding of the guild's horses. The sale of a horse brought in f50.0, the sale of the horse manure collected at the stable was good for f80.0, the sale of 1.5 *last* of surplus horse beans (*paardebonen*) brought in f8.0, and the provision of horse-pulling services to various yachts that made use of the trekvaart earned the skippers f250.4. A final f2.12 was paid by the St. Elizabeths Gasthuis in Haarlem for an unspecified reason. (G.A. Leiden, Trekvaarten en jaagpaden, no. 108, Leiden–Haarlem register, 'De korte bij-eengebracht rekening... van de schippers van Haarlem op Leyden,' 1731.

25. G.A. Leiden, Trekvaarten en jaagpaden, no. 70, 'Jaarlijkse lopende onkoste in 12 maanden voor een schuyt op den Haag.'


27. R.A. Utrecht, Staten van Utrecht, no. 940, Resolutien van de gecommitteerden, 'Ordonnantie op de jagers,' 1628; G.A. Amsterdam, Archief Burgemeesters, Port. IV, Veren, UZ.N8., 'Ampliatie op de ordonnantie voor de beurtschippers, vaarende van Amsterdam op Utrecht,' 23 December 1744.

28. G.A. Gorinchem, O.A., no. 2178. One other estimate of horsepower costs is available. The Rotterdam–Utrecht beurtveer made use of horses over a portion of its route. In 1663 the horse costs amounted to 70 stuivers per trip. The total distance was 75 kilometers, which yields a horsepower cost of 0.93 stuivers per kilometer. Since the distance over which horses were employed was shorter by at least 22 kilometers (the distance Rotterdam–Gouda), the real cost must have been at least 1.3 stuivers per
Notes to pp. 168–181

kilometer. (G.A. Utrecht, Archief 1577–1795, no. 566.)
30. G.A. Alkmaar, O.A., no. 1882 (the cost of 9 barges in 1660 was f430 each); G.A. Leiden, Trekvaarten en jaagpaden, no. 183, Leiden–Utrecht register, 1664 (the barges cost f410 each); G.A. Gorinchem, O.A., no. 2179. In this last document, the costs of a new barge bought in 1664 are specified as follows: the barge itself, f500; sails and coverings, f272; paint, f74; fittings, f17.8; for a total cost of f863.8.
31. G.A. Amsterdam, Part. archief no. 16, Wegen en vaarten, no. 19.
32. G.A. Leiden, Trekvaarten en jaagpaden, no. 70.
33. G.A. Delft, 1e afdeling, no. 1060.
34. G.A. Gorinchem, O.A., no. 2178.
39. This program was administered by the Nationaal syndicaat.
40. G.A. Haarlem, kast 7, loket 14, bundel 11, no. 4.
42. G.A. Haarlem, kast 24, no. 45 (1097), ‘Vinders en schippers rekening,’ 1789.
43. Ibid., 1816.
44. G.A. Amsterdam, Part. archief no. 16, Wegen en vaarten, no. 19.
45. The cross-correlation of the two independent variables, rye price and winter temperature, is r = .20, significant at the 5 percent level.
# Chapter VI

1. The following is a table of implicit average labor productivity on various seventeenth- and eighteenth-century routes served by sailing vessels:

<table>
<thead>
<tr>
<th>Route</th>
<th>Average ship-km per day</th>
<th>Number of skippers</th>
<th>Date</th>
<th>Kilometers per day per skipper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam–Alkmaar</td>
<td>96</td>
<td>8</td>
<td>18th cent.</td>
<td>12.0</td>
</tr>
<tr>
<td>Amsterdam–Amersfoort</td>
<td>112</td>
<td>6</td>
<td>18th cent.</td>
<td>18.7</td>
</tr>
<tr>
<td>Amsterdam–Enkhuizen</td>
<td>220</td>
<td>22</td>
<td>1633–1703</td>
<td>10.0</td>
</tr>
<tr>
<td>Amsterdam–Enkhuizen</td>
<td>110</td>
<td>12</td>
<td>1703–</td>
<td>9.2</td>
</tr>
<tr>
<td>Amsterdam–Harlingen</td>
<td>222</td>
<td>12</td>
<td>18th cent.</td>
<td>18.5</td>
</tr>
<tr>
<td>Amsterdam–Workum</td>
<td>182</td>
<td>12</td>
<td>18th cent.</td>
<td>15.2</td>
</tr>
<tr>
<td>Amsterdam–Zwolle</td>
<td>206</td>
<td>16</td>
<td>18th cent.</td>
<td>12.9</td>
</tr>
<tr>
<td>Rotterdam–Nijmegen</td>
<td>200</td>
<td>17</td>
<td>1800</td>
<td>11.8</td>
</tr>
<tr>
<td>Groningen–Lemmer</td>
<td>114</td>
<td>8</td>
<td>1756–1814</td>
<td>14.3</td>
</tr>
<tr>
<td>Dordrecht–Antwerp</td>
<td>86</td>
<td>5</td>
<td>1693–</td>
<td>17.2</td>
</tr>
<tr>
<td>Rotterdam–Utrecht</td>
<td>130</td>
<td>8</td>
<td>1663</td>
<td>16.3</td>
</tr>
</tbody>
</table>

