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A SURVEY OF TRADE THEORIES

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ABSTRACT

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This report is a survey of trade theories and reviews international trade implications of the new growth theories. Theories are reviewed by focusing on questions like why countries trade with each other, what can be gained by trade and how trade patterns can be explained. These questions have been addressed by many economists since Adam Smith and David Ricardo and still there is much controversy in explaining the causes of trade. Differences between countries, for instance in natural factor endowments and factor prices, can be a motive for trade between two countries. Countries trade in order to take advantage of these differences. This concept of trade is based on (the theory of) comparative advantage. However, other - more modern - theories state that countries may also trade because there are inherent advantages in specialization, arising from the existence of economies of scale. Some other models in modern trade theories emphasize imperfect competition, product differentiation and technology gaps (innovation) across firms and countries as a major source of explanations for international trade. Finally, the trade implications of the 'new' growth theories will also be taken into account because these theories shed light upon the dynamic evolution of comparative advantage. This review results in a summary of the main characteristics of the theories, their way of explaining international trade, implications of trade and the influence of government intervention. Furthermore, the empirical evidence of the theories is discussed.

Trade theories/Growth theories/Comparative advantage/Policy/Economies of scale/
Product differentiation/Technology gaps/Knowledge

CONTENTS

FOREWORD

Most agricultural trade analysis focuses on basic agricultural commodities and rests on traditional theoretical insights of comparative advantage, assuming perfect competitive markets on which goods are homogeneous and produced under a technology of constant returns to scale. However, the observation of changing trade characteristics in agriculture and food products, private business concentration and active government policy suggest that international agricultural trade analysis implies investigating market structures other than the competitive mode. In order to strengthen and buildup the theoretical and empirical knowledge base in the field of international trade in agricultural and food products, the Agricultural Economics Research Institute (LEI-DLO) launched the research project 'Policy and Patterns of International Trade' which is financed by the Institute's budget for Strategic Expertise Development (SEO programme).

The objectives of this research project are to:

- analyse international trade theories, with the aim to answer the question: what determines international trade patterns and which role does government policy play in this?
- assess the usability of general trade theories in explaining agricultural trade;
- design a concept for explaining world trade patterns in agricultural commodities.

This publication reports on the first objective of the project. Its main aim is to present an overview of the main theories that deal with international trade, as there are the neo-classical, 'traditional' trade theories and the 'modern' trade theories. The trade implications of the 'new' growth theories are also taken into account. This review of theories - written mainly during the course of 1996 - acts as an input in the following stages of the project. The second stage, on the assessment of the general trade theories on their applicability for explaining agricultural trade, has been reported in Onderzoekverslag 162.

The director,

The Hague, April 1998

L.C. Zachariasse

SUMMARY

The question why countries trade with each other has been answered in many different ways. Differences between countries, for instance in natural factor endowments and technology, can be a motive for trade between countries. Countries trade in order to take advantage of these differences. This concept of trade is based on (the theory of) comparative advantage. However, other recent theories state that countries may also trade because there are inherent advantages in specialization, arising from the existence of economies of scale. Some other models in modern trade theories emphasize imperfect competition, product differentiation and technology gaps (innovation) across firms and countries as a major source of international trade. Finally, the 'new' growth theories emphasize the endogenous generation of technological change which has important implications for international trade.

The main aim of this study is to present an overview of the main theories that deal with international trade. The general structure of this overview is illustrated in figure 1. In a historical sense we can identify three major streams (depicted as the three columns in figure 1). First, we can identify the classical and neo-classical trade theories which we call the 'Traditional Trade Theories'. The most prominent model of this stream became the neoclassical Heckscher-Ohlin model that dominated the field for almost eighty years. Despite their theoretical dominance, some implications were not supported by empirical evidence. This induced economists to search for new trade theories. These new theories, which were mainly developed in the late seventies and early eighties, are collected in our second major stream, the 'Modern Trade Theories'. In the late eighties, ideas that were generated by these modern trade theories induced changes in the growth literature and led to the so-called 'new' growth theories, which also shed light upon the dynamic evolution of comparative advantage. The trade implications of these growth theories are also taken into account and captured in our third main stream, 'Trade Implications of Growth Theories'.

Within each major stream a further classification in schools of thought is made based on crucial assumptions and the main mechanism of trade. Each school of thought is presented with a grey ellipse in figure 1; the arrows between two ellipses or schools indicate a strong relation between these two schools. A relation in the sense that it builds forward on (elements of) a former one but changes or brings in a crucial (new) assumption.

An important discriminating aspect is whether or not technology differs between countries (the horizontal line in the middle of figure 1 represents this distinction). When a school of thought assumes that technology differs across countries it is depicted in the upper part of figure 1, and when a school assumes that technology is identical across countries it is depicted in the lower

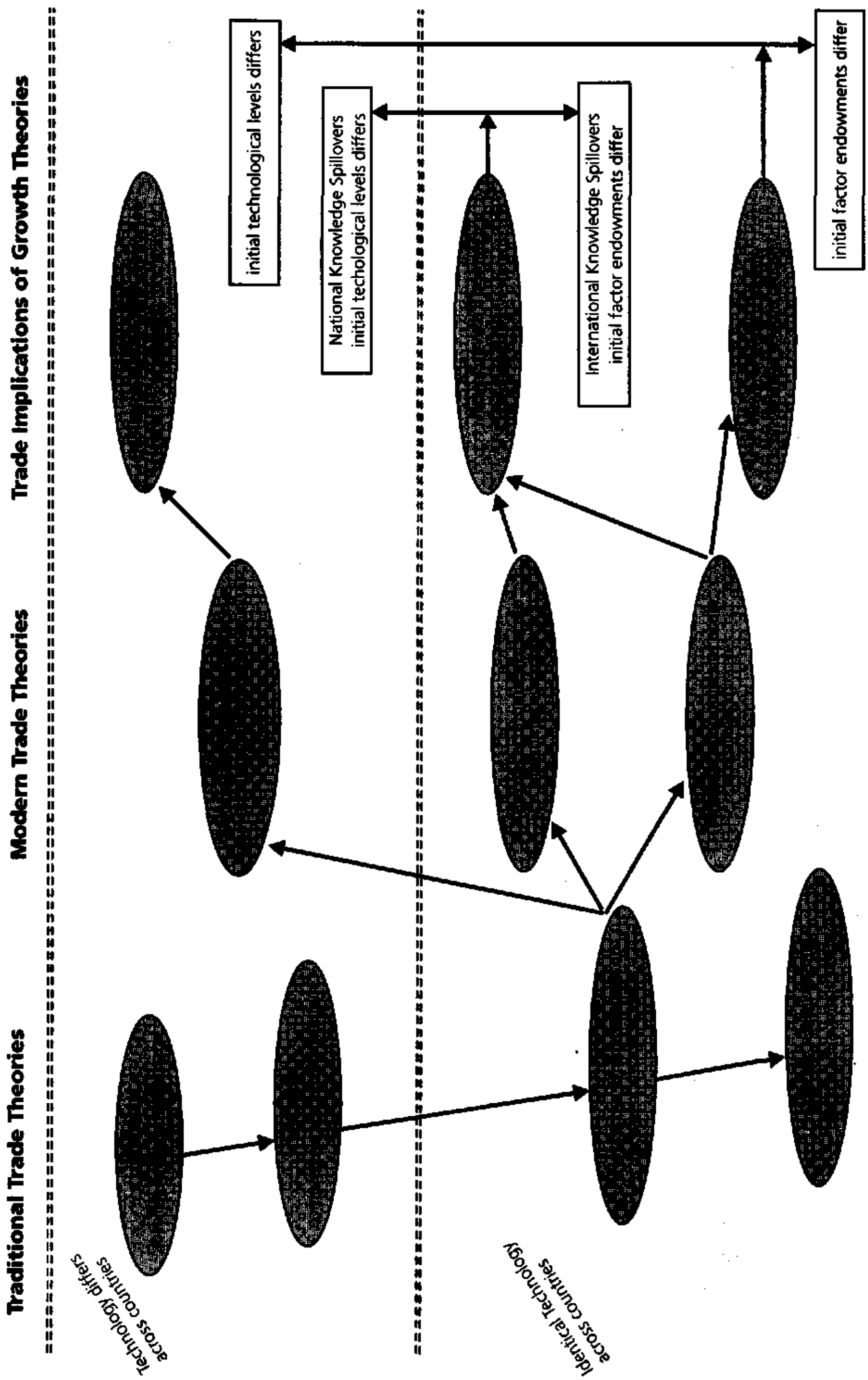

Figure 1 Overview of theories

part. Because in the new growth theories within one school technology can vary across countries, we identified two directions within these schools. Each direction is illustrated as a white box in figure 1.

Before we discuss the schools of thought in more detail we discuss the main relation (arrows) between the schools. As many other theories, the trade theories find some of their roots in 'The Wealth of Nations' of Adam Smith. Smith showed that trade is possible when one country can produce a certain good with less labour than the other country and the other country can produce another good more efficiently. Ricardo showed that trade is even possible when one country can produce all goods more efficiently than the other country if the relative costs of production of two goods differ between countries. This is known as the principle of comparative advantage which is still one of the most important concepts in trade theory. The Neo-classical Heckscher-Ohlin-Samuelson (H-O-S) model elaborated the theory of Ricardo by introducing another factor of production (capital), but assuming identical production techniques across countries. An implication of this change in assumptions is that factor endowments became the main explanation for trade. The specific-factor model assumes that one factor is specific to the production of one good; because the income implications are different from the standard H-O-S this theory is treated separately.

Because some of the trade implications of the H-O-S model were not supported by empirical evidence, the modern trade theories replaced the assumption of constant returns to scale or identical production technologies. Economies of scale can be external or internal to a firm. With external economies of scale perfect competition remains why internal economies of scale imply imperfect competition. This distinction is important because trade implications differ between the two approaches. The third school within the modern trade theories, i.e. the neo-technology trade theories, like the classical theories, stressed the central role of technology. However, in contrast to these theories technological differences are not static between countries but are temporarily created by innovations. The evolutionary growth theories build forward on this theory and focussed more in depth on the innovation process; innovations are cumulative, specific and irreversible.

Like the neo-technology trade theories, the more formalized 'new' growth theories also stressed the role of knowledge creation. The various ways in which knowledge creation can be modelled are taken from the modern trade theories that stressed economies of scale. When knowledge is a by-product of other activities or caused by learning-by-doing effects, there is a close resemblance with external economies of scale. However, when knowledge is the intentional outcome of economic behaviour firms have to invest some resources in knowledge creation. This means that firms have some fixed costs that lead to internal economies of scale and imperfect competition. This approach uses also elements of the neo-technology trade theories because an innovation leads to (temporary) new products. Furthermore, it uses some elements from the external economies of scale approach because a part of the knowledge created by the firm can be used by other firms. Important with regard to trade and growth implications is whether these so-called knowledge spillovers are

national or international in nature. In both schools of the new growth theories the initial trade pattern is caused by differences in factor endowments or differences in initial knowledge levels.

Traditional theories

Within the traditional trade theories, classical theory (Smith and Ricardo) and neo-classical theory (Heckscher-Ohlin-Samuelson) are the schools of thought to be distinguished. Traditional trade theories focus on differences among countries that are the result of differences in technology (classical theory) or differences in relative factor endowments (neo-classical theory). One of the first theories of international trade is the classical theory of absolute cost advantages. According to Smith, trade only appears when there are absolute cost differences between countries. David Ricardo showed the shortcomings of this theory because, even if one country can produce all goods more efficiently than another country, trade is possible and beneficial. A pre-condition is that the relative efficiency gap is not the same for all goods. When this is the case, a country has a comparative advantage in a good that has the highest efficiency gap. In the Ricardian model labour is the only production factor and differences in labour productivity are the main explanation for trade. Labour productivity differs between countries because their technological knowledge level differs and/or there are differences in natural circumstances (natural resources, climate, soil, geographical position).

The neo-classical theory elaborated these theories by including more production factors. However, contrary to the classical theories this theory assumed identical production techniques over countries. Furthermore, the standard neo-classical Heckscher-Ohlin-Samuelson (H-O-S) model assumes constant returns to scale, identical consumer preferences and perfect competition. These assumptions imply that differences in factor endowments are the only explanation of trade in the H-O-S model. The larger the difference in factor endowments, the more trade between countries and all this trade is inter-industry trade. A country exports the good which makes the most intensive use of it's abundant factor of production. The relative abundant factor will gain from trade. In the trade equilibrium relative factor prices are the same across countries.

In the traditional theories gains from trade come from exchange and specialization. All countries will benefit from trade because of a more rational allocation of productive resources and lower relative prices for the importing competing product. The less barriers to trade there are, the more beneficial trade will be. Therefore, free trade policy is seen as the best trade policy, unless countries can improve their terms of trade (only large countries). Trade policy to 'correct' domestic distortions or for political reasons (for instance income-distributional effects of trade) are second best.

The specific-factor model is a special version of the standard neo-classical H-O-S model. In the standard H-O-S model all production factors are mobile between sectors, while in the short-term specific-factor model some are immobile. This implies, for example that trade implications for production factor rewards are totally different from the standard model. Trade is beneficial for

the specific factor that is necessary to produce the export good and it reduces the income of the specific factor used in the import good. The welfare implications of trade for the mobile factor depend on the consumption pattern of a worker and are ambiguous.

Despite the theoretical dominance of the neo-classical model for a long period the implications of this model were not unambiguously supported by empirical studies. The most influential study was done by Leontief (1953) who found that imports of the US (a capital abundant country) were more capital intensive than its exports. However, the application of Leontief's method has been criticized by many authors and the suggestion that the H-O-S theory performs badly has been counteracted. As a byproduct of Leontief's results and the debate that followed, the H-O-S theorem has been extended to allow for additional factors beyond just capital and labour to explain trade, or make a clearer distinction between skilled and unskilled labour and human and physical capital as factors determining international trade flows.

Modern trade theories

Still, empirical studies showed that - contrary to what would be expected according to the H-O-S theory - most trade is between countries with the same factor endowments that a major part of trade between industrial countries is of an intra-industry nature and that income-distributional effects of trade are small. These contradiction with traditional theory induced economists to search for new trade theories. The 'new' trade theories elaborated the neo-classical framework by replacing the assumptions of constant returns to scale and perfect competition. A second stream, the 'neo-technology theories', like the classical theories, stressed the central role of technology and proposed a radical departure from the neo-classical framework.

The 'new' trade theories assumed increasing returns to scale and this implies imperfect competition unless economies of scale are assumed to be totaly external to the individual firms. A first approach assumes these so-called 'external economies of scale'; an industry still contains many small firms and perfect competition remains. A second approach assumes internal economies of scale which lead to imperfect competition. Within this approach two directions have been identified. The first direction concentrates on modelling economies of scale and treats market imperfections as simply as possible by assuming monopolistic competition. A second direction concentrates on imperfect competition and uses economies of scale to cause these market imperfections. The main market structure they use is 'Cournot' or 'Bertrand' oligopoly. The main difference between these 'new' trade theories and the neo-technology trade theories is that the former assume identical production technologies across countries while the latter emphasize (endogenous) technological innovation and technology gaps across firms and countries as a major reason for international trade.

Economies of scale and (im)perfect competition

According to the new trade theories, trade is possible between countries identical in factor endowments, technologies and tastes. In these theories the main explanation for trade are economies of scale. However, in contradiction to the traditional theories, the direction of specialization with economies of scale is often unknown. Consequently, this theory gives an important role to history and accident in determining the pattern of international trade.

Economies of scale can be external or internal. Implications of trade differ when economies of scale are external or internal. When external economies are important, a country starting with a large industry may retain that advantage even if another country could potentially produce the same goods more cheaply. Gains from trade come from exchange, specialization and exploiting economies of scale. However, the division of welfare between countries can be very unequal, depending on the specialization pattern (whether the country specializes in the good produced with external economies of scale or not) and terms of trade (depending on supply and demand of goods in the trade equilibrium). Countries can even loose from trade. In that case trade (or industrial) policies can be beneficial.

With monopolistic competition, an industry contains a sufficiently large number of 'similar' firms producing differentiated 'unique' products and profits are competed away in the equilibrium. The main mechanism of trade at a market structure of monopolistic competition are (internal) economies of scale and product differentiation which cause the production of each variety to be concentrated in each country. Each country produces a different set of varieties of a certain product. Because consumers display a 'love of variety', they demand all varieties, which implies that a country imports each of the varieties produced in other countries and exports each of the varieties domestically produced. So, there will be intra-industry trade. However, it is unclear which country produces which variety. Again the exact specialization pattern depends on history and accident.

The gains from trade with monopolistic competition are from exchange, specialization, exploiting economies of scale, exit of redundant firms and more product variety. Income-distributional effects of intra-industry trade are less than those of inter-industry trade (H-O-S model) because there are additional gains from trade. Because intra-industry trade will be dominant between countries at a similar level of economic development, trade without serious income-distributional effects is most likely to happen in trade between countries similar in their relative factor endowments.

In an oligopolistic market structure, the behaviour of the firms influences each other. Trade occurs because of economies of scale. However, if market segmentation and price discrimination are possible, there can be trade even without economies of scale and comparative advantage. Gains from trade appear in the form of the pro-competitive effect (i.e. lower mark-up), the exit of firms which are unable to cover their fixed costs, and lower average costs if the production scale of a firm increases. Welfare implications are unclear.

The assumption of constant returns to scale and perfect markets justified the domination of free trade policy for almost a century. These 'new' trade theories question this free trade policy by introducing economies of scale and imperfect markets. They find that an active trade policy can be beneficial in certain circumstances. For instance, if in an industry makes excessive profits, such an industry should be desired. Under certain conditions, the use of export subsidies can also shift profits from foreign to domestic firms. This is the so-called 'strategic' trade policy. However, the new arguments for protection are very dependent on specific assumptions. A slight change in one of the assumptions changes or even reverses the implications of a policy. Good policy therefore requires that the government has a lot of information to help choose the right model. This information has to be so detailed that it is not readily available. The empirics also show that benefits from deviations from free trade are small. Furthermore, empirical tests of theories related to economies of scale and imperfect competition appear to be rather suggestive. Estimates of the impact of trade policies under imperfect competition lend no support to a strategic role for trade policy. Therefore, free trade is still considered to be a good rule of thumb, although it is not optimal under imperfect competition.

Neo-technology theories

The common feature of technology-oriented theories of trade is an emphasis on technological change and the resulting patterns of trade. In these theories trade patterns are explained in terms of technological progress. Technological differences or gaps across countries are an endogenous outcome through firm level product and process innovation that reduces costs of production and generates new products. The flow of technological developments and innovation is assumed to be not free and instantaneous, which implies that a firm/country has at least a temporary comparative advantage in production and exports. The difference with the Ricardian trade models is that in those models differences in technology (productivity) for some *given* goods cause trade, where in the neo-technology trade models trade is induced because the innovating country generates some *new* products that other countries, at least temporarily, are unable to produce.

Early contributions in this field have been made by Kravis, Posner, Vernon and Hirsch in the 1950s and 1960s. These authors describe a continual process of innovative developments in which countries where the innovations occur enjoy temporarily technological advantage over trading partners until the new technology is imitated in other countries. Each of the contributors stresses different reasons in explaining why countries will produce and export new products, like the availability of technology to produce new products (as in Posner's 'technology gap' model), the availability of skilled labour (Hirsch) or vicinity of their markets (as in Vernon's 'product cycle hypothesis').

