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A COMPARISON OF THE EFFECTIVENESS OF INCENTIVES AND DIRECTIVES: THE CASE OF DUTCH WATER QUALITY POLICY

The Netherlands is a small country, approximately the size of Maryland and Delaware combined. Yet, it has much industry and, with a population of some 14 million people, it has one of the highest population densities in the world. Criss-crossed with thousands of miles of waterways of all sizes, it is also a country rich in surface waters. By 1970, the year the Pollution of Surface Waters Act went into effect, industry and private households were producing roughly 45 millions of population equivalents[1] of oxygen-consuming organic pollution. As a result, overall water quality in the country had, in plain terms, become rotten--both figuratively and literally! But by 1980, organic pollution caused by industrial production had declined by two-thirds. Almost half of the remaining organic pollution, from both industry and households, was removed in sewage treatment plants, many of which had been newly built. Everywhere biologically "dead" waters revived. In light of the results achieved, water quality policy is regarded in The Netherlands as one of the few examples of effective governmental intervention (Hoogerwerf, 1985).

Government intervention can take many forms and in the case of Dutch water quality policy many different instruments are involved. Production of collective goods by the state (the treatment of sewage in plants owned by local water boards) has been a major component of this policy. In this article, however, I want to focus on those aspects of the policy that deal with the regulation of industrial water pollution. This regulation works with a mix of different policy instruments, including not only instruments of direct regulation but also the much-disputed instrument of indirect regulation, the effluent charge. As far as the level of charges levied, the Dutch system of effluent charges is the most substantial in the world (Johnson & Brown, 1976). It is also one of the oldest systems in operation.

The use of effluent charges as an instrument of regulatory policy has been the object of much dispute, as much in The Netherlands (Bressers, 1985) as in the United States (some interesting examples from the high point of this discussion in the USA are: White, 1976; Majone, 1976; Rose-Ackerman, 1977; McSpadden-Wenner, 1978). The controversy between advocates and opponents of replacing directives by incentive strategies in various fields of public intervention has always been rather heated, though carried on more in terms of theory than empirical evidence drawn from experience with charges in actual operation (cf. Mitnick, 1980, pp. 373-383). Much like permit trading, an incentive approach actually used in the United States, regulatory effluent charges in The Netherlands more or less "sneaked in through the back door" (Oates, 1983). The Dutch system of

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water quality charges had originally been designed to fulfill a revenue raising function. Indeed, until the publication (Bressers, 1983) of the results of the research on the actual operation of this system of charges reported on in this article, many environmental organizations, political parties and students of environmental policy (especially lawyers), doubted whether these effluent charges had any regulatory effect at all.[2]

A BRIEF SURVEY OF DUTCH WATER QUALITY POLICY

In an effort to combat pollution at the source, the 1970 Pollution of Surface Waters Act prohibits all nonlicensed discharges into surface waters. Indirect polluters, those discharging into a sewage collector, must meet the conditions imposed by municipalities for those hooked up to the collection system. In turn, the municipalities are often subject to conditions from the water authorities regarding the quality of the sewage that they discharge into the treatment plants of the water boards. In the Netherlands, the water boards own and operate the treatment plants. In the past decade, an enormous effort was made to expand effluent treatment capacity, with the result that the amount of organic pollution removed from sewages discharges increased to 25 percent in 1975 and to 46 percent in 1980. This removal rate put The Netherlands more or less on par with its neighboring countries.

The "polluter pays" principle is the basis for the effluent charges of the Pollution of Surface Waters Act. Officially, the sole purpose of these charges is to raise the money needed to finance sewage treatment measures. In view of the ambitious program for expanding treatment capacity, these charges involve large amounts of money. In 1971, they generated revenues of about \$30 million; in 1975 approximately \$200 million; in 1980 almost \$450 million; and in 1985, \$550 million.

In The Netherlands each firm has to pay a fee roughly according to the amount of pollution it produces. The amount of pollution is calculated in pollution units called "population equivalents." A population equivalent is defined as being equivalent to the amount of organic pollution in wastewater normally produced by one person. The fee per pollution unit rose sharply during the period the charge system has been in effect (moving from about \$6/unit to about \$30/unit). The fee charged varies according to the region within which the firm is located. These regional differences are not, however, based on different environmental conditions or quality objectives but rather reflect regionally different costs of building and operating treatment plants.

The unique features of The Netherlands system make it an interesting example of the use of charges. The Dutch system of effluent charges has been in operation since 1970 and, in terms of the level of the charges, is more than twice as large as the comparable German program (Brown & Johnson, 1983). But the most distinguishing feature of the Dutch system is that its use as a regulatory instrument has been "accidental." It was not intended to work in this way. Originally, the charges were to be used to finance the construction and operation of sewage treatment plants. In this sense, they did not replace the official intervention strategy of direct regulation. Given this situation, the Dutch case provides a unique opportunity to examine the effects of these two approaches as they were applied to the same case. It also was possible to collect for the period 1975-1980 data on industrial pollution by type of pollution, branch of industry and water district.[3] In addition, it was possible to collect information on the degree to which different water authorities employed various types of policy instruments. On the basis of these data, it was possible to draw inferences regarding the relative effectiveness of effluent charges and direct regulation based on a number of different statistical analyses.

In the following section, the degree of effectiveness, our dependent variable, will be defined. In section three, we will then look at three statistical analyses of the impact of the policy instruments used. These analyses are supplemented in section four by two expert assessments of these impacts. The final section presents some general conclusions regarding the Dutch experience with effluent charges.