In 1795 the six Harderwijk skippers completed 120 round trips, i.e., 6.0 kilometers per day per skipper.

In 1824 the official schedules show 16 skippers sailing 865 kilometers per week, or an average of 7.7 kilometers per day per skipper.

**Notes:**


5. The capacity figures are guesses based on reasoning outlined in the text and knowledge of the effective capacity of modern-day airline services. On routes served by several daily flights load factors in excess of about 60 percent are regarded as imposing unacceptable levels of inconvenience on the traveling public because the incidence of waiting lines grows exponentially with arithmetic increases in load factors.

6. See chapter V (p. 168) for this evidence.


8. See chapter III, table 3.4 and p. 76.


11. G.A. Amsterdam, Notariële archieven, no. 2968, fol. 177–179, 10 Maart 1667. This source was kindly provided to me by Dr. Simon Hart, emeritus archivist of the City of Amsterdam.

386
Notes to pp. 197–204

CHAPTER VII

1. See tables 9.1 and 9.2.


3. See figures 6.1 and 6.3.


10. Ibid., no. 248, ‘Generaal plan voor het tarief voor het veer op Delft,’ n.d. [circa 1740].


14. Ibid., 1717. Despite the existence of locks at Leidschendam, the skippers did not sail through to their destinations. Instead, they continued to force their passengers to disembark and board other barges waiting on the other side of the locks. Passengers were apparently very put out by this requirement. The ordinances (here and on the Amsterdam–Haarlem route, where a similar maneuver was necessary) made much ado, about the rule that guaranteed passengers the same seat in the new barge that they had had in the old one.

15. Ibid., 22 September 1752. The cessation of the 23:00 departure from Leiden had, in fact, no discernible effect on the connecting 18:00 departure from Haarlem. The cessation of the northbound 23:00 departure from Delft did have some effect on the connecting 3:30 departure from Leiden to Haarlem. In the six years before discontinuance an average of 1407 passengers per year used that 3:30 departure. In the six years thereafter only 868, or 62 percent of the initial volume, made use of it. What is perhaps more important, however, is that even before 1729 the passenger loads on this early morning departure were only 37 percent of the average passenger load of all departures.


Notes to pp. 204–224


22. G.A. Amsterdam, Part. archief no. 16, Wegen en vaarten, no. 19. The accusation seems true. Beginning around 1790 the number of passengers recorded by the Haarlem skippers was systematically less than that recorded by their Amsterdam counterparts. There is also some evidence that the Haarlem skippers employed the same tactic on the Haarlem–Leiden route. In the quantitative data presented in later chapters this underreporting has been compensated for.

23. I wish to thank Professor D.J. Roorda for discussing with me the historical plausibility of this policy motive.


27. For an account of a trip on the vliegende schuit that must have been taken just before 1843, and that conveys how impressive the extra few kilometers per hour were to the traveling public of that time, see Hendrik de Veer, ‘De Vlieger wacht niet!’ Toen… en nu (1877).


Chapter VIII


3. These figures assume a population of 1.2 million and a labor force participation rate of 67 percent.

4. It is the burden of Colin M. White's investigation of the social saving concept that its application yields significant underestimates of the 'true' economic benefits conferred by railroads. This he finds to be particularly true in his own application of Fogel's methodology to Russian railroads in the 1870s. It is noteworthy that precisely the conditions that he regards as increasing the likelihood of underestimation (p. 100) are absent or relatively unimportant in the Dutch case being considered here.


6. Fishlow, p. 32.

7. Ibid., p. 23.

8. The only detailed records of postal coach operating costs that I have found refer to the Amsterdam–The Hague route in the period 1815–1824. The total expenses amounted to 12 st. per coach-kilometer. Such a level of expense, when applied to
the 9.4 million coach-kilometers needed to replace the trekschuiten, produces the fantastic total cost of £5.6 million or four times my original estimate of coach costs. Operating costs in 1815 considerably exceeded seventeenth- and eighteenth-century costs, and the 12 st. per coach-kilometer figure includes taxes and tolls that should be excluded in the estimation of social saving. But when all these factors are discounted, the cost of operating coaches remains extremely high. Each of the 16 horses maintained to operate this service were run an average of 15.5 kilometers per day and the annual maintenance cost usually exceeded £1,000 per horse. G.A. Amsterdam, Part. archief 11, Commissie uit de regering van Amsterdam en 's-Gravenhage voor de postwagens rijzend tussen deze steden, no. 1.