Krugman has formalized the attempts to try to explain trade in terms of technology in his North-South model. In this model the North innovates a continuous stream of new product varieties on the market, while the South only imitates after a time-lag. The main mechanism for trade are technology gaps

which grow with innovation and close with imitation. Both countries benefit from trade because of exchange, specialization and more product variety. However, while the world is better off as production is shifting to a lower-cost country, the North may lose from imitation by the South. The innovating country may try to increase the innovation rate (innovation policy) or consider protectionistic measures to reduce imitation, unless there is a correct internationally technology transfer system.

Most, if not all empirical tests of the technology trade theories try to explain the pattern of trade of the US, simply assuming that the US is the innovative Northern country with high per capita incomes and relative wages and the rest of the world the imitating South. These tests are usually rather successful. Several authors sought and found positive correlations between US export performance across industries and various measures of R&D. Since R&D is related to technological progress, whatever its cause or effects, this evidence lends support to all technology theories of trade. Several tests of the technology theory of trade have also introduced additional explanatory variables, including those that are appropriate to the factor proportions theory, and support the conclusion that there is a strong and positive correlation between trade performance and technology-related variables. At the same time, however, it becomes clear that technology-related variables are much related to the ability of individuals, firms, or countries to develop and exploit technology which is related to the availability of knowledge and skills. It is, therefore, difficult to distinguish evidence supporting technology from evidence supporting human capital or skills as determinants of trade. Furthermore, more recent observations suggest that technological levels among countries converge rapidly and because of multinationals the speed of diffusion of innovations accelerate. So it appears that, besides the older tests with US data, empirical tests or application of the product cycle theory are limited in extent. The support from these studies for the idea of the 'technology gap' as driving force behind trade is fragmentary at best, suggesting evidence for the idea that transitory advantage resulting from innovation can be a major factor in trade for only some industries.

Trade Implications of Growth Theories

While all trade theories are mainly static and focus on allocation issues, an interesting development has taken place in the growth literature. The 'new' growth theories build forward on the static 'new' trade models and put them in a dynamic context. The new trade theories provided the building blocks such as the treatment of economies of scale and market imperfections. Like the neotechnology theories the 'new' growth theories stress the role of technological change. By putting these elements in a dynamic context these 'new' growth theories deal with the dynamic evolution of comparative advantage and the consequences of trade in a world of global technological competition.

The new growth theories found several ways to endogenize technological change in a general equilibrium model. Two approaches can be distinguished. The first approach assumes that externalities or 'learning-by-doing' effects,

which are by-products of other activities, cause growth and the external economies of scale approach is used to model these effects. The second approach assumes that technological change is the intentional outcome of economic behaviour and firms have to 'invest' in knowledge creation to obtain technological change. Investments in knowledge can be seen as a kind of fixed costs and monopolistic competition makes it possible to cover these fixed costs. Most studies that use the second approach, also assume that knowledge generates some externalities and are therefore a mixture of both approaches.

In models where external economies of scale determine the dynamical evolution of the specialization pattern (the first approach), the central mechanism is that a firm - unintentionally - creates knowledge and this knowledge flows directly to all other firms, where it increases the productivity level of the production factor that can be accumulated. In principle the initial specialization and trade pattern is determined by comparative advantage (initial factor endowments) or the initial knowledge stock (technological capabilities). The dynamic implications of these external economies of scale growth theories are that a country will built up knowledge or expertise in the goods in which it specializes and therefore reinforces its comparative advantage in these goods. Because the technological opportunities differ between goods the specialization pattern determines therefore also the welfare level and long term growth of a country.

Depending on the specific demand conditions, trade or industrial policy may be beneficial if a country specializes in the low-tech good; this may reduce welfare or may lead to less welfare than in the case the country had specialized in the high-tech good. Protection measures or industrial policies may reverse the specialization pattern when specialization in an other sector increases welfare. However, to deduce the correct policy advice is very difficult because one has to know the exact technological opportunities of different goods in different countries.

Models that concentrate on the investment in knowledge (human capital) combine imperfect competition with externalities. Through investments in R&D, a firm produces new goods by expanding product variety or quality. Furthermore, there are also some spillovers on the aggregate stock of knowledge. A larger stock of knowledge, in turn, reduces the costs of producing blueprints of new products. This causes a constant incentive to invest in R&D. Manufacturing will therefore also be growing at a constant ratio. Important for the generation of endogenous growth is that the incentive to invest in R&D does not decline. In all these kind of models the growing stock of knowledge as a side product of R&D generates this constant incentive. The R&D investments are dependent on the specialization pattern which is caused by the principle of comparative advantage (factor endowments), history, the initial stock of knowledge, the scale of a country and the demand structure. These factors determine the number of people that are working in the R&D sector, the high-tech and the low-tech sector. The welfare and growth implications are therefore also dependent on the specialization pattern. Important is whether knowledge spillovers are national or international in scope.

When there are international knowledge spillovers, all innovators will have the same knowledge and national advantages in R&D arise only from differences in relative factor prices (which are dependent on resource endowments). Factors such as the size of a country and the history of its production play no role in the long-term trade pattern; what only matters are factor endowments.

With only national knowledge spillovers the initial conditions govern long run outcomes. In many situations the country with the initial greater stock of knowledge has an advantage in R&D and accumulates knowledge more quickly than its trading partner. This sustains and adds to its productivity lead. History alone determines long-run trade patterns and growth rates (i.e. hysteresis).

Arguments for policy are to obtain a higher welfare level by reversing the specialization pattern if there are only national knowledge spillovers. Industrial policy (R&D subsidies) are considered first best and trade policy measures as second best policy.

Evolutionary growth theories assume that technology plays the fundamental role in economic life. Technological change and innovation is a cumulative, specific and irreversible process. The main trade mechanism is that absolute technological differences determine the world market position of all sectors. Relative technological gaps play a minor part. They determine the specialization pattern between sectors according to the mechanism of comparative advantage. Future growth and technological developments is determined by the current specialization pattern. The current specialization pattern of a country has therefore a dynamic effect because this pattern determines in which sectors technical skills will be accumulated, innovations will be done, economies of scale will be realised, etcetera. Sectors differ in their growth opportunities such that the present specialization pattern is extremely important for the countries' future economic performance. A specialization pattern according to the traditional mechanism of comparative advantage can lead a country to specialize in those industries (sectors) and activities in which the opportunities for growth and technological development are least. A specialization pattern which is static (Ricardian) efficient can therefore be dynamic inefficient and vice versa. If this tradeoff occurs, a country can try to change the specialization pattern and future growth path through industrial or trade policy.

Evaluation on policy

Traditional theories suggest that trade is beneficial for all countries involved and therefore support free trade. Only in some circumstances (a large country may improve its terms of trade) there is an argument for trade policy. Modern trade theories extend the traditional arguments for trade policy and add some new arguments for government policy intervention such as the strategic trade argument. However, the circumstances in which a trade policy may be beneficial appear to be very specific. Moreover, a government needs a lot of very detailed information to make the right decision. And besides that, empirics show that benefits from deviations from free trade are very small. So, modern trade theories still support free trade, although it is recognized that

free trade is not optimal under imperfect competition. The 'new' growth theories most of the time assume free knowledge spillovers across countries. Then, trade policies will not be beneficial. However, the evolutionary growth theory assumes that a crucial part of the generated knowledge is cumulative, specific and path dependent and spillovers are therefore local or national in scope. In that case trade policy may become beneficial because the gains at stake can be very large in some circumstances. Government policy still requires a lot of information about many difficult to measure economic variables such as technological opportunities, knowledge spillovers, and external economies of scale. Still, government policy seems to be more worthwhile than in the case of the modern trade theories because the gains at stake are larger.

1. INTRODUCTION

The survey of trade theories is part of the research project 'Policy and Patterns of International Trade', executed by the Agricultural Economics Research Institute (LEI-DLO), financed by the Institute's budget on Strategic Expertise Development (SEO programme). The objectives of this research project are to:

1. analyse international trade theories, with the aim to answer the question: what determines international trade patterns and which role does government policy play in this?
2. assess the usability of general trade theories in explaining agricultural trade;
3. design a concept for explaining world trade patterns in agricultural commodities.

The first activity in this research project, a review of literature, should throw light upon the factors that are crucial in explaining trade. A second activity is to assess the usability of these theories for research on agricultural sectors. We first describe the features of agricultural chains and markets (focusing on all factors that could be of importance) and thereafter confront the trade theories with these features and empirical data on the agricultural sector. This confrontation will result in depicting the factors of importance (and circumstances under which they are of importance) in explaining agricultural trade. Then these factors should become the building stones for a design of a concept explaining world trade patterns in agricultural commodities. Of course, questions of data-availability to operationalize the concept are addressed.

This report analyses international trade theories (objective 1 of the project). An introduction to the trade theories is made by classifying them according to certain key elements. In the following chapters, international trade theories are described more exhaustively, focusing on the explanation of international trade and the role of governments to play.

Why do countries trade with each other? What can be gained by trade and how can trade patterns be explained? These questions have been addressed by many economists ever since Smith at the end of the eighteenth and Ricardo in the early nineteenth century. Many different answers have been given to the question what causes trade and still there is much controversy on this issue. Differences between countries, for instance in natural factor endowments and factor prices, can be a motive for trade between two countries. Countries trade in order to take advantage of these differences. This concept of trade is based on (the theory of) comparative advantage. However, other - more modern - theories state that countries may also trade because there are inherent advantages in specialization, arising from the existence of economies

of scale. Some other models in modern trade theories emphasize imperfect competition, product differentiation and technology gaps (innovation) across firms and countries as a major source of explanations for international trade. Finally, the trade implications of the 'new' growth theories will also be taken into account because these theories shed light upon the dynamic evolution of comparative advantage.

A General Classification of Theories of International Trade

In the economic literature, international trade theories can be classified in two major streams: the traditional and modern trade theories. Within both schools, a further differentiation can be made, based on the major elements the theory is focused on. In the following, an outline of the theoretical principles of each mainstream will be given, plus the thoughts of the most important authors of each stream. International trade theories may be classified in the following way:

1. Traditional trade theories
   - Mercantilism
   - Classical theory
     - Absolute advantage (Smith)
     - Comparative advantage (Ricardo)
   - Neo-classical theory (Heckscher-Ohlin-Samuelson)
     - specific factors model (short term)

2. Modern trade theories
   - Economies of scale and imperfect competition
     - External economies of scale
     - Internal economies of scale and imperfect competition
       - Monopolistic competition
       - Oligopolistic competition
   - Neo-technology trade theories
     - Technology gap theory

3. Trade Implications of the Growth Theories
   - New Growth Theories
     - Knowledge as side product: External economies of scale
     - Knowledge as investment: A combination of external and internal economies of scale with monopolistic competition
   - Evolutionary Growth Theories

The term 'mercantilism' stands for the theory and system of political economy prevailing in Europe after the decline of feudalism (approximately 1,500 to 1,750). This system was based on national policies of accumulating gold bullion, establishing colonies and a merchant marine, and developing industry and mining to attain a favourable balance of trade. Mercantilism emphasized policies that encouraged exports of domestic products and discouraged imports.

Neo-mercantilism is a modern concept defined as a tendency of a country to accumulate large amounts of hard foreign exchange.

Traditional trade theories focus on differences among countries that are the result of differences in technology (classical theory) or differences in relative factor endowments (neo-classical theory). One of the first theories of international trade is the classical theory of absolute cost advantages. According to Smith, the main representative of this school, trade only appears when there are absolute cost differences between countries. David Ricardo showed the shortcomings of this theory because, even if one country can produce all goods more efficiently than another country, trade is possible and beneficial. A precondition is that the relative efficiency gap is not the same for all goods. When this is the case, a country has a comparative advantage in a good that has the highest efficiency gap.

The neo-classical theory, which dominated international trade theory for a long time, elaborated these theories by including more production factors. However, contrary to the classical theories this theory assumed identical production techniques over countries. Furthermore, the standard neo-classical Heckscher-Ohlin-Samuelson (H-O-S) model assumes constant returns to scale, identical consumer preferences and perfect competition. These assumptions imply that differences in factor endowments are the only explanation of trade in the H-O-S model. The larger the difference in factor endowments, the more trade between countries and all this trade is inter-industry trade.

The specific-factor model is a special version of the standard neo-classical H-O-S model. In the standard model all production factors are mobile between sectors, while in the specific-factor model one factor is mobile and one factor is immobile. We include this so-called short term version of the H-O-S model in this review because the trade implication for production factor rewards are totally different from the standard model.

Despite the theoretical dominance of the neo-classical model for a long period the implications of this model were not supported by empirical studies. The most influential study was done by Leontief (1953) who found that the US (a capital abundant country) imports were more capital intensive than US exports. Furthermore, empirical studies showed that most trade is between countries with the same factor endowments and that a great part of trade between industrial countries is intra-industry trade (Balassa 1967, Grubel and Lloyd 1975).

These contradictions with traditional theory induced economists to search for new trade theories. The 'new' trade theories elaborated the neo-classical framework by replacing the most unrealistic assumptions of constant returns to scale and perfect competition. A second stream, the so-called 'neo-technology theories', like the classical theories, stressed the central role of technology and proposed a more radical departure from the neo-classical framework.

The 'new' trade theories assumed increasing returns to scale and this implies imperfect competition of scale unless economies of scale are assumed total external to the individual firms. A first approach assumes these so-called 'external economies of scale'; an industry still contains many small firms and perfect competition remains. A second approach assumes internal economies

of scale which lead to imperfect competition. Within this approach two directions can be identified. The first direction concentrates on modelling economies of scale and treat market imperfections as simple as possible by assuming monopolistic competition (Dixit and Norman 1980, Helpman and Krugman 1985). A second direction concentrates on imperfect competition and uses economies of scale to cause these market imperfections. The main market structure they use is 'Cournot' or 'Bertrand' oligopoly (Brander and Spencer 1985, Helpman and Krugman 1989). The main difference between these 'new' trade theories and the neo-technology trade theories is that the former assume identical production technologies across countries while the latter emphasize (endogenous) technological innovation and technology gaps across firms and countries as a major reason for international trade.

While all these trade theories are mainly static and focus on allocation issues, an interesting development has taken place in the growth literature. The 'new' growth theories build forward on the static 'new' trade models and put them in a dynamic context. The new trade theories provided the building blocks such as the treatment of economies of scale and market imperfections. Like the neo-technology theories the 'new' growth theories stress the role of technological change. By putting these elements in a dynamic context these 'new' growth theories deal therefore with the dynamic evolution of comparative advantage and the consequences of trade in a world of global technological competition (Romer 1990, Grossman and Helpman 1991b). This makes it very interesting to include the trade implications of the growth theories in our review of international trade theories.

Classification Criteria

We use the following criteria to survey the trade theories.

1. Assumptions: what are the main assumptions of a theory?
2. Central mechanism: what is the central mechanism in a theory to explain trade?
3. Implications: what are the main implications of a theory (e.g. gains from trade)?
4. Policy: what are the main effects of government policy in a theory?
5. Empirics: which kind of empirical tests are done to test the theory and do these tests support the theory?

Each criterion to survey trade theories consists of many elements or aspects. Next, the main key elements of each criteria to be distinguished are shown. Most of the key elements are subdivided in a number of aspects which need to be considered in reviewing trade theories.

Ad 1. Assumptions:

Supply:

- *Production factors*
  - number
  - which? (land, labour, capital, human capital, knowledge)
    - mobile across sectors
    - immobile across sectors
    - mobile across countries
    - immobile across countries
    - initial endowments differ between countries
  - which factor can be accumulated (in case of growth theories)?
- *Sectors/goods*
  - number
  - homogeneous
  - differentiated

Technology:

- *Economies of scale*
  - constant economies of scale
  - increasing economies of scale
    - external economies of scale
    - internal economies of scale
- *Production technology*
  - identical between goods
  - different between goods
  - identical between countries
  - different between countries
  - no technological change
  - technological change
    - exogenous
    - endogenous
      - process innovations
      - product innovations
        - new varieties (horizontal product differentiation)
          - consumer products
          - producer products
        - quality improvements (vertical product differentiation)
- *Knowledge spillovers*
  - knowledge spillovers do not exist
  - knowledge spillovers do exist

- national knowledge spillovers
- international knowledge spillovers
- knowledge spillovers across different kinds of goods
- good specific knowledge spillovers

Demand:

- *Consumer preferences*
  - identical across income levels (i.e. homothetic)
  - different between income levels
  - identical between countries
  - different between countries

Markets:

- *Good market*
  - perfect competition
  - imperfect competition
    - monopoly
    - oligopoly
    - monopolistic competition

- *Factor market*
  - perfect competition (markets clear)
  - markets do not necessarily clear

Ad 2. Main mechanism

- differences in technology (technology gaps)
- differences in factor endowments
- differences in consumer preferences
- economies of scale
- imperfect competition
- market segmentation and price discrimination

Extra for growth theories
- Main growth mechanism

Ad 3. Implications

- Which country exports which goods?
  - inter-industry trade
  - intra-industry trade
- *Gains from trade*
  - specialization
  - gains from exchange
  - exploiting economies of scale

- more product variety
- pro-competitiveness effect
- higher rate of innovation

- *Do factor prices converge between countries?*
- *Which production factors gain, which loose?*

Extra for growth theories

- *Which factor can increase growth rate?*
- *Welfare implications: Is the growth rate optimal in the equilibrium?*
  - yes
  - no
    - which policy is needed to obtain the optimal equilibrium?

Ad 4. Policy

- *Arguments for government policy*
  - terms of trade
  - infant industry argument
  - externalities
  - strategic trade argument
  - political arguments

- *Which government policies can be implemented?*
  - trade policy (tariffs, quota)
  - industrial policy (subsidies, taxes)
  - innovation policies (subsidies)
  - competition policy

- *Main effects of these policies on*
  - total welfare
  - government budget, consumer, and producer surplus
  - different sectors
  - different factors of production
  - neighbour countries

Ad 5. Empirics

- *Is it possible to test the theory?*
  - no
  - yes
    - empirical studies support theory
    - empirical studies contradict theory

- *Critical remarks*

Elaboration

In the next chapters, each school of thought is described by focusing on the five specific issues mentioned above: assumptions, mechanisms, implications, government policy and empirical evidence of the theory. This review should result in a summary of the main characteristics of the theories, their way of explaining international trade, implications of trade and the influence of government intervention. Furthermore, the empirical evidence of the theories are discussed. These issues are summarized in a matrix.

The review of theories are to be used as an input in the following stages of the project. In the second stage, the general trade theories are assessed on their usability in explaining agricultural trade. Here we take a broad definition of agricultural products: these are not only agricultural products produced by primary sectors, but all products produced in the agricultural chain, including, for example, products produced by the food processing industries. In order to do this evaluation, first the features, such as for example production technology and market structure, of the food and agricultural chains and markets have to be described. Thereafter, these agricultural characteristics will be confronted with features of the trade theories reviewed, and this results in an overview of the major factors of importance in explaining agricultural trade.

We can illustrate this idea with the matrix 'Confronting characteristics of product X with assumptions of the trade theories' presented below. The columns represent the theories that are studied in phase one and the rows depict the characteristics of an (group of) agricultural product. When one characteristic of the agricultural product is embodied in a certain theory we put a cross in the matrix. In this way we can identify which theory or theories explain a part of the trade for a certain agricultural product.