Goal Attainment and Effectiveness: What has been accomplished?

The first question to be answered empirically regards trends in Dutch industrial water pollution during the period under investigation. These trends are examined in relation to the two most important types of industrial water pollution: oxygen-consuming organic pollution measured in PEs (so-called population equivalents) and heavy metal pollution.

In 1975, the year in which the first Multi-Year Indicative Program on water pollution control was issued, Dutch industry still produced a staggering 19,670,000 population equivalents (PE) of oxygen-consuming organic pollution. This was substantially more than the pollution produced by all Dutch households together. By 1980, the end of the period covered by the program, the total amount of industrially produced organic pollution had dropped to 14,331,000 PE. This represented a reduction of more than five million PE, or 27 percent. A decrease of roughly this magnitude had been projected by the 1975 policy program. There were, however, enormous regional differences. In some areas (water board districts) organic industrial pollution had actually increased, whereas in other areas this type of pollution had been reduced by more than one-half.

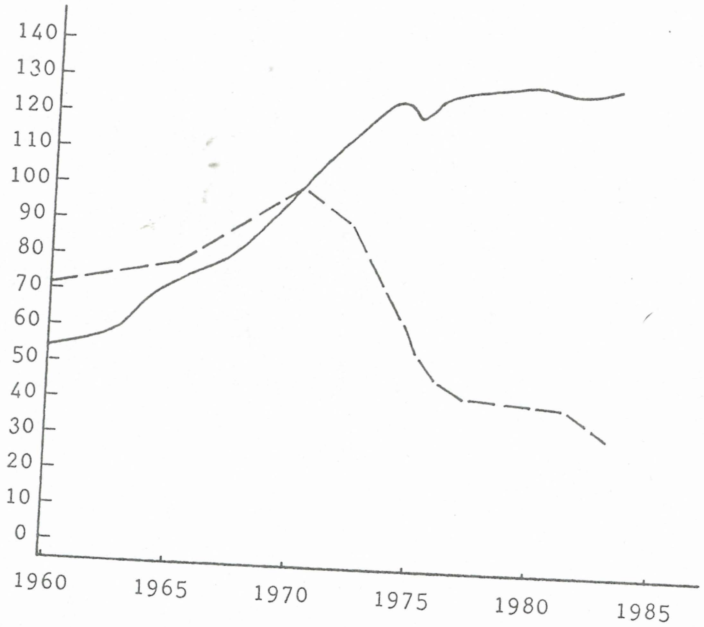
The 1975 program had set no explicit targets regarding the abatement of industrial water pollution with heavy metals. As was the case with organic pollution, there have also been huge regional differences in the amount of reduction attained in heavy metal pollution. In general, however, it can be concluded that industrial pollution with heavy metals has, on the whole, been reduced by approximately one-half in the period involved.

MEASURING EFFECTIVENESS I: MULTIPLE TIME SERIES

Without further analysis it is not clear whether these decreases in industrial wastewater pollution are in fact the results of the water quality policy pursued by the government. As is often the case in evaluating policy, it also was not possible in this case to employ a truly experimental research design in examining this question. For this reason, a number of other methods have been combined to determine the extent to which levels of pollution reduction attained can be attributed to the policy measures taken.

We first carried out a time-series analysis of the trends in industrial wastewater containing biodegradable organic substances. Until 1970, the year in which the water quality law went into effect, organic industrial pollution increased. Thereafter there was a sharp, continuous decline. (see Figure 1.) However, even such evidence of a striking decline does not, in itself, provide ironclad proof of a causal relation between the policy pursued since 1970 and the pollution reduction achieved, the more so as the policy was not abruptly introduced, but was implemented gradually. Before such a relationship can be established, it is necessary to consider alternative explanations for the decline observed.

Figure 1
Index Figures on the Amount of Industrial Production (solid line) and Oxygen-Consuming Industrial Pollution in Industrial Wastewater (dotted line)



The extent of pollution is obviously influenced by decisions taken by the industrial firms. In this connection, the relevant decisions are regarding:

- the overall level of production (to increase or decrease production)
- the amount of pollution produced per unit of production (to produce with more or less pollution).

The firm may decide to reduce production because the costs of water quality control are so high that maintaining the present level of production is not profitable. A 1972 Dutch Central Planning Agency study concluded that production level in 1983 would be 4.5 percent less due to the direct and indirect costs of water quality policy. It is, however, better to be cautious in this regard and to attribute any change in the level of production not to water quality policy but instead to such factors as economic recession, making production decline an alternative explanation for the pollution decline observed.

Figure 1 shows that, in fact, the volume of production did not decline, not even in the recessionary period of 1975-1980. At the same time, however, there was a dramatic decrease in pollution between 1970 and 1975, a time when the economy was booming. If we look at the separate branches of industry, in order to make sure that this overall decrease in pollution is not the result of a decline in production in some of the heavily polluting industries, we find that there are only a few industries that have experienced a decrease in production. Even if we assume that any decrease in pollution leads directly to a proportionate reduction in pollution (an overly-optimistic assumption!), the production decreases in these industries would result in a decrease in total oxygen-consuming industrial pollution of only 2 to 3 percent as compared with the actually recorded overall decline of 27 percent. A similar situation can be found with regard to pollution with heavy metals. Given the fact that production has, on the whole, tended to increase instead of decline, we can conclude that pollution per product unit has decreased more sharply than total pollution and that the level of pollution per product unit has decreased more sharply than total pollution and that the level of pollution reduction attained tends to underestimate the effectiveness of water quality policy.