12. Hawke, Chapter Two.


15. Figure 8.1 and the discussion in the next two paragraphs follow closely the approach of Boyd and Walton, pp. 241–243.

16. A telling example of the unattractiveness of beurtveren when a trekschuit alternative was available is provided by the history of the Amsterdam–Enkhuizen beurtver. All through the seventeenth century two ships set sail in each direction daily, one at 8 a.m. and a second in the evening. Since the sea route between these two cities is considerably shorter than the trekschuit-coach (via Hoorn), the 10 st. passenger fare of the sailing vessels was only one-third of the trekschuit-coach alternative. But in 1693 and again in 1703 the skippers petitioned that their service be reduced by half; their reasons were the ‘general decline of commerce’, and ‘the competition of the postal coach to Hoorn [and the connecting trekschuiten]’. D. Brouwer, *Enkhuizen, aantekeningen uit het verleden* (Enkhuizen, 1948), pp. 199–200.

17. Recall from evidence presented in chapter II that many seventeenth- and eighteenth-century coaches did not even attain the modest average speed of the trekschuit.

18. At the fall of the Republic, in 1795, no more than about 400 kilometers of road had been paved. By the end of the French period, in 1814, an additional 300 kilometers had been paved, including the routes connecting the large cities of central Holland. During the reign of King Willem I considerable attention was given to road improvement.

   The steamboat, a second competing mode of transportation is first used to carry passengers in inland navigation in 1823. It rapidly replaced sailing vessels on many routes on the Zuider Zee and in the Delta. However, it was not yet used on the trekvaarten in this period. For a list of steamboats in use in North Holland in 1851 see *Verslag van den toestand der provincie Noordholland over het jaar 1851*, p. 500.


20. A few months after the inaugural run of the Amsterdam-Haarlem railroad, in January, 1840, the old hourly trekschuit service had been reduced to two daily departures. In this much-reduced form barges continued to serve the route until 1860. Despite its formal disbandment in that year, one continues to read of a single daily barge connecting the two cities as late as 1883. J. M. Fuchs, ‘Amsterdam–Haarlem Beurtverete’, *Haarlems Jaarboek* (1939), 102–103.

21. *Verslag der Hollandsche IJzeren Spoorweg Maatschappij*, 1870. The other Dutch railroad companies also depended heavily on passenger traffic. As late as 1878 passengers accounted for 60 percent of the revenues of the five largest railroads. H. P. H. Nusteling, *De Rijnvaart in het tijdperk van stoom en steenkool*, 1831–1914 (Amsterdam, 1974), Bijlage 18, p. 495.


24. Beginning in 1815 the Dutch currency was decimalized. One stuiver, which had been one-twentieth of a guilder, then equalled five cents.

25. R.A. Utrecht, Staten van Utrecht, no. 940, Resolutiën van de gecommitteerden, 1845.

26. G.A. Haarlem, Archief Franse tijd, W88 (120), 'Manuaal van inkomsten en uitgaven aan de Leidse trekvraat'; G.A. Leiden, Secretarie archief, nos. 9050, 9051, 9075, Trekvraat rekeningen.' The Leiden–Delft route continued to attract 6000 to 7000 passengers annually in the two years that the railroad did not extend beyond The Hague. As soon as it served Delft directly travel on the Leiden–Delft barges fell to 3000 per year.

27. Jonkers Nieboer, p. 27.

28. Verslag van den toestand der provincie Noordholland over het jaar 1851, pp. 500–501. The estimate of market share was made by combining the travel volume recorded in this document with that reported in the Verslag der Hollandsche IJzeren Spoorweg Maatschappij, 1851.

29. A great deal of information about the types of travelers using the various modes of transportation just prior to the coming of the railroad is conveyed in Hildebrand [Nicolaas Beets] Camera Obscura. See also, 'Rapport van de commissie tot onderzoek van den aanleg van spoorwegen in Nederland,' 19 April 1836.