Confronting characteristics of product X with assumptions of the trade theories

	Theory 1	Theory 2	.....	.....	Theory n
Characteristic 1	X			X	
Characteristic 2		X			
.....	X	X	X	X	
Characteristic n		X			X

The main objective of this study is to design a concept to explain agricultural trade patterns. Most trade theories focus on one mechanism for trade that is dependent on one or two assumptions. All the other assumptions are treated as simple as possible and assumed to be identical across countries. However, in the real world countries differ in many aspects and many mechanisms for trade work at the same time (some mechanisms reinforce each other, other neutralise each other). In this study we try to design a framework or concept for certain groups of agricultural products with more or less homogenous characteristics (for each homogenous group a different framework). Such a frame-

work starts with the characteristics of the homogenous product group, such as homogenous or differentiated product, and incorporates all the trade mechanisms that are linked to these characteristics. This will be no framework with formulas and equations but a framework, containing the major factors of importance and circumstances under which these factors are of importance in explaining agricultural trade. Such a framework will be a qualitative model, in which the importance of the factors distinguished are discussed in relation to specific circumstances cq. features of agricultural product and markets.

2. TRADITIONAL TRADE THEORIES

2.1 Classical theories

The classical theories explain trade by differences in production technologies between countries. First, we briefly discuss the absolute advantage theory of Adam Smith and second we describe the comparative advantage theory developed by David Ricardo in a more elaborated way.

2.1.1 Absolute advantage (Smith)

One of the first theories of international trade is the classical theory of absolute cost differences or absolute advantages. According to this theory trade appears only when there are absolute cost differences between countries. We illustrate this principle with a simple example. Assume there are two goods X and Y, two countries Home (H) and Foreign (F), the only factor of production is labour, and the labour requirements to produce one good X and Y are:

Labour requirements

	X	Y
Country H	20	20
Country F	10	30

Country F has an absolute advantage in the production of good X and country H has an absolute advantage in the production of good Y. According to this theory the countries specialize in goods in which they have an absolute advantage and consumers maximize their utility through international trade.

2.1.2 Comparative advantage (Ricardo)

David Ricardo showed the shortcomings of the theory of absolute advantage by demonstrating that trade is also possible and beneficial when one country has an absolute advantage in both goods, but when the efficiency gap is not the same for both goods.

Basic assumptions

Production factors: one production factor, labour (domestically mobile and internationally immobile)
Sector/goods: two homogeneous goods (X and Y)

Economies of scale: constant returns to scale
Technology: fixed labour requirements to produce each of both goods, these requirements differ between goods and between countries. No technological change.
Knowledge spillovers: no
Consumer preferences: identical across income and between countries
Market structure: perfect competition on both factor and good markets.

Main mechanism

Just as in the absolute advantage theory, the main mechanism in the classical theory of comparative advantage is the difference in production technology between countries.

The technology of an economy is summarized by the productivity in labour in each industry and comparative advantage is the result of international differences in labour productivity. A country has a comparative advantage in producing good X when its ratio of labour requirements in good X to that in good Y is lower than in an other (foreign) country, i.e. the home country's relative labour productivity in good X is higher than in the other country. We can illustrate the principle of comparative advantage with the following example.

Labour requirements

	X	Y
Country H	5	5
Country F	10	30

Country H has an absolute advantage in both goods and according to the theory of absolute advantage trade is not possible. However, the relative efficiency differences between good X and Y are not equal between the countries. In country F it costs the economy three times as much to produce one unit of Y as it does to produce one unit of X ($p_f = P_X / P_Y = 1/3$). In country H the labour cost of production are equal ($p_h = 1/1$). These relative efficiency differences create possibilities of profitable exchange between the two countries. If the world price (p_w) is equal to ½ then it is possible to exchange two units of good X for one unit of good Y. This world price is profitable for country H because it can obtain 2 units of good X for one unit of good Y, while in production it can obtain only one unit of X by giving up one unit of Y. Therefore, despite country H having an absolute advantage in the production of both goods, trade is nevertheless profitable for this country; it is profitable for country H to specialize in commodity Y and import commodity X. Country F on the other hand can obtain more units of Y for one unit of X by trading than by producing. It is therefore profitable for country F to specialize in good X and import good Y. Although country F does not have an absolute advantage in the production of either of the two commodities, she has a comparative advantage in the production of good X, in the sense that X can be produced relatively less expensively than in country H. Therefore trade creates profitable possibilities for both

countries despite that one country is more efficient in producing both goods. The observation that trade depends only on comparative advantage and not on absolute advantage is one of the major contributions of Ricardo.

Implications

- *Gains from trade*

In the absence of trade, the relative prices of both goods in each country are determined by the relative unit labour requirements. We can illustrate this with figure 2.1 in which the production possibility curve (PPC) for country H is depicted (total amount of labour in country H is equal to 50). Before trade the autarky equilibrium price ratio is tangent to the community indifference curve (I_0) and the production possibility curve. In this case the tangency is independent of the equilibrium point (A) and fully determined by the slope of the PPC. Therefore, only cost conditions determine the relative domestic price level before trade. The pre-trade relative price (P_X/P_Y) is therefore $p_f = 1/3$ in country F and $p_h = 1$ in country H. The normal result of trade is that the equilibrium world price (p_w) ends up somewhere between the pre-trade levels in the two countries ($p_f < p_w < p_h$) 1). A possible world equilibrium price is included in figure 2.1. This world price implies that country H completely specializes in the production of good Y (production point is point C) and consumes where the indifference curve is tangent to the world price (point B). The consumption point after trade is associated with a higher utility level ($I_1 > I_0$), so country H gains from trade (the same is true for country F, however this country specializes in good X).

Both countries derive gains from trade from this specialization because by producing the good in which it has a higher relative labour productivity and trading this good for an other good in which it has a relative lower productivity. This is a more efficient method than direct production of the good with a lower productivity and it increases the consumption possibilities in both countries.

The total gains from trade (movement from A to C) can be divided into gains from exchange and gains from specialization. Gains from exchange occur if one can obtain a higher utility level by simply changing one commodity for another. In figure 2.2 this 'gains from exchange effect' is depicted by the movement from A to D: the production stays in point A while the price level changes from the pretrade to the world price level. The movement from D to B represent the gains from specialization; country H specializes in the production of good Y (movement from A to C) while the price level stays the same.

The gains from trade for a country are dependent on the world price level. If the world price level is equal to the autarky level ($p_w = p_h$) then there are no gains from trade for this country because the consumption (and the associated indifference curve) stays in point A (figure 2.1). If the world price

---

1) Note that at any price ratio outside this range, both countries would want to specialize in the production of the same commodity, and this could not possibly lead to an equilibrium situation.

declines (the relative price of good Y, the export product of the home country, increases) the terms of trade of country H improves (the relative price of its export product increases) and country H obtains a higher indifference curve (for example movement from A to B). Therefore the world price determines how much a country will gain from trade and how the gains from trade are divided over the countries.

In contrast to the autarky price level, which is only determined by supply conditions, the equilibrium world price level is determinated by supply and demand conditions. The offer curves for both countries reflect the excess demand (imports) or excess supply (exports) for both commodities. These offer curves for country H and F are depicted in figure 2.3. The world price is determined where both offer curves intersect; point E (import or excess demand for good Y by country H is equal to export or excess supply of good X by country F, and vice versa for product X). Because the world price is important for the division of the gains from trade over countries, we consider a few determinants of the equilibrium price:

- *demand preferences*

If the demand preferences in country H shift towards good X (indifference curves shift to the X-axis) then the offer curve for country H shifts from OAF_h to $OA'F'_h$ (figure 2.4). The world price level increases from p to p' (relative price of good X increases) and the terms of trade for country H deteriorates. In general, shifts in demand toward; the import commodity will tend to deteriorate the terms of trade and reduce the gains from trade;

- *size of countries*

If country H gets bigger (increase in labour) its PPC shifts outwards and the offer curve shift from OAF_h to $OA'F'_h$. Therefore an increase in labour deteriorates the terms of trade. If country H gets even bigger and bigger then the offer curve of country F intersects the offer curve of country H in the flat part of the offer curve and the world price level becomes equal to the pre-trade level of the large country. The large country does not gain from trade in this situation. Therefore, both countries will specialize completely when the world price is between the cost ratios of the two countries, this is only possible if both countries have the capability of producing a large enough quantity of one of the goods to satisfy world demand;

- *production technology*

Changes in the production technology in general change the slope of the production possibility curve. A small increase in labour productivity from the import good does not change the terms of trade. An increase in the labour productivity of the export goods shifts the offer curve again from OAF_h to $OA'F'_h$ and deteriorates the terms of trade.

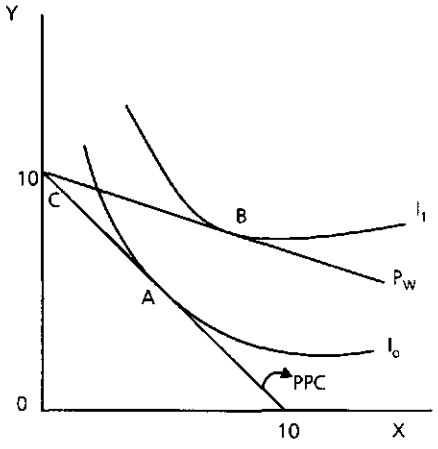

Figure 2.1 Ricardian trade model

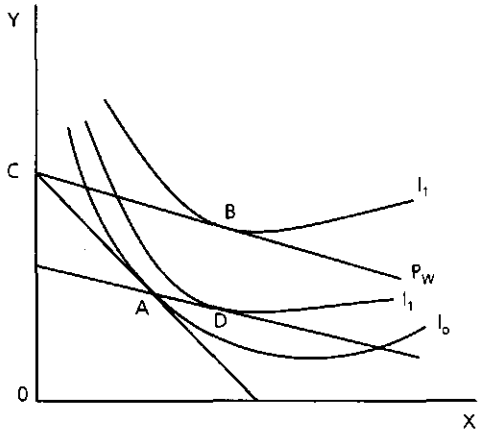

Figure 2.2 Gains from exchange and specialization in the Ricardian trade model

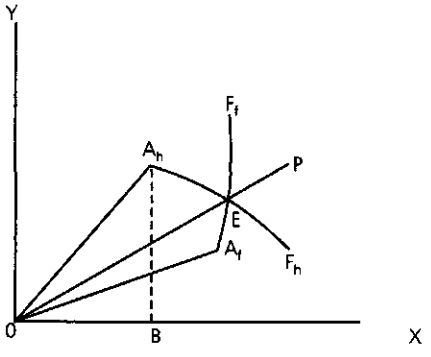

Figure 2.3 Determination of the world price in the Ricardian model

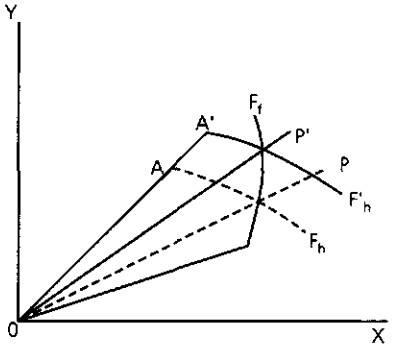

Figure 2.4 Demand and supply factors influence the world price in the Ricardian model

Policy

The main policy message from this theory is that a country should avoid anything that may restrict trade with other countries. The governmental policies should be as non-distortive as possible as nonintervention in trade is considered to be the optimal way to benefit from the gains of trade. These gains are obvious, according to the model and are best served by free trade.

Only when a country can influence its terms of trade or when there are domestic distortions (externalities), trade policy can be beneficial for a country. These arguments are the same for all the traditional theories and these are therefore treated in section 2.3.

2.2 Neo-classical theory

2.2.1 Heckscher-Ohlin-Samuelson model

The Heckscher-Ohlin-Samuelson theory provides important insights into the relationship between commodity trade and factor endowments.

Basic assumptions:

Two production factors: labour and capital (both factors are domestically mobile and internationally immobile). Initial factor endowments (apparent in capital/labour ratios) differ between countries.
Economies of scale: constant returns to scale
Technology: production functions are different for the two commodities (factor intensities reflected in capital/labour ratios differ between goods) but identical across countries. No technological change.
Knowledge spillovers: no
Consumer preferences: homothetic 1) and identical between countries.
Market structure: perfect competition.

Main mechanism

The central explanation for trade in the standard Heckscher-Ohlin-Samuelson (H-O-S) model is the difference in factor endowments between countries. Taking into account all the assumptions, these differences in factor endowments lead to different factor prices and different prices of goods between countries. Because prices of goods differ there's a reason for trade. Let us illustrate this with the following example. Assume that factor endowments differ between countries and between goods. Then there is a relatively labour-abundant and a relatively capital-abundant country and a relatively labour-intensive and a capital intensive good. In autarky, the relative factor price of labour to capital will be lower in the labour-abundant country. The labour-intensive good will therefore be relatively cheaper in this country. As in the Ricardian theory when relative good prices differ, there is an incentive for trade.

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1) Similar tastes between income levels.

We can elaborate this principle with the following illustration. Assume a two goods (X and Y) and two countries (Home and Foreign) model 1). Country H is relatively capital abundant and Country F is labour abundant. Good Y is capital intensive and good X is labour intensive. The product possibility curves of country H and F and the indifference curves are depicted in figure 2.5.

In the autarky situation, the relative price of good X to Y for country H and F is given by the price lines P_h en P_f (price lines are determined by the tangency of product possibility curves and indifference curves). Given these relative prices, country H produces and consumes Y_{ha} and X_{ha} while country F produces and consumes Y_{fa} and X_{fa}. Therefore in the autarky situation the relative price of good X to Y is higher in country H (P_x/P_y for H $>P_x/P_y$ for F). According to the principle of comparative advantage, country H will export good Y and country F will export good X. Because the demand for good Y (X) increases in country H (F) the relative price ratio of X to Y will decrease (increase). When trade expands, each country's exporting sector grows and the import-competing sector contracts. Factors of production move in the same direction and result in income-distribution effects. Because the export sector uses relatively more of the abundant factor, the relative factor price of this factor will increase and therefore the relative price of the export good increases. This process will continue until the relative prices in both countries are the same (world price is P_w in figure 2.5).

In the trade equilibrium H produces Y_{hp} and consumes Y_{hc} and will therefore export $Y_{hp} - Y_{hc}$ to country F. Country F produces Y_{fp} and consumes Y_{fc} and will import $Y_{fc} - Y_{fp} = Y_{hp} - Y_{hc}$ For good X it is the other way around. It is important to know that trade enables each country to reach a higher indifference curve (I_1 in stead of I_0).

Implications

From the above illustration of the H-O-S theorem several conclusions can be draw:

1. The Heckscher-Ohlin theorem
   Given the assumptions of the model a country exports the good which uses most intensive it's abundant factor of production. In our example, the labour (capital) abundant country F (H) will export the labour (capital) intensive good X (Y) and will import the capital (labour) intensive good Y (X).
2. The factor-price-equalization theorem
   Relative factor prices will be the same across countries in the trade equilibrium. As in our example, in the trade equilibrium relative good prices are the same in both countries. With the same production technology and constant returns to scale this is only possible when factor prices are identical.

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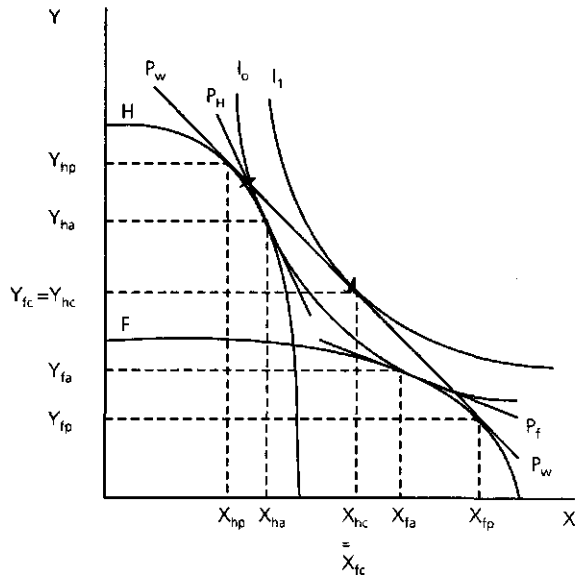
1) This model with 2 goods, 2 factors, 2 countries is considered to be the basic H-O-model.



H = production possibility curve of country H
F = production possibility curve of country F

I_o = indifference curve in autarky
I_1 = indifference curve with trade

P_h = Px /Py for country H, pre-trade relative price of X to Y
P_f = Px /Py for country F, pre-trade relative price of X to Y
P_w = Px /Py in the trade equilibrium

Figuur 2.5 Relation between factor intensity and trade

3. The Stolper-Samuelson theorem
   An increase in the relative price of a good increases the factor reward of the factor which is used intensively and decreases the reward of the other factor.
4. A combination of the Heckscher-Ohlin theorem and the Stolper-Samuelson theorem implies that the scarce production factor in a country will loose from trade and the abundant production factor will gain from trade.
5. The Rybczynski theorem
   An exogenous increase in the supply of one production factor leads to an increase in the production of the good that uses this production factor intensively and to a decrease of the other good.

6. Trade will increase the welfare of both countries
In our example both countries reach a higher indifference curve in the trade equilibrium. This is caused by a more rational allocation of productive resources and lower relative prices for the import competing product.

Policy

The traditional theories explain trade as a result of differences between countries. By using these differences between countries trade is beneficial to all countries. The less barriers to trade there are, the more beneficial trade will be. Free trade policy is therefore the best trade policy under normal conditions (arguments for trade policy are treated in section 2.3).

2.2.2 Specific factors model

The Heckscher-Ohlin model assumes that all production factors can move freely between sectors, which is clearly a long run feature. In the short run capital is not perfectly mobile because capital used in agriculture is quite different from capital used in making cars. In the short run specific-factor model, there are two factors of production, labour is mobile between sectors, but capital is assumed to be immobile and therefore good-specific.

Another interpretation is that the specific factors model represents Ricardian technological differences. Now, the resemblance with the Ricardo model is striking. The only difference is that Ricardo assumes a fixed marginal product to the mobile factor labour whereas this so-called Ricardo-Viner model assumes diminishing marginal products to labour.

A third interpretation of the specific-factor model is that this model explains trade flows when there are really specific factors from their own nature. Trade based on natural resources is an example of this interpretation.

Basic assumptions

Three production factors: labour (domestically mobile), two kinds of capital (good specific); all factors are internationally immobile. Initial factor endowments differ between countries.
Sector goods: 2 homogeneous goods
Economies of scale: constant returns to scale.
Technology: production functions are different for the two commodities but identical across countries. No technological change.
Knowledge Spillovers: no.
Consumer preferences: homothetic and identical between countries.
Market structure: perfect competition on goods and factor markets.

Main mechanism

In contrast to the Heckscher-Ohlin model, the international trade pattern can not be predicted from initial factor endowments alone. The specialization pattern is also dependent on the nature of the production functions and the allocation of capital between the two industries.