MEASURING EFFECTIVENESS 2: FURTHER ANALYSIS OF ALTERNATIVE EXPLANATIONS

Theoretically, changes in pollution per product unit might very well be accounted for by other factors apart from policy outputs. Before we can say anything about their relative influence, we must first list the different kinds of factors that may have an impact on per unit pollution. We have constructed such an inventory using five dimensions of decision making in the mode of the "subjectively rational actor" (Hennipman, 1945; cf. Simon, 1955). Figure 2 provides an overview of these dimensions and the alternative explanations available to account for reductions in per unit pollution. Below we present a summary of the conclusions reached by applying Michael Scriven's "modus operandi" method (Scriven, 1976) to the examination of these different factors.

The conclusions drawn from this analysis of alternative explanations all point consistently in the same direction: the factors considered cannot in themselves account for the amount of pollution reduction attained. They will, however, tend to further or impede the impact of water quality policy on the amount of pollution produced. "Environmentally friendly" technological developments (see "a," Figure 2) do not just appear out of nowhere. Since other factors have always given the impulse for such developments, they cannot themselves be viewed as an independent cause of pollution abatement levels. However, technological development can sometimes be indispensable for the realization of the abatement that companies, for other reasons (such as in response to policy measures), deemed necessary. In the case of heavy metal pollution, developments with respect to the price of these materials cannot account for the amount of abatement achieved since, in the period under investigation, these prices declined instead of rising (see "b," Figure 2). It is unlikely that the environmental awareness of industrial leaders and the population in general (see "c and d," Figure 2) has been an independent cause of pollution abatement, among other reasons because of the "logic of collective action" (Olson, 1971). But it is conceivable that the extent to which and the rate at which policy leads to results will be influenced by the level of environmental awareness. In

addition, the impact of information provided by nongovernmental bodies regarding abatement measure (see "e," Figure 2) should be considered marginal (supplementing other factors). Information is necessary but in itself hardly ever sufficient for companies to decide to reduce pollution. This is so because these measures usually lead to higher production costs.

Figure 2
Inventory of Alternative Explanations of Reductions in Pollution per Produce Unit

Decisionmaking dimension	Alternative explanatory factor
1. new behavioral alternatives	a. independent technical developments
2. fewer alternatives	
3. change in properties of alternatives	b. increase value waste matter as raw material c. increase environmental awareness with population
4. change in valuation of properties of alternatives	d. increase environmental awareness with companies
5. information on presence and properties of alternatives	e. information given by nongovernment institutions

CONCLUSIONS

After the Water Pollution Act had gone into effect, pollution of Dutch industrial wastewater sharply decreased, not only in the initial period, when simple and cheap abatement methods could be applied, but also later, when the costs of abatement measures were higher. Time series analyses, supplemented by analyses using the "modus operandi" method, provide support for the conclusion that the level of pollution reduction achieved can be attributed to the policy pursued. The answer to the main question of this paper, i.e. which policy instruments have had the greatest effect on the abatement of pollution in industrial wastewater, obviously depends on determining, first of all, how important policy as such has been in bringing about a reduction in industrial water pollution. If the empirically observed decrease in pollution cannot be accounted for by other factors, then it would seem, logically speaking, that policy measures taken must account for it. As the next sections will demonstrate, this has indeed been the case in The Netherlands. The substantial reduction in industrial wastewater pollution has been the result of Dutch water quality policy. Since that policy contains a "mix" of different measures, the questions remains as to which of the various instruments applied has contributed most to the policy's apparent effectiveness.

THE CONTRIBUTION OF DIRECTIVES AND INCENTIVES 1: A STATISTICAL ASSESSMENT

In the previous section we noted that there have been substantial regional differences in the extent to which the policy objectives have been achieved. However, these differences cannot, without further investigation, be explained by the extent to which the individual water boards applied the various policy instruments at their disposal. First of all, the water districts themselves vary greatly in size and thus in pollution loads. Along with 17 rather large districts, there were, during the research period, 23 of rather small area. In 1975, 97 percent of the total volume of organic pollution was produced in these 17 large districts. Since the percentage decreases in pollution often reached extreme values in the 23 smaller areas, based, however, on only a few observations (firms), these areas have been excluded from the analysis reported below. The impact of developments in these districts on the results of the analysis would have been out of proportion to their actual importance.

Differences in goal attainment among the remaining areas can be accounted for by two sets of factors. On the one hand, they can be partly explained in terms of differences in the economic structure of different water districts with regard to the relative weight of particular branches of industry. In the case of heavy metal pollution, differences in abatement levels may be attributed to the relative share of various metals in the total volume of pollution. Using data on the share of different branches of industry in the regional economy and, for heavy metals, the share of various substances in the regional pollution in 1975, and on the average decrease in pollution per industry and substance in The Netherlands between 1975 and 1980, the amount of pollution decrease that could be expected on the basis[4] of the structure of regional economy was calculated for each water district. This expected value was closely correlated to actual decrease of pollution. In the case of organic pollution the Pearson's r was +.79 (r^2 = .62) and in the case of heavy metals pollution it was +.74 (r^2 = .55).