32. Verslag der Hollandsche IJzeren Spoorweg Maatschappij, 1848–1871.

33. The only direct observation I have found of pre- and post-railroad travel volumes for first class passengers refers to the Amsterdam–The Hague route. The volume of first and second class rail travel between these cities in 1855 was 250 percent of the annual volume of coach travel in the period 1829–1824. This jump in volume from 5000 to 17,700 passengers is consistent with the following combinations of values for \( e \) and \( V \): \( e = -1.6, V = 0.1; e = -1.4, V = 0.6 \). G.A. Amsterdam, Part, archief no. 11, Commissie uit de regering van Amsterdam en ’s-Gravenhage voor de postwagens rijdend tussen deze steden, no. 2.

34. J. Teijl, 'Nationale inkomens van Nederland in de periode 1850–1900,' Economisch- en sociaal-historisch jaarboek 34 (1971), 232–282. See also, J. H. van Stuijvenberg, 'Economische groei in Nederland in de negentiende eeuw: een terreinverkenning.' In P. W. Klein, ed., Van stapelmarkt tot welvaartstaat (Rotterdam, 1970), pp. 52–74. The reader will note that GNP estimates for the mid-nineteenth century greatly exceed those we have used for the seventeenth through early nineteenth centuries. The implied discontinuity, in the face of economic stagnation, wage stability, and rough price stability, remains to be explained.

35. C. Soetens and E. J. van Starkenborgh Strachouwer to Wehe, Iets over de ijzerbanen en het asphaltspoor in de straatweg van Amsterdam op Rotterdam (The Hague, 1844).

36. 'Rapport van de commissie tot onderzoek van den aanleg van spoorwegen in Nederland,' 19 April 1836. The commission concluded that railroads might be built, but that it did not appear that they would serve a crying, unfulfilled need. This accurate conclusion has often been cited by historians as an example of nineteenth-century Dutch complacency and fear of innovation.


CHAPTER IX


2. The passenger volume figures for each of the five sub-routes that comprised the Amsterdam–Hoorn trekvaart declined steadily throughout the second half of the eighteenth century. By the end of the century the average number of passengers per barge that set sail was below one! This by itself renders the data suspect, but in addition the ratios of passenger volume among the five sub-routes, which exhibit long-term stability before the mid-eighteenth century, become highly erratic. In some years more passengers are recorded on the segments connecting small cities than on those serving Amsterdam. In short, the passenger volume data recorded for the second half of the eighteenth century do not inspire confidence. However, the source of error is not known.


4. See tables 3.4 and 3.5.

5. See, for instance, the *Nieuwe geographische Nederlandsche reise- en zak-atlas* (Amsterdam, 1773).

6. For sources see chapter VII, footnote 5.


9. This is the recommendation of the *Nieuwe geographische Nederlandsche reise- en zak-atlas*; Benjamin Silliman, *A Journal of Travels in England, Holland, and Scotland... in the years 1805 and 1806* (New Haven, 1820); Joseph Marshall, *Travels through Holland, Flanders... in the years 1768, 1769, and 1770* (London, 1772).

10. See chapter VI, pp. 188–189.


12. G.A. Haarlem, Trekvaarten en veerdiensten, nos. 13–27, Rekeningen, Amsterdamse trekvaart. The annual consolidated financial statements show large deficits for the years 1762 through 1766. Altogether, the two cities spent f335,000 in excess of normal maintenance expenditures in those five years. Since this capital investment was recorded as a current expense there is no other way to distinguish it from the true current expenses. The source of this capital is also not specified. We know only that it was made available to the trekvaart commissioners by the city treasuries. No interest rate or repayment conditions were mentioned. Presumably, there were none. For the construction costs of the paved road between Rotterdam and Gouda see J. E. J. Geselschap, ‘De straatweg Rotterdam–Gouda (1680–1857) en het Goudse wagenveer (1653–1852),’ *Rotterdamse jaarboekje* 8 (1970), 213–214.

13. G.A. Haarlem, Trekvaarten en veerdiensten, nos. 13–27, Rekeningen, Amsterdamse trekvaart. Only after 1795, when toll collections were again handled directly by the cities, is this large gap between the official revenues of the two tollbooths diminished.
The possibility is strong that fraud or favoritism played a role in the leasing of the tollbooths in the intervening years, rendering these tollbooth lease revenues of little value as an economic indicator. Militating against this view, however, is the fact that the total lease revenue in the period 1768–1795 generally exceeded the direct revenues of the post-1795 decade.


16. G.A. Amsterdam, Part. archief no. 16, Wegen en vaarten, no. 20, ‘Dagstaat der ontvangers van de tolgelden aan het hek en de brug bij Sloterdijk,’ 1 t/m 31 May 1837.