Implications

- The Heckscher Ohlin theorem does not always hold. A relative labour-abundant country will not always export the labour intensive commodity.
- The implications of the specific-factor model also differ from those of the Heckscher-Ohlin model on the field of income-distribution. Trade raises the relative price of the good in which the country has a comparative advantage (say good X). The mobile factor labour moves into sector X and this raises the income of the specific factor in this sector. For the good Y the results are just the opposite. Therefore, trade is beneficial for the specific factor that is necessary to produce the export good and it reduces the income of the specific factor used in the import good.
  The marginal product of labour (the real return to labour) has fallen in the export sector X and risen in the import sector Y. The welfare of a worker will depend on the consumption pattern. If the consumer prefers the export good X which price has increased, the welfare of the consumer declines, when the consumers prefers the import product Y the welfare increases. Therefore the welfare implications from trade on labour are ambiguous.
- An increase in the endowment of one of the specific factors reduces the real income of both specific factors and increases the real income of labour the mobile factor (even if we keep the relative price ratio unchanged). This is in contrast with the Heckscher-Ohlin model in which endowment changes do not influence factor prices when the relative price ratio remains unchanged.
- An increase in the amount of labour reduces the return to labour and increase the return to both the specific factors.
- An increase in one of the specific factors increases the output of the industry that uses this factor and reduces the output of the other industry. An increase in the supply of labour increases both outputs. The first effect is conform the Rybczynski theorem and the second effect is in contrast with this theorem.
- The equalization of commodity prices by international trade does not equalize factor prices.

Policy

Again free trade policy is the best for a country's welfare.

2.3 Trade policy under perfect competition

In the traditional theory with perfect competition free trade is the best policy from a world point of view. However, for an individual country trade policy can be beneficial under the following conditions. First, if a country can influence the world price (i.e. a 'large country' case), it can improve its terms of trade (terms of trade argument) at its trading partners' expense. Second, trade policy can be used to correct for domestic distortions. Third, trade policy can also be desired for political reasons.

1. *Trade policies when a country can improve its terms of trade*
   - A *tariff* raises the domestic price level which generates tariff revenues at the expense of consumer surpluses. The net effect contains two elements. On the hand, there is a (consumer) distortion loss through the wedge between supply and demand and on the other hand, there is a terms of trade gain because importers lower their price. For small tariffs, the second effect (first order effect) dominates the first effect (second order effect) and a tariff is therefore beneficial. For larger tariffs, the opposite is true. Therefore, there is an optimal tariff for a large country (e.g. Corden, 1971).
   - An *import quota* is equivalent to a tariff only if all the rents are collected by the domestic economy. If this is not the case, a quota (or a Voluntary Export Restraint (VER)) is worse than a tariff because the rents are taken by foreigners (Bhagwati, 1965).
   - An *export subsidy* is never beneficial because it worsens the terms of trade and it creates (production) distortion effects. The right policy is an export tax which can compensate the distortion loss with an improvement of the terms of trade. Again, the second effect dominates the first and a small export tax is beneficial.
2. *Domestic distortion and trade policy*
   Market failures or domestic distortions cause that consumer and producer surplus do not accurately measure social costs and benefits. Trade policy can be useful to correct for these distortions. There are two main types of market distortions. First, there are imperfections in factor markets (differences in wages among industries, unemployment, etc.). Second, there are external economies: technological spillovers between firms, learning effects and negative externalities such as pollution.
   Trade policy can shift production to activities with positive externalities and out of activities with negative externalities. This creates an additional welfare gain in addition to all the effects mentioned in the case of the terms of trade argument. This means that all trade policies can become beneficial even when there is no terms of trade effect (small country assumption). However, trade policy will always be a second best policy, because a production subsidy can achieve the same result without generating the consumer distortion.
3. *Trade policy for political reasons:*
   Sometimes trade policy is used to achieve political goals:
   - National defence: you need certain industries because their output is vital in time of war when foreign supplies are unavailable.
   - Income-distribution: Sometimes trade policy is desired to achieve a more desirable income-distribution or to avoid undesirable income-distribution effects of trade. As in the case with distortions, trade policy is only a second best policy whereas income-distribution policy is the first best policy.

2.4 Empirics

Test of the Ricardian theory of comparative advantage

There are a number of ways in which the Ricardian model makes misleading preconditions (for example: that an extreme degree of specialization will occur, or that, ignoring income-distributional effects of international trade within countries, countries as a whole always gain from trade) and, obviously, the Ricardian one-factor model is far too simple to be a complete analysis of either the causes or the effects of international trade. But according to Krugman and Obstfeld (1994:29) the basic prediction of the model - that countries should tend to export those goods in which their productivity is relatively high - has been strongly confirmed by a number of studies (for evidence, the authors refer to studies by MacDougall, 1951/52, MacDougall et al., 1962, and Balassa, 1963). Therefore, Krugman and Obstfeld conclude that, also because of its relative simplicity, a focus on relative labour productivities can be a very useful tool in thinking about international trade. Leamer (1994), however, is less convinced by the evidence from these empirical studies. To his opinion, first, 'the Ricardian model is not sensibly interpreted literally' in the empirical work and, second, 'the studies are done without referring adequately to the range of alternative hypotheses that might be considered.' (Leamer, 1994:71-72). Therefore, Leamer concludes that what we may have learned from this empirical work on the classical comparative cost theory is 'not too much' (1994:71).

Testing the Heckscher-Ohlin theorem

The H-O theorem is a three-way relationship of factor abundance, factor intensity and trade. A proper test must therefore include all three of them. Few, if any investigators have managed this and therefore what we have is a large body of evidence that is suggestive but hardly conclusive as to the empirically validation of the H-O theorem (Dearndorff, 1984). Although the study does not include a measuring of factor endowments, the work of Leontief (1953) is considered as a first, comprehensive empirical application of the H-O theorem. He used an input-output table for the US economy to measure the capital and labour embodied in US exports and import substitutes. He found that the ratio of capital to labour embodied in US exports was smaller than that embodied in import substitutes, while USA was supposed to be a capital-abundant and labour-scarce country. The debate that followed from this 'paradox' concentrated mainly on the method Leontief applied. Several authors have reapplied Leontief's basic methodology and the results have typically reaffirmed the paradox in the early years but found that it may have disappeared by 1970 (see Dearndorff, 1984: 480-485, also for references). As a byproduct of Leontief's results and the debate that followed, the H-O theorem has been extended to allow for additional factors beyond just capital and labour to explain trade, or make a clearer distinction between skilled, unskilled labour, human and physical capital as factors determining international trade flows.

An important step towards resolving the 'Leontief paradox' has not been as much the acknowledgement of additional factors of production that may explain Leontief's results, but the notion by Leamer (1980) that the US in Leon-

tief's data was a net exporter of both capital and labour. A trade surplus makes it possible for a country to be a net exporter even of the services of factors with which it is relatively poorly endowed. Leamer shows that when this happens, the ratios of factors embodied in exports and imports need bear no particular relationship to relative factor endowments. Then a capital abundant country need not embody a higher ratio of capital to labour in its exports than its imports and Leontief's results are not paradoxical at all. Instead Leamer shows that a valid test of the unbalanced trade must be stated in terms of the factor ratios embodied in production versus consumption, rather than exports versus imports. Taking this approach to Leontief's data he finds that the US was a net exporter of both labour and capital services and that the capital-labour ratio embodied in production was indeed greater than that embodied in consumption (Leamer illustrates his analysis with a three-factor numerical example, which is corrected later by Heravi, 1986, see Leamer, 1994). The presumed abundance of US capital relative to labour is supported after all and the paradox disappears.

More recently Bowen et al. (1987) have attempted to test the H-O-model using data for 27 countries and 12 factors of production. Their study is based on the idea that trading goods are actually an indirect way of trading factors of production. According to the H-O-theory, by calculating factors of production embodied in a country's exports and imports, a country is expected to be a net exporter of the factors of production with which it is relatively abundant endowed, and a net importer of those with which it is relatively poorly endowed. Bowen et al. calculated the ratio of each country's endowment of each factor to the world supply. They then compared these ratios with each country's share of world income. If the factor proportions theory were right, a country would always export factors for which the factor share exceeded the income share and import factors for which it was less. However, the outcome of one of the key tests in Bowen et al. is that for two-thirds of the factors of production, trade ran in the predicted direction less than 70 percent of the time. This results confirm the Leontief paradox on global scale: trade does not run in the direction the Heckscher-Ohlin theorem predicts.

Three empirical observations that contradict the implications of the Heckscher-Ohlin theory

1. The first empirical observation is that major trade flows occur among countries with practically the same factor proportions. However, according the H-O-S theory the volume of trade is expected to be larger depending on the differences between countries.
2. Grubel and Lloyd (1975) discovered that intra-industry trade is empirically significant and its proportion of total world trade has grown over time. However, the H-O-S model can only explain inter-industry trade and not intra-industry trade.
3. Income-distribution effects of trade are small. However, the H-O-S model predicted that there are large income redistribution effects associated with trade.

Tests of the specific factors model

Tests of this model do not differ much from tests of the Ricardo model if one assumes the specific factors to be fixed over time (again the relation between labour productivity and trade is central). There have been no tests of the specific factors model, however, a study to the relation between international events and the allocation of new investments could be interesting (Leamer, 1994).

Conclusion

Sofar the results of empirical tests of the pure H-O-theory have shown to be rather disappointing and there are no tests of the specific-factor model at all. At the same time, empirical evidence supports the Ricardian model's prediction that countries will export goods in which their labour is especially productive. Although the limitations of the Ricardian model are widely acknowledged, Krugman and Obstfeld (1994) conclude from these tests that the trade pattern is largely driven by international differences in technology rather than resources. However, it is still important to ask what factors are embodied in a country's exports and imports, as trade affects income-distribution. The H-O-model and the specific-factor model, therefore, retain but to a more limited use, as a way of predicting the income-distribution effects of trade and trade policy.

Woods (1994) counteracts the proposition that H-O theorem is inaccurate to explain global trade patterns. He argues that the traditional Heckscher-Ohlin theory probably provides a much better description of reality than is usually supposed by empirical tests of the H-O theory, suggesting that the H-O theory performs badly. Woods states that H-O models are likely to work better if capital - defined as finance - is excluded than if it is included in the usual, wrong, way. Capital is usually considered to be an immobile production factor, like land and labour. However, financial capital is internationally mobile and, therefore, does not generally influence the pattern of trade. Skill availability matters, according to Wood, in explaining North-South trade in manufactures, not capital. He suggests that a skill-only H-O model can explain the commodity composition of North-South trade in manufactures rather well. His hypothesis is that the North, because of its larger supply of skilled (relative to unskilled) labour, exports skilled-intensive manufactures from the South, and imports (unskilled) labour-intensive manufactures. Woods finds evidence for his hypothesis that North-South trade is based on differences in the abundance of skills. His conclusion is that when the H-O theory is correctly specified - excluding capital - it provides 'an accurate and illuminating description of a large part of the global pattern of trade' (Woods, 1994:20).

3. MODERN TRADE THEORIES

3.1 Economies of scale and imperfect competition

Trade need not be the result of comparative advantage. Instead, it can result from increasing returns or economies of scale. An industry is characterized by economies of scale when doubling of inputs more than doubles the industry's production. Economies of scale provide an incentive for international trade by concentrating production on a limited number of goods. This enables a country to produce these goods more efficiently than if it tried to produce everything for itself. These specialized economies then trade with each other to be able to consume the full range of goods.

Economies of scale and market structure

However, economies of scale as a determinant for international trade was known for a long time. The problem was that economies of scale are inconsistent with the perfect competition standard Neo-classical model because they imply a different market structure, namely imperfect competition.

In the first and oldest departure from the standard model economies of scale were assumed to be external to the firm. These so-called 'external economies of scale' occur when the cost per unit depends on the size of the industry but not necessarily on the size of the firm. An industry where economies of scale are wholly external (where there are no advantages to large firms) will typically consists of many small firms and be perfectly competitive. This is the Marshallian approach to increasing returns (see Krugman, 1990:65-74). The early literature on the Marshallian approach (the early postwar period), however, seemed discouraging in that even with the simplest assumptions it seemed to lead to welter of multiple equilibria. Only since the work of Ethier (1979, 1982) it has become clear that under certain circumstances it is possible to bring order to this complexity. The new version of the Marshallian approach distinguishes from the older approach by the way that it works from resource allocation to trade. By assuming that a trading world reproduces the aggregate outcomes of a hypothetical perfectly integrated economy it follows that both factor proportions and scale economies contribute to international trade and both are sources of gains from trade.

In the second departure economies of scale at the firm level are assumed. Internal economies of scale give large firms a cost advantage over small and lead to an imperfectly competitive market structure. Within this approach there are two directions. The first direction concentrates on modelling economies of scale and treats market imperfections as simple as possible by assuming monopolistic competition (Dixit and Norman, 1980; Helpman and Krugman, 1985). A second direction concentrates on imperfect competition and uses economies

of scale to cause these market imperfections. The main market structure they use is 'Cournot' or 'Bertrand' oligopoly (Brander and Spencer, 1985; Helpman and Krugman, 1989).

3.1.1 External economies of scale

Basic assumptions

Production factors: labour (and capital): this factor is domestically mobile and internationally immobile. Initial endowments of countries may be identical.
Sector/goods: 2 homogeneous goods
Economies of scale: one good produced with constant returns to scale, the other good with external economies of scale which are country specific.
Technology: different across goods and identical production functions between countries, no technological change;
Knowledge spillovers: no
Consumer preferences: identical across incomes and between countries
Market structure: perfect competition in good and factor markets

Main mechanism

External economies are economies of scale that occur at the level of the industry instead of the firm. To keep it as simple as possible, imagine a world with two countries, two goods and one factor of production (labour). Good A is produced with external economies of scale and good B is produced with constant returns to scale at the firm and industry level. Assume further that both countries have the same production techniques and that both countries produce both goods. The fact that both countries produce good B implies equal wages. But this means that whichever country had the larger A industry would have lower costs in that industry. Trade will cause the relative size of that industry to increase still further; economies of scale reinforce the relative cost advantage of this industry, now trade expands. This process is going on until at least one country specializes. So, increasing returns leads to specialization and trade.

Implications

1. Trade is possible between identical countries (same factor endowments, technologies and tastes).
2. With external economies of scale the direction of specialization is often unknown. This theory gives an important role to history and accident in determining the pattern of international trade. When external economies are important, a country starting with a large industry may retain that advantage even if another country could potentially produce the same goods more cheaply.
3. The implications for the wage level in both countries are ambiguous. If in the trade equilibrium both countries produce the good with constant returns to scale, the wages in both countries will be equal and higher than before trade. If one country specializes in the good produced with

external economies of scale and for which demand is high, than the relative price of this product will increase, and wages of this country will rise relative to the other country. Real wages in the other country may still rise (through gains from specialization and gains from exchange), however, if they consume a lot of the more expensive goods, their real wages may even decline.

4. An implication of these real wage movements is that the division of welfare between countries is very unequal and very dependent on the specialization pattern. Countries can even lose from trade.

Policy

A country may specialize in goods that are less desirable in terms of welfare. Trade or industrial policy can reverse the initial cost advantage and therefore reverse the specialization pattern. In this case trade and industrial policies can be beneficial.

Trade policy can even be desirable from a world point of view. This happens when a small country has an initial advantage in the sector with external economies of scale and demand for this product is large. The sector with the external economies of scale will be situated in the small country, but the country is too small to achieve the optimal scale from a world point of view and production costs will therefore be higher than necessarily.

Empirics

Identification of external economies is very difficult. As a matter of fact, externalities are inherently hard to measures as by definition they do not leave any trace in market transactions. Still there are some examples which give evidence of the importance of external economies. Such examples are the concentration of semiconductor manufacturers in California's 'Silicon Valley', and the concentration of financial and banking firms in London and New York.

Some of the most important external economies probably arises from the accumulation and spillovers of knowledge: production costs of individual firms fall as the industry as a whole accumulates experience. Dynamic scale economies, like external economies at a point in time, potentially justify protectionism. The argument for temporary protection of industries to enable them to gain experience is known as the infant industry argument.

3.1.2 Internal economies of scale and imperfect competition

3.1.2.1 Monopolistic competition

With monopolistic competition, an industry contains a sufficiently large number of 'similar' firms producing differentiated products and profits are competed away in the equilibrium. Products can be differentiated in two manners. On the one side, each consumer has a taste for many different varieties, this is the so-called 'love of variety approach' (Dixit and Stiglitz 1977, Spence 1976). Product differentiation in this case is only producing a different variety. On the other side, each consumer has its own preferred mix of attributes, this

is the so-called 'diversity of tastes approach' (Lancaster 1980). In this case product differentiation shows up by products that consist of different attributes. Although the latter approach has the advantage of greater realism, the former approach is mostly used because it can be modelled more easily.

With product differentiation each product is unique, therefore some fixed costs are assumed to produce this product (internal economies of scale). Because product differentiation is possible, firms have some monopoly power (downward sloping demand curve). However, additional firms can enter a profitable industry until monopoly profits are competed away (profits are equal to fixed costs). The number of firms in the equilibrium are therefore dependent on the size of the market (a large market will support a larger number of firms), the amount of fixed costs (larger fixed costs will decrease the number of firms) and the degree of product differentiation (if differentiation is valued very much by consumers, more products will be there in the equilibrium).

The number of firms in a monopolistically competitive market, and the prices they charge, are determined by two relationships. On the one side, the more firms there are, the more intensively they compete and hence the lower the industry price is. This relationship is presented by PP (see figure 3.1). On the other side, the more firms there are, the less each firm sells (given the size of the market) and therefore the higher its average cost. This relationship is presented by CC. If price exceeds average cost, the industry will be making profit and additional firms will be entering the industry; if the price is less than average cost, the industry will be incurring losses and firms will leave the industry. The long-run equilibrium price and number of firms occurs when price equals average cost, at the intersection of PP and CC.

Basic assumptions

Production factors: labour (and capital): this factor is domestically mobile and internationally immobile. Initial factor endowments of countries are identical in backbone model.
Sector/goods: n differentiated products.
Economies of scale: increasing returns to scale at firm level.
Technology: identical across goods and countries, no technological change.
Knowledge spillovers: no.
Market structure: monopolistic competition in good markets and perfect competition in factor markets.
Consumer preferences: identical across incomes and between countries.

Main mechanism

To concentrate on the mechanism caused by product differentiation and internal economies of scale we assume identical factor endowments between countries. We take the Dixit-Stiglitz assumption that each consumer has a taste for many different varieties of a product. Product differentiation of product A causes each country to produce a different set of varieties of product A. Because each country is assumed to demand all varieties (consumers have a 'love of variety') each country exports each of its own varieties and imports each of

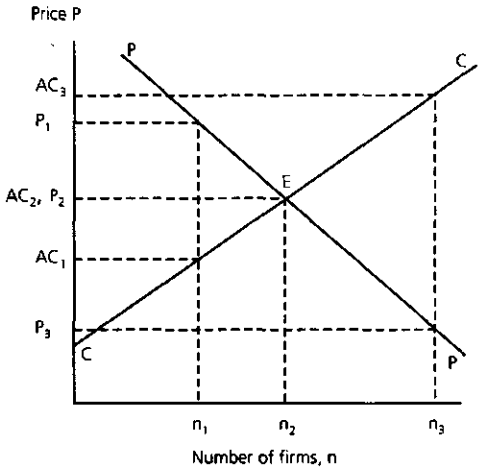


Figure 3.1 Equilibrium in a monopolistic competitive market

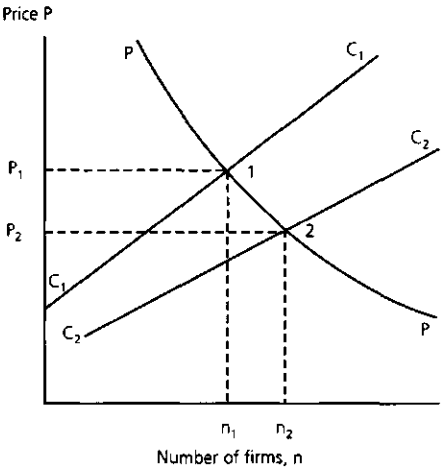


Figure 3.2 Effects of a larger market

the varieties of the other country 1) So, there will be 'intra-industry' trade. This intra-industry trade is essentially caused by scale economies. If there were no scale economies each country would be able to produce all varieties of product A itself. But the existence of scale economies make sure that each variety must be concentrated in one country. So, it is the combination of scale effects and the specification of the product differentiation process which causes intra-industry trade.