Effluent Charges and Branch Differences in Pollution Decrease

In 1969, the first time organic pollution of industrial wastewater was measured by industrial branch, it was determined that fourteen industries accounted for 90 percent of this pollution. These fourteen industries form the research units in the analysis described below. Since they accounted for such a large part of the pollution, this analysis is not so much a sample study but rather a semipopulation study. Nevertheless, in view of the small number of units involved, a word of caution is in order when drawing conclusions based on this sample of industries.[5]

There are a number of factors that could account for the differences found between these industries with regard to the percent of decrease in their organic pollution. Most obviously, decreases or increases in the level of production of the different industries could affect the volume of pollution produced in the period under investigation. A second cause of differences in abatement rates can be found in the fact that in a particular industry it is much more difficult, and thus more expensive, to produce more "cleanly" than it is in another industry. Therefore, in addition to the increase or decrease in production, relative abatement costs can play an important role in determining the level of pollution reduction achieved. Finally and (in connection with the focus of this study) most importantly, it is also conceivable that effluent charges could lead to differences in abatement between industries. The more pollution units per unit of production value that are caused by an industry, the greater the impact that the charges will have on production costs. This can mean that some industries will bear charges that are significantly greater than other industries. Efforts to

reduce the number of pollution units produced will be greater to the extent that a given industry is liable for higher charges compared to its production value. In the discussion that follows this factor will be referred to, for convenience, as the "charge factor."

The extent to which organic pollution of industrial wastewater decreased between 1969 and 1980 appears to be related to the three above-mentioned factors as follows: production increase, r = -.21; abatement costs, r = .50; and charge factor, r = .73. The signs of these relations are all in the anticipated direction. The strong correlation with the charge factor is very striking. When the three factors are related simultaneously to pollution decrease, they account statistically for 63 percent of the decrease. The regression equation across the 14 major branches was estimated as: $P = .33\,C - .32\,AC - .01\,Prod$, $R^2 = .63$ where

P = percent decrease in discharge 1969-1980
C = charge factor calculated as pollution (in 1000 PE) liable to charges divided by total production value in millions of Dutch guilders in 1969
AC = estimated average cost of treatment per branch
Prod = percent change in output during 1969-1980

The standardized contribution (beta) of the three factors is: production increase, -0.30; abatement costs, -0.25; and charge factor, 0.61.

In the case of two of the fourteen industries (potato-starch industry and the stock-raising industry), charges had less influence than was to be expected on the basis of their charge factor. In anticipation of ultimately being hooked up to a "smeerpipe" (literally, a dirt pipe), the potato starch industry had been allowed to continue with untreated discharges. During this time, the industry was paying much lower charge-rates than were other industries. The stock-raising industry is composed of thousands of relatively small farms. Here the charges are seldom calculated exactly on the basis of the amount of pollution actually produced. Hence it is to be expected that the impact of charges will probably be less in this case than in other industries with a similar charge factor. When these two industries are left out of the analysis, the correlation of the charge factor with the decrease in pollution is even stronger: r = .84. The correlation with the other two factors remains about the same, with production increase showing a r of -.24 and abatement costs an r of -.48. These three factors, taken together, account for 76 percent of the differences in the decrease of organic pollution in industrial wastewater between these twelve industries.

Policy Instruments and Regional Differences in the Decrease of Organic Pollution

An important part of the regional variation in pollution abatement cannot be explained by differences in the industrial structure of the regions. If the conclusion of the above section is correct, this leftover variation can be explained entirely in terms of the degree to which different policy instruments are being used. The degree to which these different instruments are actually used will also vary greatly from region to region. In this section, we will examine the extent to which this explanation is accurate.

As in the discussion of the alternative explanations of pollution decline, policy instruments can also be grouped in terms of factors that influence decision making by subjectively rational actors.[6] All instruments mentioned are used simultaneously in Dutch water quality policy.

As can be seen in Figure 3, prohibitions have not been linked with reducing the number of behavioral alternatives available to the decision maker. Although this would appear to be the aim of such directives, it would be unrealistic to assume that they are always successful in this regard. What effect prohibitions in fact have upon behavior will have to be established empirically for a given situation.

Figure 3
Inventory of Types of Policy Instruments

Factor in decision model	Type of policy instrument
1. new behavioral alternatives	a. promotion of technical know-how development
2. fewer alternatives	
3. change in properties of alternatives	b. directives 1 (permits and prohibitions) c. directives 2 (inspection and the courts) d. incentives (effluent charges)
4. change in valuation of properties of alternatives	e. deliberation, persuasion and negotiations without specific legal grounds
5. information on presence and properties of alternatives	f. advice to companies about properties of existing abatement techniques

Since we are particularly interested in effluent charges and since, on the basis of the branch analysis above, we expect to find a clear impact of charges on decisions affecting the amount of pollution, we will examine the impact of this instrument first and then look at the other instruments.[7]

The dependent variable for this part of the analysis is the "relative success of abatement." This variable has been calculated as the difference between the actual percent of abatement and the percent of abatement expected in view of the industrial structure of the region. Regional variation in the charge level cannot, however, straightforwardly be related to this variable. The reason for this is as follows.

The relative success of abatement has been calculated for the period 1975-1980. Prior to this time, however, pollution of industrial wastewater had already declined substantially. Our analysis of interindustry variations (see above) makes it plausible to assume that abatement in this period was also largely the result of charges. The 1975 amount of pollution was already more or less in equilibrium with the charge level of that time. For this reason, the charge factor influencing the abatement of pollution of industrial wastewater is indicated much better by the difference between the rate before 1975 and the rate at the end of the period 1975-1980 than by the level of the charge in any one of the preceding years.