17. G.A. Leiden, Trekvaarten en jaagpaden, no. 137, Leiden–Haarlem rekeningen; G.A. Haarlem, L313–323 (1078), or Trekvaarten en veerdiensten, nos. 40–60, Haarlem–Leiden rekeningen. A clue to the character of travel on this towpath is the provision in the Warnsmond tollbooth tariff schedule that reduced by half the tolls levied on Saturdays. Saturday was Leiden’s most important market day.

18. At any rate, this was the conclusion of the Leiden official assigned to the task of explaining the fluctuations in the northbound collections. G. A. Leiden, Trekvaarten en jaagpaden, no. 70, ‘Remarques op ’t gabel van de trekpaarden tussen Leyden en den Leysendam,’ 1714.


21. R.A. Utrecht, Staten van Utrecht, nos. 950, 951, ‘Contra rollen van de verpachting van passagiegeld.’ Note that these routes are not trekvaart towpaths.


The only other tollgate series that I have for the northern provinces refers to the three tollgates along the Harlingen–Franeker–Leeuwarden towpath. They register a more modest 20 percent increase between 1748–58 and 1780–1802. The evidence for the period 1678–1748 is incomplete, but toll receipts fell steadily and substantially from 1655 to 1678. (G.A. Harlingen, O.A., no. 736.)

24. G.A. Groningen, O.A., no. 332r, Stadsrekeningen, 1660–1809, and Plakkaten, no. 70, 28 July 1654. The Foxhol tollgate was leased for annual sums that rarely strayed from about 1250 guilders in the period 1670–1752. Each passing wagon was charged 4 st. while each pedestrian paid 4 placken (¼ stuiver).

25. W. Albert, *The Turnpike Road System in England, 1663–1840* (Cambridge, 1972). Of the major paved roads in Holland, that connecting Hoorn and Enkhuizen was massively unprofitable. Revenues were often no more than 30 percent of expenses. The depressed economy of eighteenth-century North Holland may account for this, but no such excuse can dismiss the financial results of the Gouda–Rotterdam paved road. Even before deducting anything for interest payments on the invested capital this road lost money in the 1730s, 1770s, and through most of the first half of the nineteenth century (Geselschap, ‘Rotterdam–Gouda,’ p. 216). The long delay in the completion of the road paving project between Den Bosch and Liege (work was begun in 1740 and not completed until the nineteenth century) also testifies to the lack of financial viability of road improvement schemes in this area.

26. The most complete discussion is found in Johan de Vries, *De economische achteruitgang der Republiek in de achttiende eeuw* (second edition, Leiden, 1968). But see also Van der
Notes to pp. 274–279


27. The literature that presents and interprets the evidence left by this tax includes H. E. Becht, *Statistische gegevens betreffende den handelsomzet van de republiek der Vereenigde Nederlanden gedurende de 17e eeuw* (1579–1715) (The Hague, 1908); J. G. Westermann, 'Statistische gegevens over den handel van Amsterdam in de zeventiende eeuw,' *Tijdschrift voor geschiedenis* 61 (1948) 3–15; Johan de Vries, *Economische achteruitgang.*


31. Posthumus, *Lakenindustrie,* 3: 1142. This index was preferred over Posthumus' 'cost of living' index. The latter index is heavily weighted with bread grains, an article with which passenger transportation probably did not interact as a substitute or complement. The price of bread grains probably had a greater impact on passenger travel through the income effect, a subject discussed in chapter X.

31a. Sources: 1622: J. G. van Diljen, 'Summiere staat van de in 1622 in de provincie Holland gehouden volkstelling,' *Economisch-historisch jaarboek* 21 (1940), 167–189. 1795: Volks-telling in de Nederlandsche Republiek (The Hague, 1796). Between 1622 and 1795 no overall census was held. As a consequence, the population figures displayed above are estimates based on local sources.

Amsterdam: E. Boekman, 'De bevolking van Amsterdam in 1795,' *Tijdschrift voor geschiedenis* 45 (1930), 278–290; M. Houttuyn, *Bedenkingen over de sterfelijkheid en het getal des volks te Amsterdam in vergelijking met andere plaatsen* (Amsterdam, 1783); P. Schraa, 'Onderzoekingen naar de bevolking van Amsterdam tussen 1550 en 1630,' *Jaarboek Amstelodamum* 46 (1954), 1–33; Leonie van Nierop, 'Het zielental van Amsterdam in het midden van de achttiende eeuw,' *Maandblad Amstelodamum* 38 (1951), 151–154; Simon Hart, *Bronnen voor de historische demografie van Amsterdam in de 17de en 18de eeuw* (Historisch-demografische kring, 1965); Simon Hart, *Geschrift en getal* (Dordrecht, 1976), pp. 118–120. My estimates generally follow those of Hart. The greatest problem is in estimating the mid-eighteenth-century population. Several scholars have suggested population figures considerably higher than my estimate.