Besides the increased number of varieties available to consumers, a second possible gain from trade could be an increased scale of production which together with internal increasing returns to scale implies lower average costs. Whether or not the scale of production will increase is dependent on the specific formulations of, for example, the product differentiation function (Helpman, 1981). With Dixit-Stiglitz preferences (constant elasticity of demand), trade offers greater variety but not greater scale. With Lancaster preferences, trade leads often to a more elastic demand: in this case, a larger market leads to greater diversity and lower average costs (Helpman, 1981).

The case when the scale of production increases after trade is represented by a downward shift in CC in figure 3.2. The result is a simultaneous increase in the number of firms (and hence in the variety of goods available) and a fall

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1) In the monopolistic competition model each firm makes a unique product because it is not profitable to enter the market with a product that already exists.

in the price of each good. The integrated market supports more firms, each producing at a larger scale and selling at a lower price, than either national market did on its own.

Implications:

1. Even with identical resource endowments, trade is possible. All trade in this case is intra-industry trade and the precise pattern of trade is indeterminate (which country exports which variety).
2. Gains from trade appear in the form of:
   - Increased product variety.
   - Potential higher scale of production which results in lower average costs.
3. In a model where both internal economies of scale and relative factor endowments are present, intra-industry trade is caused by monopolistic competition in combination with scale effects and inter-industry trade is caused by the traditional H-O-S model. Intra-industry trade is more important between similar countries and inter-industry trade becomes more important the greater the difference in relative factor endowments.
4. Intra-industry trade does not generate the same strong effects on income-distribution as inter-industry trade. In the models describing comparative advantage, trade had all its effects through changes in relative prices, which in turn have strong income-distributional effects (scarce factors lose from trade). However, when 1) countries are similar in their relative factor supplies so that there is not much inter-industry trade and when 2) scale economies and product differentiation are important, so that possible gains from larger scale and an increased choice are large, intra-industry trade is the dominant source of gains from trade. In these circumstances, the income-distribution effects of trade will be small and there will be substantial extra gains from intra-industry trade. The result may well be that despite the effects of trade on income-distribution, everyone (the owner of the abundant *and* of the scarce factor) gains from trade. Because intra-industry trade will be dominant between countries at a similar level of economic development, trade without serious income-distributional effects is most likely to happen in manufactures trade between advanced industrial countries (for example the Common Market of the EU).
5. It is possible to treat multinationals and trade in technology in these models. Investment in knowledge is hard to model except as a kind of fixed cost. In the monopolistic competition models it is possible that firms in one country develop a product and sell the knowledge about this product abroad. In the foreign country a new monopolistic competitor enters on the basis of this knowledge (Feenstra and Judd, 1982). For some knowledge this is not possible and knowledge can be only transferred within a firm. This results in the existence of multinational enterprises (MNE) (Helpman, 1985).
6. Transport costs: when there are transport costs the size of the market has an important influence on trade patterns. Ceteris paribus, countries ex-

port products for which they have a large home market (Krugman, 1980; Helpman en Krugman, 1985).

3.1.2.2 Oligopolistic competition

Basic assumptions

Production factors: no assumptions about production factors in most models.
Sector/goods: two or a few products.
Economies of scale: increasing returns to scale at firm level (but not in Brander/-Krugman's (1983) model).
Technology: identical across goods and countries, no technological change.
Knowledge spillovers: no.
Market structure: oligopolistic (usually Cournot) competition in good market and perfect competition in factor markets. In Brander/Krugman model a Cournot duopoly is assumed.
Consumer preferences: identical across incomes and between countries.

Main mechanism

In this approach it is normally assumed that internal economies of scale lead to an oligopolistic market structure. In such markets the behaviour of a firm has influence on the behaviour of other firms. In the international trade theory most of the time it is assumed that firms behave in a Cournot fashion: imperfectly competitive firms take each others' output as given.

One of the main elements in this theory is the relation between trade and market power. If firms compete in the Cournot fashion its price will be higher than marginal costs by a mark-up that depends on the perceived elasticity of demand per firm. When trade occurs each firm becomes part of a larger more competitive market and it will perceive a higher elasticity of demand, leading it to expand output and to setting a lower price. Therefore, trade or 'potential' trade reduces monopolistic distortions. This effect is called the 'pro-competitive' effect.

Dixit and Norman (1980) show that there are two effects of opening trade in a Cournot market with increasing returns to scale. On the one hand the number of firms in each market will be reduced because a lower mark-up (higher perceived elasticity because the number of competitors increases when trade is opened) implies that some firms are not able to cover their fixed costs. This is the so-called 'exit of redundant firms' effect which leads to an increase in the productive efficiency. On the other side increases the total number of firms in both markets together so that competition increases and the monopoly distortion decreases. This is again the 'pro-competitive' effect.

Price discrimination as a new determinant of trade

If market segmentation and price discrimination are possible, there can be trade even without economies of scale and comparative advantage (Brander 1981, Brander and Krugman 1983). Assume two identical monopolists in two identical countries. They produce with constant marginal costs and take the

production level of the other firm as well as the distribution of this production between markets as given. Trade is not costless; there are transportation costs. If the difference between marginal costs and the foreign price level is greater than the transportation costs it is beneficial for the domestic monopolist to export its good.

The transportation costs imply that the market share in the foreign market will be lower than in the domestic market. This means that the domestic firm will face a higher elasticity of demand in the foreign market and its price in the foreign market will be lower than in the home market. So, one would expect that, if a firm would like to expand sales, additional sales at the domestic market are more profitable than additional exports. However, the marginal price decrease of one extra unit sold has a smaller negative effect in the foreign market, because the number of products sold by the domestic monopolist in that market is lower. When a firm charges a lower price for exported goods than it does for the same goods sold domestically, this behaviour is called 'dumping'. The reason why a firm may choose to dump is the difference in the responsiveness of sales to prices in the foreign and domestic markets. Because both firms are identical, Brander and Krugman talk in their model about 'reciprocal dumping'. The result is two-way trade in the same product (cross-hauling). This model gives, therefore, another explanation of intra-industry trade than the interaction of product differentiation and economies of scale argument. In this model, intra-industry trade is possible in identical products and the driving force is price discrimination.

Implications

1. Gains from trade appear in the form of the pro-competitive effect, the exit of firms which are unable to cover their fixed costs, and lower average costs if the production scale of a firm increases (if there are increasing returns to scale). Welfare implications are ambiguous. As can be identified with the Brander/Krugman model, there are two effects. First, the pro-competitive effect, imports from the foreign monopolist imply that the total supply in the domestic market increases which lowers the domestic price level. Second, some imports replace domestic deliverancies which leads to welfare loss through transportation costs. The total effect is ambiguous. If transportation costs are low, the first effect is larger than the second and trade is beneficial.
2. The most important implications of this Cournot-approach are on the field of trade policy (see section 3.1.3).

3.1.3 Trade policy and imperfect competition

The assumption of constant returns to scale and perfect markets justified the domination of free trade policy for almost a century. These 'new' trade theories question this free trade policy by introducing economies of scale and imperfect markets. They found that an active trade policy can be beneficial in the certain circumstances. However, arguments against protection remain valid

in other circumstances. An overview of the arguments for and against protection under imperfect competition is given below.

Arguments for protection

1. In case of foreign market power, the terms of trade may improve.
   Under a variety of circumstances, a foreign firm with market power will absorb a part of the tariff by increasing its price by less than the full tariff (it reduces its mark-up). This argument is similar to the optimal tariff argument in the traditional trade theories (see section 2.3). However, in this case the 'large country' assumption is not necessarily, the only requirements are a firm with foreign market power with price discrimination.
2. Rent shifting.
   If in an industry excessive profits are earned, such an industry should be desired. Under certain conditions, the use of export subsidies can also shift profits from foreign to domestic firms. This is the so-called 'strategic' trade policy (Brander and Spencer, 1983, 1985; Dixit and Kyle, 1985) 1). An argument that justifies export subsidies is totally in contradiction with the traditional theories and extremely useful for lobbyists. Therefore, this argument gets a lot of attention and we will treat it in a more elaborate way.

   The argument is linked to the Cournot model of oligopolistic behaviour of firms. Cournot's idea is that equilibrium (or stability) will occur when each firm is maximizing its profits through the choice of its own level of production, given the output level of its rival. If firms are on equal footing at the market place, there is no reason to expect that one firm should be intimidated by the threat of the other to increase output in trying to induce contraction of the rival. So, if a firm expands its output, the other firm might well match the increase, inducing a price war. But now suppose, a firm discovers to produce more efficiently and is able to reduce its costs of producing additional output. Than the firm will expand its output and the rival will contract because it has no reason to believe the increased competitiveness is only temporary. The new equilibrium will involve a higher market share and output for the firm with lower costs and a smaller market share and output for the other firm.
   Brander and Spencer make the point that for a firm an export subsidy (or production subsidy) has the same effect as lowered costs. A subsidy makes it in the firm's interest to expand output, it is a credible threat to the rival's position, who can best respond by contracting its output, and in effect the subsidy induces the subsidized firm to stake out a larger share of the international market. The firm's profits will increase, but it is also beneficial for the nation as the benefits exceeds the cost to taxpayers:

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1) Strategic because it is not profitable viewed in isolation but it alters competition in the future. For example a firm invests in excess capacity that it does not use but which deters potential competitors.

first, there is the cost saving effect of the subsidy, which is equal to the transfer from government budget, and second, there is the contraction by the rival which in itself raises the domestic firm's profits by an additional amount.

Strategic export subsidies which improve the welfare of a country are very dependent on the specific assumptions of the model. Various trade theorists show that the argument is not true: 1) if the Cournot assumption is replaced by the Bertrand assumption (Eaton and Grossman, 1986), 2) if retaliation of foreign government occurs (Dixit and Kyle, 1985), 3) as other sectors will be adversely affected ('general equilibrium'-argument), so government needs very detailed information (Dixit and Grossman, 1986), 4) when entry eliminates supernormal profits and then subsidies will only worsen terms of trade in the long run (Horstmann and Markusen, 1986). Therefore, the strategic trade argument seems to make a case for protection, however, so much information is needed that it is unlikely that this amount of information is available by the government.

3. Reducing marginal cost.

Krugman (1984) showed another beneficial trade policy in a variant of the Brander-Krugman model with declining marginal cost instead of constant marginal cost. Assume a country which protects its domestic market with a tariff. The immediate result is that the foreign firm sells less and the domestic firm sells more in the domestic market. The marginal cost of the domestic firm declines and the marginal cost of the foreign firm increases. The indirect effect is that the domestic firm sells more in the unprotected foreign market. Krugman calls this 'import protection as export promotion'. If there is no retaliation, this protection policy could be worthwhile. Declining marginal costs are not very common, but Krugman shows that this analysis is also usable when time is made explicit and one considers dynamic economies of scale, arising for example from R&D or learning effects (see also 'new' growth theories).

4. Prompting entry: a tariff can lower the domestic price.

Venables (1985) shows that a small tariff can raise welfare by inducing entry. He assumes free entry in the Brander/Krugman model in which there are constant marginal costs with fixed costs. A tariff raises profitability in the home market and reduces profitability in the foreign market, which leads to entry in the home market (reduces degree of market power) and exit in the foreign market. There are two effects on the home market. On the one hand, the increased competition in the home leads to a lower price and on the other hand the tariff raises this price. For a small tariff, the first effect dominates the second effect so that the domestic price level actually declines. Welfare increases because consumers gain (lower price level) and there are additional tariff revenues.

5. External effects.

The 'New' trade theories have broadened the basis of this argument by emphasizing the positive external effects of R&D activities in connection with imperfect markets (Brander and Spencer, 1983). Positive external effects appear especially by R&D activities because these have positive

spillover effects on other industries and because individual firms cannot internalise all the benefits of its own R&D activities. The investments in knowledge development are characterised by a constant cost component (These markets are therefore imperfect which is caused by economies of scale). When the scale of production increases the cost of these investments per unit of product decline (Krugman, 1987). Investments in knowledge development are the source of positive spillover effects and the contribution of the 'New' trade theories is that these effects can now be explicitly modelled. Another contribution is that industries with external effects can be identified, because these theories suggests that positive external effects especially can be found in industries where R&D cost are a substantial part of total cost.

Arguments against protection

1. Market power.
   Normally, protection reduces competition in the domestic market and increases the market power of domestic firms.
   - domestic monopoly faces competitive foreign suppliers (Bhagwati, 1965).
     Indeed, protection raises the market power of domestic firms and leads to a higher domestic price level. Interesting is also that the equivalence of import tariffs and quota's disappears in this case. In case of a tariff, a monopolist cannot raise its price above the tariff-inclusive import price otherwise it will loose the total domestic market. In case of a quota, it can use its domestic market power because the amount of imports are limited. Therefore, a quota will lead to a higher domestic price and lower domestic output than a tariff.
   - domestic monopoly faces foreign monopolist: non-cooperative behaviour (Krishna, 1984).
     In case of a quota and Bertrand competition, the domestic firm has two options. On the one hand, it can be aggressive and charge a low price that limits imports to less than the quota or it can be timid and charging a high price behind the protection wall of the quota. The higher the price level of the foreign firm the more aggressive the domestic firm will be. Normally, the profits of the domestic firms rise and those of the foreign firm decline, although a quota can also raise profits of both firms.
   - domestic monopoly faces foreign monopolist: collusion or cooperative behaviour (Rotemberg and Saloner, 1984).
     Collusion can reverse the intuitive implications of the Bhagwati-model, because in this case protection can increase competition and lead to lower prices than in the case of free trade because the penalty for cheating on a collusive agreement is reduced.
2. Inefficient Entry.
   Normally, protection raises the sale of domestic firms which, in the case of increasing returns to scale, lowers average costs and increases efficiency. However, what happens if entry is possible?

- Excessive entry: increasing returns to scale and cooperative behaviour (Eastman and Stykolt 1960). Protection in a collusive industry will lead to higher prices and higher profits. The long run result will be that new firms will enter these markets, which decreases the scale of production and therefore increases average costs. Therefore, protection creates many small inefficient firms.
- Excessive entry: increasing returns to scale, non-cooperative behaviour (Dixit and Norman, 1980). Trade increases the size of the market which with Cournot competition implies higher sales per firm and lower average costs (the number of firms in the world declines). Protection fragments markets and leads to higher production costs (in comparison with free trade equilibrium the number of firms increases).

The theories based on economies of scale and imperfect competition extend the arguments for trade policy. Rent shifting is a new argument. The range of possibilities to improve the terms of trade is increased because even small countries can improve their terms of trade. Market distortions are inherent in imperfect competition so for example the wedge between price and marginal costs creates an opportunity for government action, if consumers buy to few domestic products. However, trade policy is only a second best policy in this situation and industrial policy that eliminates the distortion is the first best policy.

The question is whether these theories give a systematic new reason for trade policy. The answer appears to be no because the new arguments, such as for example the strategic trade policy (rent shifting) are very dependent on specific assumptions. A slight change in one of the assumptions changes or even reverses the implications of a policy. Good policy requires that the government has a lot of information to choose the right model. However, this information must be so detailed that it is not available. The empirics also show that the benefits from deviations from free trade are small and that the value of an optimal tariff is low (see section 3.1.4). The potential for making policy errors through lack of information or the possibility of retaliation by foreign governments makes the possible losses greater than the benefits. Therefore, Krugman (1987) concludes that free trade is almost never optimal under imperfect competition but that it is a good rule of thumb. Feenstra (1995) confirms this conclusion: according to his analysis of methods used to estimate the impact of trade policies under imperfect competition, empirical results lend no support to a strategic role for trade policy.

3.1.4 Empirics of trade theories related to economies of scale and imperfect competition

The empirical study of Grubel and Lloyd (1975) was the first impressive work focusing on the importance of intra-industry trade. The authors did not test a formalized theoretical model, but pointed at the pattern of trade between countries with similar factor endowments. As such, the Grubel and Lloyd study can be considered to be evidence against the H-O theorem. Together

with the work of Leontief, the study stimulated thinking of new ways to explain international trade, focusing on increasing economies of scale and imperfect competition. Only since the late 1970s new models of monopolistic competition were seen to allow a theory of trade in the presence of increasing returns to trade. But although there are now many theoretical models, especially in the intra-industry framework, sofar there have been very few empirical studies done to test them. Some of those are referred to by Krugman (1990: 257-261) and Leamer (1994) and are briefly discussed here.

The proposition that the proportion of intra-industry trade as opposed to inter-industry trade should be positively correlated with the degree of similarity between countries' capital-labour ratios is confirmed by empirical studies of Loertscher and Wolter (1980) and two by Helpman (1985 and 1987). The first authors use differences in per capita income as a proxy for differences in resource endowments and confirm the correlation using a cross section regression for a single year. Helpman's analysis of 1985 confirms the proposition over a number of years and also shows that as the industrial countries become more similar over time the relative importance of intra-industry trade grows, just as the model would suggest. In his 1987 study, Helpman finds that for a group of 14 of the most industrialized countries both GNP similarity and trade intensity have increased more or less constantly from 1956 to 1981, giving the appearance that the model is supported. A third study, by Havryslynshyn and Civan (1984), gives evidence for the implication of the theory that intra-industry trade is likely to be more prevalent between advanced countries than between LDCs under the assumption that advanced countries produce more differentiated products. Leamer (1994) criticizes the empirical studies of Loertscher and Wolter and of Helpman, 1987, however, by questioning the theoretical base of the work. According to Leamer, the link of the empirical studies and the theory is very fuzzy, creating difficulties in interpreting the results of the regressions computed. Empirical studies like these may suggest a positive relation between intra-industry trade and GDP level and similarity, they leave the question on the role of economies of scale in international relationship unresolved (Leamer, 1994: 84-89).

There are some empirical studies done attempting to quantify models by calibrating them to data from actual industries. Examples are Dixit's (1988) model of the US automobile industry, Baldwin-Krugman's (1990) model of the semiconductor industry, focusing on the US an Japanese market, and Venables and Smith (1986) studying the UK refrigerator and footwear industries. The results of these studies all indicate that modest tariffs are welfare improving, and protection has strong export-promoting effects. The work of Dixit and of Baldwin and Krugman are a bit more discussed below.