However, it cannot be determined on theoretical grounds for which period the charge increase should be used as independent variable. On the one hand, there is a time-lag between the stimulus to abatement efforts and the installation and putting into operation of the relevant control measures. ... it is not implausible to expect a certain degree of

anticipation by the companies to charges and rate increases (Bressers, 1983-2; Ewringmann, Kibat, Schafhausen, Fedderson, Krickel, Perdelwitz, & Strauss, 1980). It is better, therefore, to decide on empirical grounds which period should be considered in determining the rate increase. This period starts in the year in which the rate of the charge has the highest negative correlation with the relative success of abatement between 1975 and 1980. The rate in that year can be taken as the best indicator for the extent to which abatement efforts before 1975 negatively affected abatement activities in the subsequent period by the resulting increase of marginal costs of further abatement. The rate charged in that year should then be subtracted from the charge at the end of the period with the highest positive correlation in order to get the best possible indicator of the charge factor that stimulated abatement of pollution in the 1975-1980 period.

As expected, the level of the charge prior around 1975 is negatively correlated with the relative success of abatement of organic pollution of industrial wastewater in the years 1975-1980. This negative relationship is strongest with the 1974 charge ($r = -.53$). The correlations gradually become more positive up to and including 1980. The 1980 rate of charge shows a clear positive correlation with relative abatement success ($r = +.53$). As an indicator for the influence of effluent charge on relative abatement success, we will, therefore, take the increase in the rate charged in the period 1974-1980. For two of the 17 water districts examined this indicator could not be calculated.

The increase in the rate charged in the period 1974-1980 has a very strong positive correlation with the relative abatement success for the years between 1975 and 1980 ($r = +.86$, $n = 15$, $p = .000$). This relation is not the result of one or two extreme values for the units analyzed, although the two water quality districts with respectively the most and the least relative success weaken the strength of the relationship somewhat. Without these two observations the correlation is even stronger: $r = +.92$ ($n = 13$, $p = .000$). Further analysis has showed that this correlation cannot be attributed to water authorities reacting on abatement efforts by industry by raising charge rates to keep the same amount of revenues.[8]

With such high correlations between the charge factor and the pollution decrease it is natural that the relationships with the indicators of the great variety of other policy instruments used are absent or only weak. Among all these indicators, only water board permit-giving to municipalities and abatement schemes show up with relatively substantial but still modest positive correlations with the relative abatement success.

The relative abatement success, the dependent variable in all these analyses, has been defined as the percentage decrease of oxygen-consuming pollution of industrial wastewater, corrected to take the regional structure of industry into account. It should, therefore, be possible to explain the variation in the percentage decrease of organic pollution by: (a) the decrease to be expected as a result of differences in the regional structure of industry; (b) the increase in the rate charged; (c) the number of municipalities with a permit issued by water boards (thus giving these authorities indirect influence on sewage permits issued to individual plants); (d) the weighted number of abatement plans.

As it turns out, 96 percent of the percentage decrease of organic water pollution can be explained, statistically, by the first two factors (R^2 after correction is .95). Ninety-eight per cent can be explained by all four factors taken together, but this is due mainly to the fact that one research unit has been dropped from the calculation. If we take this smaller group of 14 units, the two first-named factors explain 97 percent of the differences in pollution decrease.

The regression formula used to explain 96 percent of the difference in pollution decrease is:

$$y = 0.96x1 + 1.55x2 - 35.6 \text{ (constant)} \qquad R^2 = .96,\ n = 15.$$
$$\quad (0.08) \quad (0.20)$$

Where
y = percent decrease of the pollution of industrial wastewater
x1 = percent decrease to be expected on the basis of the regional structure of industry
x2 = increase in the rate charged 1974-1980 (in Dutch guilders)

In brackets the standard errors. This means that one percent of actual abatement corresponds to approximately one percent abatement to be expected on the basis of the regional structure of industry (which is an indication that the calculation is not distorted) and with an increase in rate of 1.5.

Policy Instruments and Regional Differences in Decrease in Heavy Metal Pollution

Two water boards do not impose effluent charges on heavy metal polluters. Their results are not much different from those of the other districts. However, as a matter of fact, in their negotiations with industry, when demanding quite substantial reductions in pollution level, these boards did use the possibility of introducing effluent charges as threat. In this sense, their effectiveness in achieving decreases in heavy metal pollution is not totally independent of the effluent charge system. We will not include these districts in the following analysis.

The indicators for policy outputs used here are, for the most part, the same as those used in looking at organic pollution or they have been calculated in a similar manner. The indicators for permits issued and for technology, advice and informal negotiations are different. The indicator for permits has been calculated as the percent of companies that discharge a taxable amount of heavy metals having a permit that stipulates conditions for these discharges in 1975, the percent with such permits in 1980, and the increase in these numbers between 1975 and 1980. Technology development, advice and information negotiations are also indicated by the proportion of major dischargers contacted instead of by the weighted number.

The increase of the charge rate in the period 1975-1980 is clearly related to the relative success of the abatement of heavy metal pollution of industrial wastewater, although the relationship is not as evident as with the abatement of organic pollution. The r = .65, for an n = 13 and a p = .008.

Among the other indicators of the instruments used weighted number of formal reports by pollution inspectors and the proportion of companies with which an abatement plan was drawn up were positively correlated with the relative abatement success with heavy metal pollution.