Haarlem: Nicolaas Struyck, *Vervolg van de beschrijving der staartsterren en nadere ontdekkingen omtrent den staat van 't menschelijk geslag* (Amsterdam, 1753), pp. 112–113. This source cites several local censuses on which my figures are based. Leiden: N. W. Posthumus, *De geschiedenis van de Leidsche lakenindustrie* (The Hague, 1939), 3:1997–1200. My estimates are based on the annual number of baptisms recorded in the city. The Hague: G.A. The Hague, O.A., no. 1172, 'Veraameling van nauwkeurige lijsten opgemaakt uit oorspronkelijke registers betreffende sterfte, geboorte, en huwelijken in 's-Gravenhage: 1755–1773'; *Zeven Eeuwen 's-Gravenhage* (The Hague, 1948), pp. 129–131. My estimate is based on local counts of houses and families. After 1755 the record of burials is available to check on the validity of the coefficients used to estimate populations from the number of houses. Delft: J. Rogier, 'De betekenis van de terugkeer van de Minderbroeders te Delft in 1709,' *Archief voor de geschiedenis van de Katholieke Kerk in Nederland* 2 (1960), 169–204; A. M. van der Woude, *Het Noorderkwartier,* 3 vols. (Wageningen, 1972), 3: 796. The annual number of baptisms, available from 1665, is the basis for the eighteenth-century estimates. Rotterdam: This is the only major city of the Dutch Republic for which a thorough demographic analysis has been made. A. M. van der Woude and G. J. Mentink, *De demografische ontwikkeling te Rotterdam en Cool in the XVII en XVIII eeuw* (Rotterdam,
Notes to pp. 281–294

te weten de probable meeninge des volks in de provintie van Holland en West-Vrieslandt...*
(The Hague, 1742). Kerseboom provides parish register information for the period
1700–1739. This together with house counts for the 1660s and 1732 is the basis for
my admittedly shaky estimates. Gouda: J. M. Kramer, 'De bevolkingsterke van
Gouda tussen 1550 en 1650,' (unpublished manuscript, G.A. Gouda); Kerseboom,
pp. 39–42; G.A. Gouda, O.A., no. 2300, 'Quohier van het familiengeld.' The early
eighteenth-century estimate is based on a comparison of the number of households
enumerated in the *familiengeld* tax, marriages, and burials in Gouda and Alkmaar.

32. For literature on the gravity model see W. Isard, et al., *Methods of Regional Analysis, an
introduction to regional science* (Cambridge, Mass., 1959), pp. 493–568; Gunnar Olsson,
*Distance and Human Interaction. A Review and Bibliography* (Philadelphia, 1965); Roger E.
Alcaly, 'Aggregation and Gravity Models: Some Empirical Evidence,' *Journal of
Concepts of Human Interaction,' *Journal of the American Institute of Planners* 22 (1956),
94–102.


34. Edward J. Taaffe and Howard L Gauthier, Jr., *Geography of Transportation* (Englewood Cliffs,

35. *Verslagen der Hollandsche IJzeren Spoorweg Maatschappij,* 1855–1864. The only other
attempt to make use of these data (which were published annually until 1890) is
A. C. de Voors, 'Het reizigersverkeer der Nederlandse Spoorwegen in de tweede
half der 19e eeuw,' *Geografisch tijdschrift,* vol. 16, pp. 10–13.

36. In 1854, the last year in which the *HYSM* offered the only rail service between
Amsterdam and Rotterdam, 59,795 passengers were carried. In 1857 the HYSM
carried only 40,006, but the new Rijn-Spoorweg-Maatschappij reported the move­
ment of 39,338 passengers between Amsterdam and Rotterdam on its route via
Utrecht. The total flow of traffic between these city pairs had, thus, risen to over

37. That is, one calculates $\sum_{i=1}^{n} (I_{ij})$ for each $j$.

38. Seven cities, rather than six, because Schiedam has been added to the six cities of
the gravity model exercise.

39. For further information on this technique see Abler, Adams, and Gould, *Spatial
Interaction,* pp. 265–266.

40. The effect of changes in the value of $b_2$ can most effectively be demonstrated through
an example: consider the two city pairs Haarlem–Dordrecht and Amsterdam–
Rotterdam. Other things remaining equal, a $b_2$ value equal to 0.5 would imply that
there would be 6 times as many Amsterdam–Rotterdam travelers as Haarlem–
Dordrecht travelers. Were the value of $b_2$ found to be 1.0, Amsterdam–Rotterdam
travelers would exceed Haarlem–Dordrecht travelers by 33 times. With a $b_2$ equal
to 1.5, the ratio rises to 187.