In Dixit's empirical work on the US automobile industry, the US auto market is represented as a noncooperative oligopoly of a Cournot-type (conjectural variations approach), with foreign cars differentiated from domestic. After calibrating his model with data from the industry, Dixit examines the effect of policy variables like tariffs on foreign rivals and a production subsidy to domestic producers. A modest tariff on imports appears to be beneficial to US industry for reasons of access to home market and scale economies. However, these

gains are shown to be small. If a production subsidy is granted, the additional role for a tariff is greatly reduced, with the gains from adding tariffs as an instrument extremely small.

Baldwin and Krugman elaborated a model on the semiconductor industry. Semiconductor manufacture is an extraordinary dynamic industry, where technological changes happen very rapidly. This technological change is largely endogenous, the result of R&D and learning by doing. Until the late 1970s, US firms had dominated the market of semiconductors but than Japanese firms took over. Baldwin and Krugman developed a simulation model, of which parameters are partly drawn from other published studies and partly estimated by calibrating the model to actual data. As in Dixit's study, the authors adopt a conjectural variations approach in order to match the observed industry structure. Krugman and Baldwin provide an assessment of the importance of market access by focusing on the impact of Japanese policy to protect domestic markets for their own semiconductor industry on the ability to sell not only in the domestic market but also in world markets. The analysis suggests that privileged access to the domestic market was decisive in giving Japanese firms the ability to compete in the world market. However, these protection policies resulted in higher Japanese prices, hurting consumers without generating compensating producer gain, so in welfare terms the policy impact has been negative.

Harris and Cox (1984) developed a general equilibrium model for Canada with increasing returns and imperfect (monopolistic) competition build in and adopt the assumption that firms are able to cooperate well enough to raise the domestic price to the foreign price plus tariff (Eastman-Stykolt pricing assumption). The excess profits in the protected (import-competing) industries lead to entry of new firms and result in an inefficiently small scale industry structure. Furthermore, the authors show that the inefficient scale in the Canadian export industries is due to US protection policies. Combining these effects, the authors find that the costs to Canada from its partial isolation from the US market are several times higher than those estimated by conventional CGE models. Their conclusion is that free trade between the US and Canada would be beneficial to both.

3.2 Neo-technology trade theories

The common feature of technology-oriented theories of trade is an emphasis on technological change and the resulting patterns of trade. In these theories trade patterns are explained in terms of technological progress. Technological differences or gaps across countries are an endogenous outcome through firm level product and process innovation that reduces costs of production and generates new or better products. The flow of technological developments and innovation is assumed to be not free and instantaneous, which implies that a firm/country has at least a temporary comparative advantage in production and exports. The major early contributions of this field are done by Kravis (1956), Posner (1961), and Vernon (1966).

Please note the difference with the Ricardian trade models in which differences in technology (productivity) for some given goods cause trade. In the Neo-technology trade models trade is caused by the simple fact that the innovating country generates some new products that other countries, at least temporary, are unable to produce.

According to Kravis (1956), international trade is caused by differences in the availability of certain products among countries. When unavailability at home is due to lack of natural resources, the comparative advantage explanation would be perfectly adequate, but Kravis's analysis points at differences in availability arising out of technological and product innovation. Technological progress causes comparative advantage in trade by reducing costs of production or by supplying new products.

Posner (1961) sketches what may be called a technology gap model. Posner observed that as new products and processes are continually being developed, the country in which these innovations occur will temporarily enjoy the technological advantage over its trading partners in these particular products. This advantage will last only until the new technology is imitated in other countries. But before that happens, the innovating country may export the good even though it has no obvious basis for comparative advantage in terms of factor intensities and endowments. Over time, each innovation is eventually diffused around the world and the initial advantage is lost. However, as progress continues, new discoveries are constantly being made and there exists a constantly changing list of new products in which the innovating country enjoys a comparative advantage.

Vernon (1966) analyses shifts in international trade in constructing a 'product-cycle' hypothesis. He also invokes the role of foreign direct investment by (multinational) firms in international trade. Vernon argues that the developers of new products must stay in close proximity to their markets, so as to benefit from customer feedback in modifying the product and also to provide service. In addition, he argues that discovery of the innovation itself is helped by the proximity to those whose needs the innovation will satisfy. Thus, both innovation and production tend to be concentrated in countries where new needs and wants are first making themselves known. Vernon explicitly rejects not only factor proportions but also comparative costs as determining the location of production - and later export - of new products. Instead, he predicts that new products will be first produced in, and later exported from, the country where they are first demanded. Only later still, when the product matures and becomes standardized, does its production move to a location of lower cost. According to Vernon's characterization, the product cycle might last from five to twenty years.

Unlike Vernon, Hirsch (1967) goes back to the concept factor proportions in dealing with a 'product cycle' hypothesis. He argues that new products go through a cycle of systemic changes in technology. New products at first require large amounts of skilled labour in their production and development. As larger quantities are demanded, however, more capital intensive production techniques become appropriate. Finally, when products mature and become

standardized, the production process becomes routine, and less skilled labour can play a greater and greater role. Hirsch goes on to explain the location of production by essentially applying the multi-factor H-O theorem to this pattern of factor intensities among new, growing, and mature products.

The first comprehensive formalisation of these attempts to try to explain trade in terms of technology was offered by Krugman (1979a) in his North-South-model. We will use this elementary model to represent the technology gap models.

Basic assumptions

Production factors: only labour. This factor is domestically mobile and internationally immobile;
Goods: n-different commodities (differentiated products);
Technology: the North can only produce innovative goods (new product varieties), identical production functions (labour productivity) between North and South for imitative goods;
Economies of scale: constant returns to scale;
Market structure: monopolistic competition;
Consumer preferences: homogeneous and identical between countries, consumers possess 'love of variety' (Dixit-Stiglitz utility function).

Main mechanism

The North innovates and introduces a continuous exogenous stream of new product varieties on the market. Only after a time-lag the non-innovative South imitates these new products. Because consumers in both regions display 'love of variety' they will demand all product varieties. The North will therefore export new products and imports imitated products and the opposite is true for the South. The innovation and imitation rate will therefore determine the pattern of trade and the time-lag in the adoption of new technologies is the factor that gives rise to trade.

Implications

- No fixed pattern of trade: each good is first exported by the innovative North and after a time lag it will be exported by the South (Vernon's product live cycle).
- Wages in the North are higher: The labour productivity in both countries is the same, however, for the new product varieties the North obtains monopoly power and the associated rents flow to the only factor of production, labour. The wages will therefore be higher in the North than in the South. Because the labour productivity for imitated goods is assumed equal in both regions, only the South will produce imitated products.
- An imitation of a new product by the South (technology transfer) moves production from the North to the South. At initial prices this reduces production costs and increases world output which causes allocative gains for both countries. However, imitation also alters world distribution of income because the wages in the North will decline and those in the South will rise. The decline in the wage differential improves the terms of trade

for the South. The terms of trade effect is therefore a secondary positive effect for the South but a negative effect for the North. So, imitation is beneficial for the South and the North may be worse off.

- An innovation in the North raises the number of product varieties and because consumers display love of variety, this is beneficial for both the South and the North. Production and capturing the rents takes place in the North, so their wages increase and the terms of trade improves for the North (a secondary benefit for the North and a loss for the South, however in the Krugman model this secondary effect is always smaller than the love of variety effect).
- The implication that innovation improves the terms of trade is in contradiction with the traditional theories in which technological change in the export sector generally worsens the terms of trade.
- Income in the North depends partly on the rents from their monopoly of newly produced products. Implications of the imitation and innovation process imply that the North must continuously innovate in order to preserve its wages or, to put it in Krugman's words, 'Like Alice and the Red Queen, the developed region must keep running to stay in the same place'.
- World output will raise both by innovation and imitation.
- An increase in labour in one region makes this region worse off because real wages decline and the terms of trade deteriorates.
- International movement of production factors: a two-factor version of the standard model, in which labour is immobile between countries and capital is mobile internationally has some interesting implications. Innovation in the North will be associated with capital inflows because it raises the marginal product of capital in this region. The inflow of capital is an additional (next to the effects that appeared in the one factor model) benefit for Northern wages and the outflow of capital is an additional negative effect that hurts wages in the South. Through this effect Southern workers can even loose from innovation. The profits from innovation are collected by the immobile factors: while the incomes of mobile factors will be equalized the inequality of incomes of immobile factors increases. The effects of imitation are just opposite and induce a capital inflow in the South.
- Dollar (1986) combines this North-South-model with the H-O-S model. In this model, the rate of imitation is positively affected by the North-South wage differential. Jensen and Thursby (1987) assume endogenous innovation by a Northern monopolist (innovation depends on resources devoted to R&D). One result that differs from the Krugman model is that imitation may improve the terms of trade for the North. Segerstrom, Anant and Dinoupulos (1990) developed a model in which R&D is both costly and risky (an innovation race that a firm may win or lose).

Policy

- Free trade policy is beneficial from a world point of view:
  - the decline of industries in developed countries will be a recurrent event and from a point of view of world efficiency it is desirable. However, some countries may loose from trade therefore it is essential that there will be some income redistribution effects.
- Imitation from a nationalistic point of view
  From a Northern point of view:
  - imitation has two effects, on the one side it erodes Northern profits but on the other side it increases world output. The total effect on Northern income is ambiguous. If Northern countries loose they can react in two manners. First, they introduce 'innovation policy' that may increase the innovation rate and so upset the negative effects of imitation, and whether this is impossible or the effects are too small they can use trade policy to protect their markets. The latter implies losses from a world point of view, but Northern countries will only choose for free trade if there is a correct international technology transfer system.

  From a Southern point of view:
  - imitation has not only allocative gains but it also improves its terms of trade. Policies that increase the rate of imitation are beneficial for the South. However, there must be a correct technology transfer system otherwise it encourages protection by the North that makes them even worse off.
- Innovation from a nationalistic point of view
  From Northern point of view:
  - innovation policy that increases innovation rate is beneficial.

  From a Southern point of view:
  - innovation in the North may hurt the South when it induces a capital outflow in the South. Protectionism may be worthwhile in this case.

Critical remarks

- innovation and imitation are costless and exogenous;
- innovation is only possible by introducing new varieties (product innovation), process-oriented innovations are not possible;
- the elasticity of substitution between any pair of goods is constant. This assumption is questionable with regard to new and imitated goods.

Empirics

Most, if not all empirical tests of the technology trade theories try to explain the pattern of trade of the US, simply assuming that the US is the innovative Northern country with high capita incomes and relative wages and the rest of the world the imitating South. According to Dearndorff (1984) the tests of these theories using US data have tended to be rather successful. Several authors sought and found positive correlations between US export performance across industries and various measures of R&D. Since R&D is related to technological progress, whatever its cause or effects, this evidence lends support to all technology theories of trade. The technology theories point at different rea-

sons for their prediction that the North (the US) will be an exporter of new products. Dearndorff, however, identifies several studies that support both the technology gap and the product cycle explanations of US trade (Dearndorff, 1984:495-499). These studies focus on the correlation of US trade performance and various technology-related variables, suggested by the technology theories of trade. In all studies, research and development as an important determinant of US exports appears to find strong support.

Several tests of the technology theory of trade have also introduced additional explanatory variables, including those that are appropriate to the factor proportions theory, and support too the conclusion there is a strong and positive correlations between trade performance and technology-related variables. At the same time, however, it becomes clear that technology-related variables are much related to the ability of individuals, firms, countries to develop and exploit technology which is related to the availability of knowledge and skills. Dearndorff concludes therefore that it is difficult to distinguish evidence supporting technology from evidence supporting human capital or skills as determinants of trade (1984: 499).

Dosi et al., 1990 is a recent study which shows that countries tend to be strong exporters in industries in which they invest heavily in R&D. The process of creating comparative advantage could be described by the product cycle but although some empirical studies provided evidence for some industries, recent work suggests that this explanation is not very far-reaching. Gagnon and Rose (1992) analyse US and Japanese trade statistics between 1962 and 1988 and show that both countries' trade patterns at the 4-digit level remained remarkably stable: very few goods moved from exports to imports or vice versa. Although this result need not be inconsistent with the product cycle theory, Krugman (1995:354) states that the results of this study indicates that there is no evidence for a rapidly and constantly changing industrial structure of each nation, or at least 'operates much more slowly than the rethoric of product cycle enthusiasts would suggest'. By the end of the 1970s Vernon (1979) himself already questioned some elements of his own 'production cycle' explanation of trade. He questioned whether production of new products has to start near their markets, mainly because he observed that wages and incomes have caught up to the US in several other countries. Furthermore, Vernon argued that the growth and spread of multinationals have undermined the product cycle theory. Technological levels among advanced countries showed to converge rapidly and, especially because of multinationals, the speed of diffusion of innovations accelerated.

To conclude, empirical tests or application of the product cycle theory are limited in extent. The support from these studies for the idea of the 'technology gap' as driving force behind trade is fragmentary at the best, suggesting evidence for the idea that transitory advantage resulting from innovation is a major factor in trade for only some industries.

4. TRADE IMPLICATIONS OF THE NEW GROWTH THEORIES

4.1 New Growth theories

Growth-accounting studies show that technical change is the most important factor contributing to economic growth (e.g. Solow, 1957, Denison, 1962). However, the standard Neo-classical growth model treated this important factor as exogenous to the system. Hence, the need has arisen to make technology endogenous. The 'new' growth theories found several ways to endogenize technological change in a general equilibrium model 1). There are two main approaches to model endogenous growth and both built forward on the 'new' trade theories.

The first approach assumes that externalities or learning-by-doing effects, which are by-products of other activities, cause growth and the 'external economies of scale approach' is used to model these effects (see section 3.1.1, within the 'new' trade theories). The second approach assumes that technological change is the intentional outcome of economic behaviour and firms have to 'invest' in knowledge creation to obtain technological change. Resources have to be invested in activities that are not directly productive. The 'internal economies of scale approach' within the new trade theories showed a direction to model this process (see section 3.1.2). Investments in knowledge can be seen as a kind of fixed costs and monopolistic competition makes it possible to cover these fixed costs. Most studies that use the second approach, assume also that knowledge generates some externalities and are therefore a mixture of both approaches. Because this has become the dominating approach we discuss the first approach and a mixture of both approaches.

The reason to include the 'new' growth theories in this overview is that the 'new' growth theories put the static trade models into a dynamic setting. It is important that these theories deal therefore with the dynamic evolution of comparative advantage and the consequences of trade in a world of global technological competition (Grossman and Helpman, 1991b). In this survey we focus on the dynamic trade implications of these 'new' growth theories.

4.1.1 Knowledge as side-product: external economies of scale

The central mechanism in this 'knowledge as side-product' approach consists of three elements. The first element is that a firm creates knowledge as a side product to normal business activities, such as producing goods or doing

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1) For an overview of the 'new' growth theories, see Verspagen (1990), Van de Klundert en Smulders (1991), Schneider and Ziesemer (1995) or Van Meijl (1995, chapter 2).

investments. Learning-by-doing is an important theoretical explanation for these externalities. According to Arrow (1962) the acquisition of knowledge (learning) is positively related to experience. He argues that a good measure of experience is investment because 'each new machine produced and put into use is capable of changing the environment in which production takes place, so that learning takes place with continuous new stimuli' (Arrow, 1962, p.157).

The second important element in this approach is that newly created knowledge by one firm flows directly to all other firms where it can be used without payments in return: knowledge spillover effects exist. The third important element is that the newly created knowledge increases the productivity level of the production factor that can be accumulated (e.g. capital).

To understand the role of the three elements in the growth mechanism it is illustrative to describe the standard Neoclassical growth model where growth vanishes without an assumption of external technological progress. In this standard model it is assumed that there are diminishing returns to the production factor that can be accumulated: i.e. when you add more and more capital to a piece of land the marginal benefits are diminishing. Therefore, incentives to invest in capital in this model vanish and growth will end. In the 'Knowledge as side-product approach' growth may not vanish because linked to the accumulation of capital new knowledge will be created and this knowledge makes capital more productive in all firms. The knowledge spillovers may exactly counterbalance the diminishing returns of the factor that can be accumulated by increasing its productivity level. As a consequence the incentive to invest in the factor that can be accumulated may not diminish and this may result in a positive growth rate.

In modelling terms, this approach has used the methodology of the 'external economies of scale' approach to achieve endogenous growth (see section 3.1.1, within the 'new' trade theories). More specifically, firms invest in new equipment which also generates some knowledge that increases the productivity of the capital stock of the investing firm but also of the other firms (i.e. a spillover effect). The latter effect is not taken into account by the investing firm and therefore increasing returns are wholly external to the firm which allows perfect competition to remain at the firm level. However, the existence of externalities causes increasing returns to scale in the aggregate production function. This implies that if one firms doubles its inputs, the inputs of other firms will also increase, and hence this will result in a more than proportionate increase in aggregate production. The latter causes the economy to grow with a positive endogenous growth rate. When the positive spillover effect is large enough the economy will grow with a positive growth rate (Romer 1986). Because individual producers do not take into account their knowledge spillovers on other producers a competitive economy gets a lower growth rate than socially optimal.

This approach recognizes that knowledge has some non-rival good characteristics. However, technological progress or the growth of the knowledge stock appears as a side product to activities that are not specifically directed to the creation of knowledge.

Dynamic trade implications

The trade implications of these 'new' growth models are illustrated with the Lucas-II model (1988) in which initial factor endowments determine the pattern of specialization and the Young (1991) model in which there is a continuum of goods and the specialization pattern is determined by the initial technological capabilities (i.e knowledge stock).

Initial factor endowments govern trade patterns: the Lucas II model

Lucas (1988) describes in the second part of his paper a model in which all human capital accumulation is learning by doing (no resources have to be invested to increase the human capital level). Technology is assumed identical across countries and there exists endogenous technological change by increasing the efficiency (process-oriented) via unbounded learning by doing effects that are good-specific. Lucas identifies a high technology good in which learning is faster than in the other good. Furthermore, there are two kinds of human capital which are specific for the production of one of the goods. In this model the trade pattern is determined by differences in the countries initial relative human capital endowments. Because all human capital accumulation is learning by doing, countries accumulate skills in goods in which they have already a comparative advantage, and reinforce in this manner their initial comparative advantage.

The intertemporal welfare effects that determine the desirability of a certain specialization pattern are dependent on two effects. First, learning effects are highest in the high technology good which leads to a faster growth in production of this good. However, secondly, this faster production growth implies that the terms of trade will move against it. The deterioration in the terms of trade is dependent on the degree of substitutability between the two goods: if the degree of substitutability is low (high) the terms of trade declines strongly (less). This implies that the country which specializes in the high tech good gets the highest real growth rate only if the substitution elasticity between the two goods is elastic. An important result of this model is that real growth rates are determined endogenously and they can differ across countries.