The weighted number of inspectors turns out not to be related to abatement success. The same goes for both the number of infringements detected by them (as an indicator of their activity) and the number of times they

threatened official enforcement actions. However, the situation is different with regard to the number of times these inspectors in fact officially report such infringements and use the police to enforce compliance. The weighted number of formal reports is positively related to the relative abatement success (r = .30, n = 14, n.s.). If we take the rate of increase for effluent charges into account, the correlation is even stronger (pr = .43, n = 13, p = .082).

The proportion of companies with which an abatement plan was drawn up is clearly related to the relative abatement success. Although this relation is at first relatively weak (r = .30, n = 14, n.s.) if we take into account the influence of the increase of rate charges, the correlation is stronger (pr = .55, n = 13, p = .031).

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The combination of policy outputs that accounts for the greatest part of the variation in relative success in abating pollution by heavy metals includes (after a correction for the number of independent variables):

- the increase in the charge rate 1975-1980;
- the proportion of heavy metal dischargers with an abatement plan;
- the weighted number of official reports on noncompliance.

Together these policy outputs explain statistically 82 percent of the difference in relative abatement success. These three policy outputs together with the abatement that could have been expected in view of the regional structure of industry and the shares of the various kinds of metal statistically account for 91 percent of the variation in decrease in heavy metal pollution (R^2 after correction is .87).

The standardized contribution (beta) of the different factors to this are:

x_1	- abatement expected (%)	.33
x_2	- increase in rate charged (in guilders)	.56
x_3	- proportion of companies with abatement plan (5)	.47
x_4	- weighted number of official reports on noncompliance	.36

The regression equation itself runs as follows:

$$y = 0.73x_1 + 3.35x_2 + 0.42x_3 + 6.24x_4 = 78.1$$
$$\quad (0.30) \quad (0.80) \quad (0.11) \quad (1.93)$$
$R^2 = 0.91$, n = 14 (In brackets, the standard errors)

Given that B of x_2 (charges) is more than twice as high for heavy metals as it was for organic pollution, it can be concluded that the relative level of charges compared with abatement costs is much lower for heavy metals than for organic pollution. For most heavy metals, one kilogram is equal to one population equivalent of organic pollution. In general, the relatively low level of charges on heavy metals is acknowledged by that staff of the water boards. In spite of this, the charge appears to provide the primary impetus for pollution abatement also in the case of heavy metals.

THE CONTRIBUTION OF DIRECTIVES AND INCENTIVES 2: AN EXPERT ASSESSMENT

Thus far three independent statistical analyses have shown that effluent charges have been a quite effective instrument of Dutch water quality policy. The contribution of each of the policy instruments applied to the substantial reductions of industrial wastewater pollution in The Netherlands can also be determined with the help of the assessments by insiders. In this section we will compare the results of the statistical analysis with the assessment of experts from both the water boards and industry regarding the relative effectiveness of these instruments. Both approaches have their strong and weak points (Reichardt & Cook, 1979). However, should both methods lead to the same conclusion, our confidence would be increased in the reliability of this conclusion. As was the case with the statistical analysis, independent analyses based on different sets of data were used: on the one hand, the opinions of negotiators from the water boards and, on the other hand, representatives of the companies who were responsible for water quality.

Assessment of Policy Instrument by Policy Implementors

In a questionnaire sent to the regional water boards, administrators were asked to indicate how much influence they thought the various policy instruments had on the abatement of industrial wastewater pollution. For both organic pollution and pollution with heavy metals the respondents could choose from five answers. The category "Not applied" could be checked to indicate that a particular instrument had not been used with regard to that type of pollution. In practice, "No answer" also nearly always indicated the instrument in question had not been used at all or very little. This was the case for the seven smaller water authorities that did not fill in the questionnaire completely, adding such comments as "no experience" and the like. Regarding heavy metals, the question was irrelevant for seventeen smaller water boards since there were no companies in their areas known to discharge heavy metals. Table 1 shows the answers given to this question.

In general these results correspond with those of the statistical analyses, at least as far as the main points are concerned. Charges emerge as the most influential policy instrument for dealing with organic pollution, whereas in the case of heavy metals we see that the respondents attributed equal amounts of influence to a broader range of instruments. There are, however, some small but interesting differences between the results of the questionnaire and those of the statistical analyses.

According to the statistical analysis, charges also played the most important role in decreasing heavy metals pollution, although to a lesser degree than was the case with oxygen-consuming pollution. Why was it that the regional water quality administrators recognized the importance of charges for the abatement of organic pollution, but not for decreasing pollution with heavy metals? The explanation seems to be that these officials can clearly see that there are companies that are going to abate organic pollution because of charges, but hardly any companies are going to abate their heavy metal pollution solely because of the effluent charges. Discharging heavy metals is simply too cheap. Abatement plans and inspections are almost always necessary to persuade heavy-metal polluters to take appropriate action. What these water quality administrators do not see (indeed, what they individually cannot see) is that the success of these abatement plans is much greater in districts where charges were increased than in other areas. In both cases, companies have to be persuaded by the water authorities to get started; in some cases, however, officials must continue to exert pressure to ensure that the agreed-upon measures are in fact carried out. Even when they cannot in themselves motivate companies to take abatement action, charges apparently play an important role in facilitating the task of the water quality administrators in getting abatement measures implemented. This conclusion opens interesting perspectives on the possibility of applying charges not only as an alternative for, but also as a complement to direct regulation.