41. This was the view of Christianus Schotanus, author of the *Chroniek van Vriesland
*(Franeker, 1664), p. 259. In the next century Harlingen’s leading position was success­
fully challenged by Lemmer, but observers often continued to give the honor to

42. See, for example, Alcaly, 'Aggregation and Gravity Models.' In this study of traffic
in the state of California the distance exponent ($b_2$) varied by transport mode as
follows: automobile, 2.6; bus, 1.3; train, 1.2; airplane, 0.3.

43. The railroad distribution is based on data supplied in *Verslag der Hollandsche IJzeren
Spoorweg Maatschappij,* 1861, p. 31.

44. Since the trekschuit network of 1660–70 was more extensive than the *H.Y.S.M.* rail-
394
road of 1861, longer-distance trips are probably somewhat over-represented.

45. Time and again, such fragmentary evidence as I have been able to assemble with regard to Utrecht shows travel volumes that exceed one's expectations based on the population of the city. See chapter VI, pp. 187–188, (where 1665 trekschuit travel between Amsterdam and Utrecht was found to be two- to three-times greater than the 'expected' amount) and chapter XII, p. 370, table 12.1. The hinterland explanation is stressed by the authors of the Nieuwe geographische Nederlandse reis- en zak-atlas who describe the Amsterdam–Utrecht trekvaart as ‘one of the liveliest and most important routes because of the many travelers who proceed to Germany and the Austrian Netherlands via Utrecht’.

46. The 1800–06 values for table 9.3 are (using the 1740–50 base period):

<table>
<thead>
<tr>
<th>Column</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10.8</td>
<td>118</td>
<td>130</td>
<td>.91</td>
<td>9.8</td>
<td>8.9</td>
<td>+0.9</td>
<td>+10.0</td>
</tr>
</tbody>
</table>

47. J. van Heukelom, ‘Prijsverhandeling over de inrichting van fabrieken en traafelijk,’ Verhandelingen van het prov. Utrechtsch genootschap van kunsten en wetenschappen (Utrecht, 1781), pp. 8–10; De Borger 1 (1778), 32. See also Johan de Vries, Economische achteruitgang, pp. 171–172. This view is also upheld in P. W. Klein, Kapitaal en stagnatie tijdens het Hollandse vroegkapitalisme (Rotterdam, 1967), pp. 8–10. It is, however, directly contradicted by a more recent investigation: Joel Mokyr, Industrialization in the Low Countries, 1795–1850 (New Haven, 1976), ch. 7.

Chapter X


6. I am grateful to Prof. D. J. Roorda for drawing my attention to the possible significance of several of the events mentioned in the above paragraphs.


15. If the ordinary level of winter demand stood at about 60 percent of that for the year as a whole, each winter day would ordinarily account for $1/365 \times 0.6$, or 0.16 percent of total annual traffic. If each icebound day reduced annual traffic by 0.15 percent, as the regression equations claim, the conclusion follows that very nearly no winter trips could be postponed to a later time.

16. Jan de Vries, 'Histoire du climat,' tableau III. The correlation coefficient of the variation in average winter temperature and rye prices in the period 1635–1839 was -.14.

17. Standard error of the difference test with rye prices as the independent variable:

<table>
<thead>
<tr>
<th></th>
<th>1633–1710</th>
<th>1711–1813</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mean passenger travel demand (expressed as percentage deviation from the 15-year moving average) in years of high rye prices:</td>
<td>+4.01%</td>
<td>-2.46</td>
</tr>
<tr>
<td>2. Mean passenger travel demand (expressed as percentage deviation from the 15-year moving average) in years of low rye prices:</td>
<td>-3.03</td>
<td>+1.48</td>
</tr>
<tr>
<td>3. Absolute difference of means (line 1 – line 2):</td>
<td>7.04</td>
<td>3.94</td>
</tr>
<tr>
<td>4. Standard error of the difference:</td>
<td>3.28</td>
<td>1.11</td>
</tr>
</tbody>
</table>

1633–1710: $Z$ (the standard normal deviate) $2.15 > 1.96$ (the 5% significance level).

1711–1813: $Z$ (the standard normal deviate) $3.55 > 1.96$ (the 5% significance level).


19. The convooien data have been drawn from J. C. Westermann, 'Statistische gegevens over den handel van Amsterdam in de zeventiende eeuw,' Tijdschrift voor geschiedenis 61 (1948) 3–15 and Johan de Vries, Économische achteruitgang, pp. 188–190.