Initial technological capabilities govern trade patterns: the Young model

Young (1991) investigates the dynamic effects of international trade in a world consisting of a less developed country (LDC) and a developed country (DC), the latter distinguished by a higher initial level of knowledge. There exists a continuum of technical more sophisticated goods (to produce more advanced goods, more experience/knowledge is needed). Technological change is caused by learning by doing effects that are bounded in each good (per unit output labour requirements decline until a certain boundary is met when production increases). At each point in time there are two sets of goods, one in which the learning by doing effect has stopped and one in which learning by doing continues. In a static sense this is comparable to the Lucas model, however in a dynamic sense it differs because it endogenizes the movement of goods out of the learning by doing (infant industry) sector into the other (mature) sector. Old goods will be discarded for more advanced goods and this causes an in-

crease in the labour productivity. Over time, growth causes the production of a changing basket of goods, with both the quantity and variety of goods consumed increasing (there will be gains from increasing variety without the assumption of monopolistic competition). The trade pattern will not become static but remains evolving. With trade the LDC (DC) specializes in the mature (infant industry) goods where learning by doing has (not) ended. The LDC (DC) experiences a less than or equal (greater than or equal) rate of technical progress and GDP growth to these under autarky. If the DC population is greater than or equal to that of the LDC or when the initial technical gap is large, the technical gap between these countries will grow without bound. Only when the initial technical gap is not too large and the LDC is larger there is a possibility of catching up or leapfrogging.

Finally, with regard to intertemporal welfare effects the results of this Young model are ambiguous and depend for example on the initial technology gap and on the size of the countries. If the DC maintains its technical lead, DC consumers gain from trade by dynamic (higher rate of technical progress) and the usual static gains from trade. Although its own rate of technical progress decreases the welfare of LDC consumers may still improve through the usual static gains from trade, which increases as the DC experiences technological progress. In general it can be said that the welfare of the LDC will improve when it is small relative to the DC, it will be reduced when the LDC is much larger than the DC and it cannot catch up. If the LDC catches up its welfare may increase or decrease (the latter is possible when the terms of trade deteriorates relatively fast for more sophisticated products).

Main trade mechanism

In principle the specialization and trade pattern is determined by comparative advantage (Lucas; initial factor endowments) or the initial knowledge stock (Young; technological capabilities and country size). The dynamic implications of these external economies of scale growth theories are that in general a country will built up knowledge or expertise in the goods in which it specializes and therefore reinforces its comparative advantage in these goods, although the possibility of leapfrogging and reversing comparative advantage remains (see, Young model). Because the technological opportunities differ between goods the specialization pattern determines also the welfare level and long term growth of a country.

Policy

- Industrial policy to correct for positive externalities (learning effects or knowledge spillover effects).
  In the Lucas and Young models learning effects are assumed to be external, agents do not take them into account. If they did they would allocate labour more to the good with the high growth potential in exchange for a less desirable mix of current consumption. An industrial policy focused on 'picking winners' (subsidizing the production of goods with a high learning potential) is the right policy. However, Lucas remarks 'In the model, 'picking winners' is easy. If only it were so in reality! (1988:31)'.

- Industrial or trade policy (second best) to reverse the specialization pattern:
  industrial or trade policy (second best) can also be used to obtain the specialization pattern that leads to the most desirable specialization pattern in the long run. Subsidies or protection can reverse the specialization pattern. However, to deduce the correct policy advice in this model is very difficult because one has to know the exact technological opportunities of different goods in different countries.

4.1.2 Knowledge as investment: a combination of external and internal economies of scale with monopolistic competition

An obvious drawback of the external economies of scale approach is that technological progress is a side-product of other activities. In the *knowledge as investment approach* technological progress becomes the intentional outcome of economic behaviour. The general method chosen in this approach is to identify a separate R&D sectors along other sectors in the economy. The R&D sector produces blueprints of new goods and as a side-product general technological knowledge. The blueprints are specific and provide guidelines to produce a certain 'unique' product. The R&D sector sells these blueprints to the production sector. The production sector can sell these unique products above marginal costs (i.e. imperfect competition) and can earn back the fixed costs of buying the blue-print. The general technological knowledge cannot be applied in the production of goods, but has a more general nature. It adds to a general knowledge pool which can be used in the production of blue-prints. A larger general knowledge pool, in turn, reduces the costs of producing blueprints and is therefore a stimulus for the development of new blueprints by all firms in the research sector. This continuous incentive to develop new products causes endogenous growth. Important for the generation of endogenous growth is that the incentive to invest in R&D does not decline. In all these kind of models the growing stock of knowledge as a side product of R&D generates this constant incentive, whether these models focus on R&D firms expanding product variety (Grossman and Helpman, 1991b) or on increasing quality of a constant number of varieties (Aghion and Howitt, 1992, Grossman and Helpman, 1991b).

In models where R&D expands product variety it is assumed that a larger number of product varieties is valued positively by consumers (in case of consumer products) or it increases the productivity of the final production sector (in case of intermediate products). When an individual firm determines the amount of R&D to invest, it does not take into account that the knowledge it will produce also increases the knowledge level of other firms because it does not get compensation for this. If the innovator would get compensated by the other firms for this increase in knowledge it would have had invested more: this is called the intertemporal spillover effect which dominates in these models. A R&D subsidy can give the firms the right incentive (Grossman and Helpman, 1991b). Therefore, the market provides just as in the external economies of scale approach insufficient incentives for industrial research in comparison with what is socially optimal.

In models where R&D enhances the quality of products, it is also assumed that R&D performed by a firm contributes to a general knowledge stock that can be used by all firms. This is again an intertemporal spillover effect which may lead to under-investment in R&D. However, in these increasing quality models, the firm that innovates gets the whole market and destroys the profits of the previous innovator. Because an individual firm does not take this profit destruction effect into account, this may lead to over-investment in R&D in comparison whit what is socially optimal. Therefore, the two main market distortions are the profit destruction effect (displaced leaders lose a stream of monopoly profits) and the knowledge spillover effect. The incentive to invest in R&D can therefore be too low or too high. In this case, the optimal policy can be a tax or subsidy (Aghion and Howitt, 1989, Grossman and Helpman, 1991b).

Dynamic trade implications

- *Assumptions*

Usually, these theories divide the labour market in unskilled labour and human capital. They assume that advances in technology are most often engineered by skilled people who have invested heavily in the development of their technical skills. Unskilled workers generally substitute quite imperfectly for skilled labour (Helpman and Grossman, 1991). Furthermore, it is assumed that relative factor endowments differ between countries and are fixed.

A further assumption is that the various manufacturing activities differ both in the intensity with which they employ various primary inputs and in their potential for contributing to innovation and productivity growth. In general these theories assume a traditional good that is unskilled labour intensive, a differentiated high tech good that is human capital intensive, and a R&D sector that produces blueprints for the differentiated high tech good that is even more human capital intensive. The potential for technological change is low for the traditional good and high for the high tech good. The traditional good is produced with constant returns under perfect competition and the high tech good is produced with increasing returns to scale in a monopolistic market structure. In most cases the production technology is identical across countries, in some cases one country has a larger knowledge stock and therefore a higher productivity of human capital in the R&D sector.

The dynamic trade and welfare implications of this approach are also dependent on the assumption whether knowledge spillovers are national or international in scope. Does or does not knowledge flow across borders? The trade and welfare implications of this approach are illustrated with two backbone models. In the first model knowledge spillovers are international in scope and in the second model knowledge spillovers are national in scope.

A. *International knowledge spillovers*

Assume a two factor (human capital and unskilled labour), two sector (traditional goods and high-tech differentiated goods), two-country model. The two sectors differ in their factor intensities and in their contribution to technical progress. Countries differ in their relative factor en-

dowments. Further assume that goods must be produced in the country in which they have been developed.
The human capital-abundant country (net) exports the human capital-intensive differentiated product (Heckscher-Ohlin theorem). There are net-exports because there is intra-industry trade in the differentiated sector. Each firm in each country exports his unique developed brand. The relative labour-abundant country exports the traditional labour intensive good. So far nothing new in comparison with the 'new' trade theories (see section 2.1.2, Krugman, 1981, Dixit and Norman, 1980, Ethier, 1979). But these 'new' growth theories add one important prediction to the static models: The long run growth rates of output and GDP are linked to resource endowments.
If there is imperfect specialization in the long run, the steady state rates of innovation in the high tech sectors of the two countries are the same, because both countries keep an R&D sector. However, the R&D and high-tech sectors represent a larger fraction of value added in the human-capital rich country. The labour rich country specializes relatively in the manufacturing of traditional goods, where opportunities for technical progress are fewer. Therefore the human capital rich country experiences a faster growth rate of output. Despite this both countries enjoy the same growth of real consumption because long run interest rates are the same in both countries and each has access via trade to the entire set of innovative products.
International knowledge spillover is a crucial feature for these results, because this makes that all innovators have the same knowledge and that national advantages in R&D arise only from differences in relative factor prices (which are dependent on resource endowments). Factors such as the size of a country and the history of its production play no role in the long term trade pattern, what only matters are factor endowments (Grossman and Helpman, 1991b).

B. National knowledge spillovers

Consider a world with only one production factor (labour) and in which countries only differ in size and in their prior research experience. With only national knowledge spillovers the initial conditions govern long run outcomes. In many situations the country with the initially greater stock of knowledge has an advantage in R&D and accumulates knowledge more quickly than its trading partner. This sustains and adds to its productivity lead. History alone determines long-run trade patterns and growth rates (i.e. hysteresis). Only when the countries are very different in size the large country can overcome a modest knowledge lag if the share of consumer spending devoted to traditional goods is relatively small.
The welfare implications for a country are very dependent on the specialization pattern and the related wage rates. When the country that conducts the world's R&D also enjoys higher wages in the long run, it is again possible that a country which specializes in the sector without national

knowledge spillovers loses from trade or can improve its welfare by specialising in the other sector. In this case R&D policy for the lagging country is justified 1). A sufficiently large subsidy to R&D can be used to overcome the initial productivity disadvantage. The specialization pattern will be reversed. This is called policy-hysteresis: a temporary policy can have permanent effects (Grossman and Helpman, 1991b).

Main trade mechanism

When innovation leads to the development of new varieties of horizontally differentiated firms, the pattern of trade is determined by the number of blueprints in the hands of each country's firms. Over time the trade pattern evolves in accordance with the number of new discoveries made by entrepreneurs in each country. This in turn depends upon the R&D investments that take place in each location.

With quality competition innovators try to improve the quality of existing products. If they succeed, they capture the world market. The direction of trade in a particular product may therefore reverse over time. In aggregate the pattern of trade is determined by the number of products in which a country takes the lead. This is again dependent on the amount of R&D investments.

In both cases the R&D investments are dependent on the specialization pattern which is caused by the principle of comparative advantage (factor endowments), history, the initial stock of knowledge, the scale of a country and the demand structure. These factors determine the number of people that are working in the R&D sector, the high tech sector and the low-tech sector.

The welfare and growth implications are dependent on the specialization pattern and whether knowledge spillovers are national or international in scope. With international knowledge spillovers and no full specialization all countries will gain from trade and no specialization pattern is preferable. However, with national knowledge spillovers the welfare implications of certain specialization patterns are very different and may even be negative. In this situation certain specialization patterns may be preferable to others.

Policy

Industrial policy (first best) and trade policy (second best) may be beneficial in the following circumstances:

- in models where R&D expands product variety there is an under investment in R&D (because intertemporal knowledge spillovers dominate). An R&D subsidy is the right policy;

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1) However, with equal wages an R&D subsidy often reduces welfare despite it increases the growth rate of the gross domestic product. The main reason is that trade in goods and assets produces the most efficient outcome: 'residents of the country that specializes in the production of traditional goods still benefit from innovations that are made abroad because they invest their savings in foreign assets and import the novel goods that emerge from their labs' (Grossman and Helpman, 1991: 232).

- in models where R&D increases product quality there can be an under- or overinvestment in R&D. An R&D subsidy or tax is the right policy;
- in models where knowledge spillovers are national in scale and wages linked to the high tech goods are higher, a temporary protection policy may change the specialization and trade pattern (policy hysteresis).

4.1.3 Empirics

The new growth theories developed useful concepts to deal with technological change and growth. However, just as in the case of the new trade theories (imperfect competition and economies of scale), the problem with this approach is that it is difficult to test these theories empirically. It is extremely difficult to quantify certain effects and estimate their importance and therefore it is hard to decide whether or not it is beneficial to imply some policies. At the moment there seems to be no need for more complicated models but priority should be given to the empirical implementation of these theories.

The empirical evidence on the assumptions and implications of the new growth theories has just started. Jones (1995a) has tested the relationship between changes in R&D spending and changes in macroeconomic growth implied by these models. More specifically, all the models that treat knowledge as an investment good (R&D-based models) have assumed that past knowledge is never rendered obsolete by new innovation and that therefore there are constant returns to R&D investments, which has the following implications for per capita growth rates: 'if the level of resources devoted to R&D, measured, say by the number of scientists engaged in R&D, is doubled, then the per capita growth rate of output should also double, at least in the steady state.' Jones shows that empirically this prediction receives little support. The number of scientist engaged in R&D in advanced countries has grown dramatically over the last 40 years and growth rates either have exhibited at constant mean or have even declined on average.

Furthermore, Jones (1995b) shows that if one releases the assumption of constant returns to scale to R&D, the influence of policy (e.g. R&D subsidies) on the long-run growth rate vanishes. However, how long is the long run? Policies can still have an influence on the period on the growth along the transition path to the new steady state. Whether policies are still worthwhile depends on the length of the transition path and the magnitude in which policies can shorten this path.

Several authors investigated the assumption of whether spillovers are national or international in scope because in models with only national spillovers government policy can have long lasting effects. Coe and Helpman (1993) and Bernstein and Mohnen (1994) find some evidence for international spillovers. However, Branstetter (1996), who investigated both intra-national and international spillovers, concludes that intranational spillovers are stronger than international spillovers. There is also some evidence that spillovers are geographically localized (Jaffe 1986, Acs et al. 1992). Overall, there is evidence that some spillovers are international in nature, but local or intra-national

knowledge spillovers exist too. This gives some support to models in which government policy may have long lasting effects.

4.2 Evolutionary Growth Theories

A recent direction within economics assumes that technology plays the fundamental role in economic life. In contradiction to the 'new' trade and 'new' growth theories they see the process of technical change as a dynamic evolutionair process. The innovation process is characterised by cumulative, firm-specific and irreversible processes (Dosi et all., 1988). Therefore, technology cannot be reduced to freely available information or to a set of 'blueprints'. Furthermore, they assume out of equilibrium dynamics and bounded rational behaviour. These 'technology' theories are therefore a radical department from the traditional trade models which took technology data as exogenous to the economic process. However, because the evolutionary growth theories reject many of the standard neoclassical assumptions they are less formal and more heterogeneous. Because of this heterogeneous nature we concentrate on some central features of the evolutionary economics.

Assumptions

Important assumptions in the evolutionary growth theory are that the innovation process is characterised by cumulative, firm-specific and irreversible processes; sectors differ in their contribution to the absolute competitiveness of a country; and countries differ in technology skills and innovation capacity.

From innovation process to technology trade mode

The development of technology is cumulative and firm specific. Technological changes are often caused by learning by doing and learning by using, such that technology is often firm or region specific, and is generally embodied in people and organisations (Dosi, 1988, Dosi, Pavitt and Soete 1990). This assumption of firm specific knowledge is in contrast with the new growth theories which assume that knowledge directly flows to a general knowledge stock which can be used by all firms (national and international).

Technological paradigms (Dosi, 1988) and technological trajectories (Nelson and Winter, 1977) send resources in a certain direction and take care of the fact that technical progress happens along a relatively ordered, cumulative and irreversible pattern. The technological opportunities of a firm are, therefore, constrained by activities in the past. By searching for innovations it will build further on and is restricted by his 'specific' knowledge.

Besides these private, firm-specific aspects of knowledge, some public good features of knowledge play a role in the process of technical change. First, the freely available information, such as publications. A second public good feature is related to the 'untraded interdependencies' between sectors, firms and technologies. These interdependencies appear in the form of technological complementarities, synergy effects, spillover effects and incentives and

restrictions which are not fully reflected in trading goods. The occurrence of these technological externalities differs very much between sectors.

The direction and rate of technical change in a market economy is different in every sector and dependent on (Dosi, Pavitt and Soete 1990):

- the sources and nature of technological opportunities;
- the nature of actual or potential markets;
- the possibilities for successful innovators to appropriate a sufficient proportion of the benefits of their innovative activities to justify the research effort invested in such activities.

Because sectors differ in these characteristics, their contribution to the national innovation capacity is very different.

A very important implication of the analysis so far is that there exist unequivocal a-symmetrical differences between firms and countries in technological capability. There are absolute cost differences between firms and countries. These theories are therefore against all kinds of theories which assume identical production technologies between countries.

Trade mechanism

Dosi, Pavitt and Soete (1990) developed a trade model in which the principal part is played by absolute technological advantages (technology gaps) between countries. These absolute advantages/disadvantages determine the competitiveness and world market position of 'all' sectors and have therefore a great influence on the income and employment position of a country. The minor part is played by relative technological gaps between sectors within a country. These relative technological gaps determine the specialization pattern between sectors according the mechanism of comparative advantage.

We can illustrate this model with a simple example: absolute advantages determine why a country has an average market share of 0.5% or 10%. Comparative advantage determines why one sector in the country with an average market share of 10% (0.5%) has a market share of 9% (0.4%) and another sector has a market share of 11% (0.6%).

Dominant technologies, which influence the production in almost all sectors and display often huge positive externalities, are therefore extremely important in their contribution to the absolute competitiveness of a country (MacDonald and Markusen, 1985).

Implications

1. A nation's future growth and technological development is affected by the current composition of its industries and activities, and by its paradigms of how to develop and exploit technology (Patel and Pavitt, 1990).
2. A specialization pattern according to the traditional mechanism of comparative advantage can lead a country to specialize in those industries (sectors) and activities in which the opportunities for growth and technological development are least. The current specialization pattern of a country has therefore a dynamic effect because this determines in which sectors technical skills will be accumulated, innovations will be done,

economies of scale will be realized, etcetera. Sectors differ in these opportunities such that the present specialization pattern is extremely important for the economic performance of countries in the future. A specialization pattern which is static (Ricardian) efficient can therefore be dynamic inefficient.

3. The possibility of this trade-off between static and dynamic efficiency is greater the greater the distance from a country to the technological leader (Dosi, Pavitt and Soete, 1990).
4. Static economies of plant size are not so important anymore through the continuously arising of new technologies. The scale economies which are of greatest significance now are of two sorts (Freeman, Sharp and Walker 1991):
   - economies of scale and economies of scope in research, design, production and world-wide marketing networks. The costs of designing, developing and testing new generations of products and services are often such that commercial viability is only possible if they are spread over very large markets;
   - dynamic economies of scale, which are associated with the accumulation of knowledge within a firm from R&D, design, production and marketing (Pavitt, 1984).
5. Competition between firms is a very important factor in the innovation process. Strong competition forces firms to innovate. The strength of a sector can therefore be reflected in the presence of a relatively large number of nationally based large firms. Relatively technological strengths of countries are therefore correlated with rivalry among the large firms and not with gigantism (Patel and Pavitt, 1990).

Policy

Industrial and trade policy is beneficial if:

- there is a tradeoff between static Ricardian efficiency and dynamic Schumpeterian efficiency;
- a sector has a high contribution to the absolute competitiveness of a country (is it a dominant sector) because it generates for example huge externalities;
- a sector has a high dynamic potential in terms of growth and technological opportunities.