Table 1
Assessment by Regional Water Quality Administrators of the Effectiveness of Policy Instruments

Policy Instrument	Type of Pollution	Extent of Influence ++ ++	++ +	+ +	+	0	#	Total
a. Permits	Organic	2	12	14	3	2	7	40
	Heavy metals	5	8	8	0	2	17	40
b. Inspection and the courts	Organic	1	16	13	2	1	7	40
	Heavy metals	2	10	10	1	0	17	40
c. Effluent charges	Organic	16	14	3	0	0	7	40
	Heavy metals	1	9	9	2	2	17	40
d. Promotion of technological developments	Organic	0	3	14	12	4	7	40
	Heavy metals	1	2	12	5	3	17	40
e. Advice	Organic	3	9	14	6	1	7	40
	Heavy metals	2	7	10	2	2	17	40
f. Informal negotiations	Organic	5	15	11	2	0	7	40
	Heavy metals	4	5	12	2	0	17	40

Another point calling for attention is the role played by informal negotiations. It is clear from the questionnaire than water board officials attached greater importance to this instrument that we would have anticipated on the basis of the statistical analysis. It appears that this apparent discrepancy can be accounted for by the fact that negotiations do not constitute a separate instrument in addition to other policy instruments, but rather represent a manner in which the total "policy mix" is applied. In this regard there are two interesting aspects of informal negotiations. In the first place, they serve as a sort of "lubricant" to oil the machinery put into operation by the other policy instruments discussed above (compare for Germany: Hucke, 1978; and for Great Britain: Vogel, 1983, pp. 1-2). The following statement by a water board official during one of the oral interviews that followed the written questionnaire is illustrative of this function: "When I'm going to have a talk with a company about the abatement of their discharges, I always take my pocket calculator along. I calculate their potential savings on charges and invariably get an interesting conversation started."

This, primarily informative, function of negotiations is especially important when other circumstances and the policy instruments applied have an influence strong enough to make abatement seem worthwhile to the companies to begin with. This situation will tend to occur more often in the case of organic pollution than with heavy metals. The implementation process with regard to organic waste matter is characterized by relatively small differences of opinion between administrators and companies regarding the amount of abatement aimed at. This is due to the pressure of the effluent charges, which make reductions of discharges economically attractive.

Heavy metals negotiations not only fulfill an informative function; here they also represents the way in which power is wielded. This strategy reflects the fact that in such cases there are often quite substantial differences of opinion between water quality administrators and the companies regarding the desirable amount of further discharge reduction. In these situations the balance of power is such that neither party is in a position to impose its will upon the other. It appears then that unless the administrator is in a position to exert enough power and to apply a policy instrument vis-a-vis the company so that he can achieve his abatement goals without delay, it is quite rational for him to apply the available policy instruments selectively within a framework of deliberation and negotiation with industry.

The Assessment of Policy Instruments by the Regulated Industries

In addition to the analyses mentioned above, we also made use of a study by two Dutch fiscal lawyers, Schuurman and Tegelaar (1983). This study, based on the subjective assessments of company officials directly involved with pollution abatement, was based on 150 firms constituting one-fifth of the category "large polluters." The data were collected in interviews with one or more functionaries at the staff or executive level who were responsible for company policy with regard to water pollution or who were closely involved in the implementation of these policies. In general, these officials can be considered the conversation partners of the respondents from the preceding analysis of the water board administrators.

The results of this study show clearly that in the period 1975-1980 effluent charges had a substantial effect on the abatement of pollution by the companies investigated. For nearly 60 percent of the companies interviewed, the charge levied was the decisive factor in the decision to take abatement measures. The pollution decrease realized by these measures amounted to more than 3.2 million population equivalents out of a total reduction of pollution of 4 million PEs. This means that 80 percent of pollution abatement realized in the period 1975-1980 can, according to the companies investigated, be explained in terms of the firms' response to the effluent charge, with the remaining 20 per cent attributable to other factors. The most important noncharge instrument mentioned are the discharge conditions contained in the permits. For more than 20 percent of the firms studied this factor was given as the immediate reason for taking abatement measures. The pollution decrease realized by these measures, however, amounted at most to 800,000 PEs. According to the company officials interviewed, it is expected that charges will also be an important reason for taking further abatement measures.

In this analysis, charges once again emerge as by far the most influential instrument, but somewhat less dominating with regard to organic wastewater pollution than in the statistical analysis. Two factors should, however, be kept in mind when comparing these two analyses. First of all, there seems to be a certain tendency in oral interviews to give the socially desirable answer that something is being done for environmental protection, not because it is cheaper but because one has a social responsibility to do it, or because the democratically elected authorities have asked for it. This will lead to a certain underestimation of the influence of charges on abatement actions. Secondly, charges also can play an important role in cases where discharge regulations are the decisive motive for measures taken. Without charge, the difference between demands made by water boards and what industry deems economically feasible would have been much greater and, consequently, the resistance of the firms to these demands much stronger.

CONCLUSION

Taken together these analyses lead to the remarkable conclusion that the substantial reduction of pollution of Dutch industrial wastewater between 1975 and 1980 has been much more the result of a policy instrument, effluent charges, that was not officially designed for this purpose, than a result of the use of the policy instrument, direct regulation, specifically intended to achieve this objective.

The Dutch case, with the most substantial system of effluent charges in the world, shows the enormous potential of this policy instrument. In the research reported here, I did not come across any evidence that would suggest that this result can be explained in terms of specific national characteristics of The Netherlands. Two points, however, deserve attention.