**Chapter xi**


2. The VOC ships bound for the East Indies sailed in three annual fleets, one departing around Christmas, the second in April, and the third in September. The returning vessels usually arrived more-or-less together in the late summer or fall.

3. See T. S. Ashton, Economic Fluctuations in Eighteenth Century England (Oxford, 1959) for many additional illustrations. For the seasonal scarcity of money problem, see Jean Meuvret, 'Monetary Circulation and the use of Coinage in Sixteenth and
Notes to pp. 332–352

4. G.A. Groningen, O.A., no. 742r, ‘Questie met de stadt Doccum over de trekweg.’
6. Verslag van den toestand der provincie Noordholland over het jaar 1851, p. 404.
7. This figure is reached by dividing the total average annual passenger kilometers produced in the 1660s (37.8 million) by the average trip length (22 km.). The product is then divided by the number of days per year, which product is multiplied by a summer adjustment factor (1.33) which expresses the ratio of average summer-month travel to the annual average.

Chapter XII

1. Both the number of travelers between Purmerend and Alkmaar and the transportation services used by those travelers are unclear. The Alkmaar archives mention a trekvaart connecting the two cities. Its route utilized the encircling canals (ringvaart) of the two great lake drainage projects that stood between the two cities, the Beemster and Schermer polders. (G.A. Alkmaar, O.A., no. 1889, ‘Stukken betreffende het plan tot aanleg van een trekvaart tussen Alkmaar en Purmerend in 1661’; Ordonnanties, AKIG, 7h; AKIF, 10n.) The latter ordinance, dated 1775, sets the adult fare at 6 stuivers. This implies that the planned route had, in fact, become a reality, but it is stunning that no guide books ever mention the route, no schedules have been uncovered, and no financial records seem to have been generated by its operation. Another possible means of traveling between the two cities was by wagon. The two big polders standing between them had reasonably good roads.

2. The population exponent of the gravity model, $b_1$, rose from about 0.85 in the 1660s and 1700s to about 1.15 in the 1740s and 1790s. See table 9.5.

3. There had long been a shipping service connecting Rotterdam with Brielle, but in 1763 it was renovated. Then the cities established a service from which heavy freight was banned and which was to follow a regular schedule (to the extent possible given the tides). Nederlandsche Jaarboeken 17 (1763), 249–255. Two years earlier a beurtveer was established serving the Zeeland city of Goes. The premium fare, summer season only Rotterdam–Antwerp coach began service in 1751, while the daily, summer season only coach from Rotterdam to Maassluis is first mentioned in 1793.

4. Simon Hart, ‘Geschrift en getal. Onderzoek naar de samenstelling van de bevolking van Amsterdam in de 17e eeuw, op grond van gegevens over migratie, huwelijk, beroep en alfabetisme,’ in Simon Hart, Geschrift en getal (Dordrecht, 1976), pp. 115–181. These migration data are drawn from the place of birth recorded for all persons who married in the city of Amsterdam. The data cannot claim to comprehend all migrants to the city. But, given the characteristic age distribution of migration and the relatively late average marriage age (over 27 for both men and women) it is likely that the 650,000 persons who married in Amsterdam between 1601 and 1800 provide a reasonable basis for the study of migration to the city.

5. The gravity model, used in chapter IX, takes the general form $I_{ij} = M_i M_j / d_{ij}$, where $M$ is some measure of the size, or mass of the interacting places $i$ and $j$, and $d_{ij}$ is the distance between $i$ and $j$. Using the same notation, potential, which measures the proximity of a single place to all other places in the system, can be expressed as: $V_i = \sum_{j=1}^N M_j / d_{ij}$.

In the following paragraphs I adopt this expression for potential to the study of migration to a single city from its hinterland. Potential measures the expected flow of migrants from each city $j$ to the mass of each city $i$ is regarded as its population. For


7. See chapter VI, p. 195.

8. See chapter IX, pp. 283–284 and figure 9.8.


J. A. Faber, De oligarchisering van Friesland in de tweede helft van de zeventiende eeuw, 1970, p. 39-64.


A. M. van der Woude, Het Noorderkwartier. Een regionaal historisch onderzoek in de demografische en economische geschiedenis van westelijk Nederland van de late middeleeuwen tot het begin van de negentiende eeuw, 3 dln., 1972, 858 p.


A. M. van der Woude, Het gebruik van begrippen ontleend aan de sociale wetenschappen bij het analyseren van economische en sociale verschijnselen in het verleden, 1973, p. 3-22.


C. Baars, Boekhoudingen van landbouwbedrijven in de Hoeksewaard uit de zeventiende en achttiende eeuw, 1975, p. 3-135.


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