Empirics

Dosi, Pavitt and Soete (1990) find the following empirical relations which supported their technology trade model:

- a variety of science and technology measures (e.g. R&D, Patents) gives a constant picture of the aggregate distribution of innovative activities between countries;
- international differences in innovative activities are reflected in differences in shares of world exports in most sectors, and in manufacturing as a whole;

- export performance is positively associated with differences in per capita innovative products and differences in labour productivity;
- changes in trade performance are more strongly associated with changes in innovative activities than in relative labour costs;
- international differences in per capita income have been closely related to international differences in per capita innovative activity;
- international differences in the rate of growth of per capita income have been associated with similar differences in the rate of investment and in the rate of growth of innovative activities.

5. CONCLUSIONS

5.1 Evaluation of empirical tests of theories explaining international trade

Testing trade theories has proven to be extremely difficult. Some of these problems in testing theories have been attached upon already. First, the theory should be interpreted correctly in the empirical tests. However, theories are in most cases formulated in so stylized terms that a translation of a theoretical model into an empirical application is very hard to do. Second, it may be difficult to find testable alternative hypotheses from the theoretical model. Third, it is often difficult to find any variable that closely measures the hypothetical construct stipulated by the theory (for instance, what are the 'relative autarky prices', how to measure 'imperfect competition', what is a good proxy for 'technological development', etc.). All in all, the problem in testing a theory is to find out what needs to be tested and to find data that develops a proper correspondence between the theory and observable events. Despite all the efforts done sofar there is much controversy on how well tests have been done and what these tests suggest about the validity of the model they were based on. More often than not empirical work is criticized for being misdirected or incomplete as tests of international trade models.

According to Leamer (1994) the effects of empirical testing of international trade theories on the way economist think about the determinants of international trade have been small. That is not surprising to him because as 'by definition a model is not literally true, so there is no reason to test it' (1994:66). Leamer, therefore, recommends researchers to 'estimate, not test', expressing that data analysis should not take theoretical foundation too literally. Leamer states that an influential empirical study will have to have a proper balance of issues, theory and data. The central issue in international economics which needs to be addressed is how, if at all, governments should intervene in international commerce. Attention seems too much focussed on formulating theories while the issues to be addressed are lost in the theoretical discussions and questions on mapping the theory into observable phenomena are ignored. The latter is also recognized by Krugman who finds that especially with respect to the so-called new trade theories '...the sophistication of our models in general seems to have outrun our ability to match them up with data or evidence' (Krugman, 1990: 261).

The problems concerning the possibilities of empirical validation of trade models elicit Leamer's statement that 'to make progress, economists ought to abandon the idea that models are either true or false in favour of the notion that models are sometimes useful and sometimes misleading' (Leamer, 1993: 439). Models are only tools, nothing more and nothing less. Leamer stresses

that each of the theoretical trade models is appropriate in some circumstances and inappropriate in others, and therefore, empirical studies should not try to test the validity of the theories. Instead, he claims, empirical work 'might identify the circumstances under which each of the tools is most appropriate, or measure the 'amount' of trade that is due to each of the sources. Neither of these tasks have been accomplished or often even attempted' (Leamer 1994: 69). In our later work when we focus on the explanation of agricultural trade patterns, we will try to identify the circumstances under which each of the (theoretical) explanations of trade is appropriate for agricultural products.

The circumstances meant in the former sentence are much related to what has been identified as the main mechanisms of the trade theories. The main mechanisms in the trade theories to explain international trade flows are factor proportions, economies of scale and differences in technology (technology gaps). Each of these three explanations of trade is related to specific key commodity characteristics and national attributes (see e.g. Hufbauer, 1970 and Choudhri, 1979). For instance, the factor-proportions theory focuses on capital intensity of a commodity and the relative endowment of capital and labour of a country, while economies of scale is related to the relative importance of economies of scale in the production and the size of the country. Technology theories are related to technical complexities of products (R&D intensity), and a country's income per capita. Our further research will focus on the question which of the three major explanations of trade is usable in explaining agricultural trade through identifying the key commodity characteristics in agriculture and the related national attributes. This will give us the building stones for a design of a concept explaining world trade patterns in agricultural commodities. A next stage of our research in this field will try to estimate (not test!) our concept, for instance by focussing on the bilateral agricultural trade between the European Union and Central and East European Countries (CEECs).

5.2 Government policy and international trade

The traditional trade theories explain trade by differences between countries. Exploiting these differences increases national and world welfare. Trade policies create 'barriers' to exploit these differences and are therefore welfare reducing. No intervention in international commerce is the best policy unless countries can improve their terms of trade (only large countries), there exist domestic distortions or for political reasons (income-distribution). A country can only improve its terms of trade at the expense of other countries and it risks therefore retaliation that makes everyone worse off. With respect to domestic distortions and income-distributional effects of trade, trade policy is only a second best policy. Industrial policy that adjusts directly the distortion or income policy that achieves the desired income-distribution is the first best policy. Considering these arguments the traditional theories became strong supporters of free trade.

The modern trade theories based on economies of scale and imperfect competition extend the traditional arguments for trade policy and add some

new arguments such as the strategic trade argument. The range of possibilities to improve the terms of trade is increased because this is possible in the case of foreign market power and even small countries can improve their terms of trade. Market distortions are inherent in imperfect competition so, for example, the wedge between price and marginal costs creates an opportunity for government action. However, in the former situation retaliation stays a problem and in the latter case trade policy is, again, only a second-best policy. So the extensions of the old arguments do not provide convincing arguments against free trade. What about the new arguments?

The main new argument is the strategic trade argument. Unlike in the survey we now take a broad definition of this argument. Strategic trade policy is aimed at keeping some industries that are desirable from a welfare point of view within the country. Industries can be desirable because they generate above-normal rents (rent shifting from foreign to domestic firms), they exhibit external economies of scale or they generate high externalities. The question is whether this argument gives a systematic new reason for trade policy? The answer appears to be no because the rent shifting argument is very dependent on specific assumptions. A slight change in one of the assumptions changes or even reverses the implications of a policy. The benefits related to the external economies of scale and the externalities argument are subtle and hard to measure. In both cases good policy requires that the government has a lot of information to choose the right model. However, this information must be so detailed that in most cases it is not available. The empirics also show that the benefits from deviations from free trade are small and that the value of an optimal tariff is low (see section 3.1.4). The potential for making policy errors through lack of information or the possibility of retaliation by foreign governments makes the possible losses greater than the benefits. Therefore, Krugman (1987) concludes that free trade is almost never optimal under imperfect competition but that it is a good rule of thumb. Feenstra (1995) confirms this conclusion: according to his analysis of methods used to estimate the impact of trade policies under imperfect competition, empirical results lend no support to a strategic role for trade policy.

The 'new' growth theories built forward on the modern trade theories and put these theories in a dynamic context. They deal therefore with the dynamic evolution of comparative advantage. Like the technology gap trade theories they stress the role of technological change. Important is that knowledge will be generated in current activities. The current specialization pattern determines therefore the activities in which a country accumulates knowledge or exploits economies of scale. Because the technological, scale and growth opportunities differ largely between industries the current specialization pattern becomes extremely important for a countries' future welfare. The latter crucially depends on the assumptions whether knowledge spillovers are national or international in scale. When knowledge spillovers are international in scope the specialization pattern does not influence welfare. However, when knowledge spillovers are national in scope or when there exist important dynamic external economies of scale the welfare level in the future is dependent on the current specialization pattern.

The 'new' growth theories that built forward on the neoclassical tradition assume most of the time free knowledge spillovers and therefore trade policies will not be beneficial. However, the evolutionary theory assumes that a crucial part of the generated knowledge is cumulative, specific and path dependent and spillovers are therefore local or national in scope. In this case trade policy may become beneficial because the gains at stake can be very large in some circumstances. Government policy still requires a lot of information about many difficult to measure economic variables such as technological opportunities, knowledge spillover and external economies of scales. However, government policy is more worthwhile than in the case of the modern trade theories because the gains at stake are larger.

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APPENDICES

Appendix 1. Traditional Trade Theories

	Comparative advantage (Ricardo)	Heckscher-Ohlin-Samuelson model	Specific factors (short term)
ASSUMPTIONS:			
Production factors	labour (mobile across sectors)	labour and capital (mobile across sectors), initial endowments differ	labour and product specific, initial endowments differ
Goods/sectors	2 homogeneous goods	2 homogeneous goods	2 homogeneous goods
Economies of scale	constant economies of scale	constant economies of scale	constant economies of scale
Production technology	different between countries different between goods no technical change	identical between countries differences between goods no technical change	identical between countries differences between goods no technical change
Knowledge spillovers	no	no	no
Consumer preferences	homothetic and identical across countries	homothetic and identical across countries	homothetic and identical across countries
Market structure	perfect competition	perfect competition	perfect competition
MAIN MECHANISM:	country differences in technology	country differences in factor endowments	not only factor endowment differences but also the division of the specific factors across sectors and the nature of the technology
IMPLICATIONS:			
Sources of gains from trade	gains from exchange specialization	gains from exchange specialization	gains from exchange specialization

Appendix 1

	Comparative advantage (Ricardo)	Heckscher-Ohlin-Samuelson model	Specific factors (short term)
Factor price equalization	Not applicable to this theory	yes	no
Which production *gains/looses*	labour gains	the relative abundant factor gains	specific factor for export product factor gains, specific factor for import product looses, labour unclear
POLICY:			
Arguments	In the traditional trade theories, which assume perfect competition, free trade policy is always the best policy for the world and almost always for individual countries unless: - terms of trade argument: trade policy - distortions: industrial policy (first best) and trade policy (second best) - political reasons: e.g. national defence or to obtain a more desirable income-distribution (however, in the latter case income policy is first best)		
EMPIRICS:	some support (countries export those goods in which their labour is especially productive), but not persuasive	1) Leontief paradox; 2) intra-industry trade; 3) most trade between countries with same factor endowments; 4) income-distribution effects small	tests in principle similar to Ricardo model. No empirical studies done

Appendix 2 Modern trade Theories

	External economies of scale	Internal economies of scale monopolistic competition	Internal economies of scale oloigopolistic competition	Technology gap theory (Krugman 1979)
ASSUMPTIONS:				
Production factors	labour (and capital), mobile across goods, immobile across countries, initial endowments may be identical	labour (and capital), mobile across goods, immobile across countries, initial endowments are identical	no assumptions	labour which is domestically mobile and internationally immobile
Sector/goods	2 homogeneous goods	no differentiated goods	a few goods	no (horizontally) differentiated goods
Economies of scale	one good constant economies of scale, the other external economies of scale	internal economies of scale	increasing returns to scale at firm level (not in Brander and Krugman model)	constant returns to scale
Production technology	differences between goods, identical between countries, no technological change	identical between goods and countries, no technical change	identical between countries and goods no technical change	new varieties can only be produced in North, imitated varieties can be produced in North and South with same production technology, exogeneous innovation and imitation rates
Knowledge spillovers	no	no	no	yes, international knowledge transfer
Consumer preferences	identical across income and countries	identical across income and countries	identical across income and countries	identical across income and countries

Appendix 2

	External economies of scale	Internal economies of scale monopolistic competition	Internal economies of scale oloigopolistic competition	Technology gap theory (Krugman 1979)
Market structure	perfect competition on good and factor markets	monopolistic competition on good markets, perfect competition on factor markets	oligopolistic competition on good markets, Cournot duopoly (Brander/Krugman)	monopolistic competition
MAIN MECHANISM:	economies of scale lead to inter-industry trade	economies of scale and product differentiation lead to intra-industry trade	economies of scale market segmentation and price discrimination (Brander/Krugman)	technology gaps which grow with innovation and close with imitation
IMPLICATIONS:	a country may loose from trade	countries gain from trade		the North can loose from trade
Sources of gains from trade:	gains from exchange, specialization and exploiting economies of scale	gains from exchange, specialization, exploiting economies of scale, exit of redundant firms and more product variety	pro-competitive effect exit of redundant firms gains from exchange, specialization and exploiting economies of scale	more product variety specialization and gains from exchange
Factor price equalization	not necessarily, wages in one country may be higher	not necessarily	not necessarily	no, wages in innovative North are higher
Which production factor gains/looses	labour may gain or loose	income-distribution effects of intra-industry trade are less than those of inter-industry trade (H-O-S-model) because there are additional gains from trade		imitation reduces (increases) wages in North (South), innovation increases wages in the North and South (consumers love more product variety)

Appendix 2

	External economies of scale	Internal economies of scale monopolistic competition	Internal economies of scale oloigopolistic competition	Technology gap theory (Krugman 1979)
Other implications:	inter-industry trade history and accident determine trade patterns, direction of specialization often unknown	intra-industry trade precise pattern of trade is indeterminated	intra-industry trade	North must continuously innovate to preserve its wages, world output rises through both immitation and innovation
POLICY:	can improve national and world welfare	can improve national welfare under some specific conditions		the North can loose from trade, trade is beneficial from a world point of view
Arguments	external economies of scale: - Nat: specialising in products which do not imply highest welfare - World: optimal world scale of product does not fit in a small country	terms of trade (1): even small countries can improve terms of trade (TOT) terms of trade (2): in case of foreign market power TOT may improve distortion: imperfect competition implies that distortions are built into the model rent shifting (strategic trade argument)		externalities (international knowledge transfer) imitation detoriates wages in North: trade policies can reduce imitation, however this reduces world output; correct internationally technology transfer system can withold North from protection
EMPIRICS:	difficult to test theory, some evidence (Silicon valley)	a lot of attempts to test the theory, but these attempts receive a lot of critics: theories are difficult to test because of limitations of theories and of data. Test are at best		fragmentary support to technology-gap and product cycle hypothesis

Appendix 3 Trade implications of the growth theories

	Knowledge as side product Lucas (1988)	Knowledge as side product Young (1991)	Knowledge as investment: international knowledge	Knowledge as investment: national knowledge spillovers	Evolutionary growth theories
ASSUMPTIONS:					
Production factors	2 types of human capital which can be accumulated and are good specific, the initial endowments differ between countries	labour, the initial amount of labour (country size) may differ between countries	unskilled labour and human capital (mobile across sectors), the initial relative endowments differ across countries	labour, the initial amount of labour (country size) may differ between countries	labour is heterogeneous and partly immobile over secotrs because it embodies firm specific knowledge
Sector/goods	a homogeneous high tech and low tech good	a continuum of goods	R&D sector that produces bleuprints for high tech goods, a low tech homogeneous good and differentiated high tech goods	R&D sector that produces bleuprints for high tech goods, a low tech homogeneous good and differentiated high tech goods	no formal model
Economies of scale	external economies of scale	external economies of scale	- low tech high tech good: constant economies of scale - bleuprint: dynamical increasing returns to scale	- low tech and high tech good: constant economies of scale - bleuprint: dynamical increasing returns to scale	static econ. of scale linked to plant size are not so important but spreading innovation costs and dynamic economies of scale

Appendix 3

	Knowledge as side product Lucas (1988)	Knowledge as side product Young (1991)	Knowledge as investment: international knowledge	Knowledge as investment: national knowledge spillovers	Evolutionary growth theories
Production technology	technological opportunities differ between goods, identical across countries, process innovations (unbounded learning by doing)	goods differ in their level of technical sophistication, initially level of knowledge differs between countries, process innovations (bounded learning by doing)	technological opportunities and factor intensities differ between goods, identical between countries, endogeneous technological change by process or product innovation (new varieties or quality improvements)	technological opportunities differ between goods, initial level of knowledge differs between countries, endogeneous technological change by product innovation (new varities)	sectors differ in their contribution to absolute competitiveness of a country, countries differ in technology skills and innovation capacity. Innovation is a cumulative, specific and irreversible process
Knowledge spillovers	national good specific spillovers or learning effects	national non-good specific spillover effects or learning effects	international good specific knowledge spillovers	national good specific knowledge spillovers	some knowledge is firm specific, other knowledge has some public good features
Consumer preferences	homothetic and identical	homothetic and identical	homothetic and identical across countries	homothetic and identical across countries	different between countries and incomes
MAIN GROWTH MECHANISM	externalities (unbounded learning by doing) as by-product in production process	externalities (knowledge spillovers or bounded learning by doing effects) as by-product in production process	knowledge spillovers that increase the general knowledge stock which increases the productivity of the R&D sector	knowledge spillovers that increase the general knowledge stock which increases the productivity of the R&D sector	innovation: technology is cumulative and firm specific, and also caused by learning by doing and learning by using

Appendix 3

	Knowledge as side product Lucas (1988)	Knowledge as side product Young (1991)	Knowledge as investment: international knowledge	Knowledge as investment: national knowledge spillovers	Evolutionary growth theories
MAIN TRADE MECHANISM	comparative advantage determined by initial endowments and learning by doing effects reinforce comparative advantage over time	initial technological level determines specialization pattern, is reinforced by external scale economies but may be reversed when the technology lag is small and tha lagging country is much bigger	initial factor endowments determine the initial specialization pattern, this pattern determines the number of blueprints produced in each country	initial technological level determines specialization pattern, this pattern is reinforced by knowledge investment (each blueprint is unique and leads to intra-industry trade)	absolute technological differences determine world market position of all sectors. Relative technology gaps between sectors determine specialization pattern between sectors according mechanism of comparative advantage
IMPLICATIONS					
Sources of gains from trade:	dynamic economies of scale gains from exchange specialization gains	dynamic economies of scale gains from exchange specialization gains increasing product variety	dynamis economies of scale gains from exchange specialization increasing product variety or product variety or product quality	dynamic economies of scale gains from exchange specialization increasing product variety	dynamic economies of scale gains from exchange specialization increasing product variety or product quality
Factor price equalization	not necessary	not necessary	not necessary	not necessary	no

Appendix 3

	Knowledge as side product Lucas (1988)	Knowledge as side product Young (1991)	Knowledge as investment: international knowledge	Knowledge as investment: national knowledge spillovers	Evolutionary growth theories
Other implications:	- externalities imply that the growth rate in equilibrium is lower than optimal rate of growth - countries may loose from trade	- externalities imply that the growth rate in equilibrium is lower than optimal rate of growth - countries may loose from trade	- product variety: equilibrium innovation rate is too small - product quality: equilibrium innovation rate too small or too high - countries gain from trade	- product variety: equilibrium innovation rate is too small - countries may loose from trade	- future growth and technological development determined by current specialization pattern - a country can loose from trade (if trade-off static and dynamic efficiency)
POLICY					
Arguments	- externalities: obtain optimal growth rate - reverse specialization pattern if specialization in other sector increases welfare	- externalities: obtain optimal growth rate - reverse specialization in other sector increases welfare	- obtain optimal growth rate - no reason to desire certain specialization pattern because both countries same growth of real conumption	- obtain optimal growth rate - reverse specialization pattern	a specialization pattern that is static (Ricardian) efficient can be dynamic (Schumpeterian) inefficient
Which policies are possible	industrial and trade policies	industrial and trade policies	industrial policy	industrial and trade policies	industrial and trade policies
Main effects of policies	under certain circumstances increase total welfare	under certain circumstances increase total welfare	industrial policy can be beneficial, trade policy is negative for total welfare	under certain circumstances increase total welfare	change specialization pattern and future of a country

Appendix 3

	Knowledge as side product Lucas (1988)	Knowledge as side product Young (1991)	Knowledge as investment: international knowledge	Knowledge as investment: national knowledge spillovers	Evolutionary growth theories
EMPIRICS			- there exist some spillovers that are intra- national in nature but also some spillovers that are internationally in scope - level of R&D expenditures is not linearity related with growth rates		empirics confirm role of technical change