The implementation of effluent charges can be hampered by the need for a devoted executive body that is determined to actually collect the charges. Central government policies are often frustrated by lack of cooperation by local authorities appointed to implement them (Bressers & Honigh, 1986). This problem did not arise in Holland, thanks to the fact that their effluent charges function as so-called revenue raising charges. Through the charge system, the water authorities are collecting their own money, needed very much for the building and exploitation of treatment plants, a task they were eager to undertake.

Another major problem with effluent charges is the massive amount of information that is required to assess the fee each company has to pay. Some authors even see this as the most important reason to discard this policy instrument altogether. In Holland, this problem was reduced by not charging the millions of households and small industrial polluters (less than 10 PE) in proportion to the actual pollution they caused. Having relatively few opportunities of limiting pollution, this category of polluters is of minor importance to the instrument's regulating power. The amount of information required is again substantially reduced by basing the assessment of medium-sized polluters (usually between 10 and 100 PE) not on samples of their effluent, but on a coefficient table. On the basis of easily obtainable data such as the amount of water used by the firm or the amount of certain raw materials it processes with that expertly calculated coefficient table the probable amount of pollution can be established accurately. However, the incentive to reduce pollution remains intact. Companies that feel they are overrated on the coefficient table can request their effluent to be sampled and to be charged on the basis of the results. Not always this leads to permanent sampling. Sometimes only an adjustment of the relevant coefficient is made. All these pragmatic adjustments make it possible to implement the charges at the cost of only a few percent of the total revenue, without diminishing substantially the instrument's regulating power (as could be shown).

Implementation problems being solvable and the way in which effluent charges influence the negotiation process being consistent with what we would have been led to expect by the economics literature, the greatest problem seems to be the feasibility of introducing such charges. In the words of Senator Domenici: "Charges have only one problem: they lack political support" (Domenici, 1982). Perhaps the key question is: Who's afraid of effective government?

NOTES

[1]A population equivalent is the amount of organic pollution equivalent to the average organic pollution caused by one person in a normal household, which number of PEs is therefore equal to the population. For industrial pollution the number of PEs is predominantly calculated on basis of BOD and COD figures.

[2]The publication of the study in 1983 had a substantial impact on the stance taken by the Dutch environmentalists and led to the proposal in parliament to extend the coverage of the charges. Time, however, has been not on their side due to the most severe postwar economic crisis Holland has experienced in recent years.

[3]Data of low aggregation level were obtained from the task force for the preparation of the "Indicative Multi-Year Program 1980-1984: The fight against water pollution," Ministry of Transport, Public Works and Water-affairs, 1981 (in particular data on pollution emissions) and from the Dutch Central Statistical Office (in particular parts of the branch data and the data on prices of heavy metals).

[4]The following formula was used for this calculation in the case of organic pollution; in the case of heavy metal pollution, a similar formula was used, expanded to take the relative shares of different metals into account.

$$P_i \text{ exp.} = x_{1i}b_1 + x_{2i}b_2 + \ldots + x_{ni}b_n \quad (i = 1 \ldots\ldots\ m)$$

Where

P exp. = expected percent of decrease in pollution of industrial wastewater 1975-1980

1 ... n = 7 branches: 6 highly polluting branches and one including all other branches of industry

x1 ... n = the proportion of pollution contributed by each industrial branch in the regional economy in 1975.

b1 ... n = per cent decrease in pollution by each branch

1 ... m = the 17 major water districts.

[5]A more extended version of this analysis can be found in Bressers (1983, chap. 2). Methodological problems, especially those in connection with the operationalization of the relevant theoretical notions to a model of analysis, are dealt with there in greater detail. Here we have limited ourselves to a survey of findings and a reflection on conclusions drawn from the analysis.

[6]For the purpose of effectiveness research, policy instruments should preferably be classified on the basis of the way in which they influence and not on the more usual basis of ex-ante estimates of the degree of coercion that goes along with them (cf. Nagel, 1975). In the latter type of classification, dependent and independent variables get mixed up. See for an extended classification of policy instruments on the basis of their "modus operandi," Bressers and Klok (in press).

[7]The seventeen areas analyzed here accounted for nearly all water pollution in 1975. Nevertheless, there are certain problems involved in drawing conclusions based on the statistical analysis of seventeen cases. This is especially so since a few scores are missing for a number of independent variables so that the number of units available for analysis is reduced even further. Since we are dealing with a semipopulation study, the danger is particularly great that one or more extreme values will determine the direction and strength of the correlations. In order to control for this, a plot was made of each bivariate relation so that the possible influence of extreme values could be determined. As a matter of fact the scores of the cases on the dependent and the independent variables spread out quite normally, with no real outlayers and some concentration around the center of the range.

[8]We have calculated that part of the rate increase between 1974 and 1980 that was necessary to prevent the pollution abatement attained from resulting in a reduction in revenue from effluent charges. This turned out to range from 3 percent to 20 percent of the total increase (5% on the average). Next, this part of the rate increase was subtracted from the total increase in the period 1974-80 so that what remained was only the increase that cannot be attributed to the decrease in pollution. The remaining increase in rates charged was almost as strongly related to the relative abatement success as was the total increase: 4 = .83 (n = 15, p = .000). This seems to indicate that the increase in charges is a cause rather than an effect of pollution abatement of industrial wastewater.

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