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THE STRUCTURE OF SWEDISH INTERNATIONAL TRADE AND SPECIALIZATION: "old" and "new" explanations

by

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1. Introduction.

This paper attempts to explain the structure and long run development of Swedish international trade and specialization within the framework of international trade theory. There is, however, no unique and universally valid model of international trade. On the contrary, a number of different trade models have evolved over the years, each stressing different determinants of the patterns of trade. In particular, there has been a high level of activity in the field of international trade theory in the last 10 years, partly along new lines of research.

The basic issues raised in the paper are: Which theory gives the best explanation of the Swedish trade structure? What are the major determinants of the Swedish trade pattern? Have the roles of different trade theories shifted over time? Can certain trade flows be explained by some factors that are less important in explaining others?

The paper contains an historical overview of long–run tendencies in the Swedish pattern of international trade and specialization of production. Parallel to the historical description there is a brief survey of "old" and "new" models of trade and specialization, with focus on attempts to test such models on Swedish data.

2. Swedish Trade Structure and "Revealed Comparative Advantage".

2.1 Availability of resources and trade in raw materials: the early stages of industrialization.

Most theories of the structure of international trade tend to focus on supply factors. According to this view, trade compensates for international differences in production possibilities. The patterns of trade, therefore, will reflect the geographically uneven distribution of natural resources and other factors of production, or international differences in technology, which give rise to inter–country differences in unit costs and pre–trade prices. These cost and price differences constitute the pattern of comparative advantage of countries and determine the structure of trade. Since pre–trade prices in general are not observable, empirical studies usually work with the concept of comparative advantage as "revealed" by the trade patterns.

Among supply side theories, the "availability" theory (Kravis 1956) is stated in terms of absolute supply: a raw material or agricultural product demanded but not available or not produced in a country will of course be imported. The theory may alternatively be expressed in terms of **relative** availability of natural resources, e.g location and concentration of mineral deposits, climate and fertility of land, reflected in different productivity of labor in farming, forestry and mineral extraction, and thus in different relative costs of the corresponding commodities. Trade in minerals, agricultural products and other raw materials as well as semi–manufactured products – "Ricardo goods" in Hirsch (1974) terminology – may be explained by natural resource endowments in a broad sense[1]. Forward linkages in combination with high transport costs for raw materials relative to those of the final product would exert a localizational pull on at least the primary stages of processing towards the raw material site.

The early stage of industrialization of the Swedish economy was based on the exploitation of the country's natural resources: forest land, iron ore and hydro–electric power. The demand for these resources was to a large extent export–led. The role of Swedish international trade during this period might be described by the "vent for surplus" model of trade (Caves 1965), where economic growth in a country is initiated through foreign demand for a hitherto unused natural resource. Swedish exports in the 1870s and 1880s was dominated by raw materials: timber, sawnwood, iron ore and agricultural products provided 80% of export revenue (Ohlsson 1969).

During the period up to World War II there was a strong tendency towards diversification of exports and further processing of natural resources: exports of pulp, and later paper, were substituted for exports of timber and sawnwood.

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[1]In the textbook version of the Ricardian theory, international trade patterns are determined exclusively by differences in relative labor productivity. These differences, however, are explained in terms of national differences in technology in a wide sense, including climate and fertility of land as well as availability of natural resource deposits.

The Swedish export pattern, however, still reflects the availability of domestic natural resources, though this dependence – including exports of processed intermediate goods – has been declining.

2.2 Factor proportions and manufacturing exports.

Thus the "availability" and Ricardian theories seem to explain the basic structure of Swedish trade in the early stages of industrialization, though the decreasing share of raw materials and resource based products point to other explanations as well. According to neo–classical trade theory, the pattern of international trade is explained by differences in relative factor endowments of countries, in combination with different factor requirements of products. A country will have a comparative advantage in, and therefore export, products that require a large relative input of resources that are abundant. The Heckscher–Ohlin model was originally stated in terms of two (homogeneous) factors, labor and land[2], whereas the standard textbook exposition uses labor and capital.

Studies of comparative advantage have chosen either of two alternative approaches. By means of an input–output table, the average content of factor services per million dollar of exports and imports may be computed: this will answer the question whether exports are more or less capital intensive than imports (Leontief 1954, 1956). Alternatively, a regression analysis across products or industries could be used in order to reveal systematic relationships between exports (or net exports) and various measures of factor requirements. A comparison of the regression results with data for the country's resource endowments would constitute a test of the Heckscher–Ohlin theorem.

According to the basic factor proportions model, a country will have a net import of services – embodied in imports of goods – of scarce factors of production. In contrast to this theorem – the factor contents version of the Heckscher–Ohlin theorem – which extends to any number of goods and factors

[2]In the standard Heckscher–Ohlin framework, "land" as well as labor is of a homogeneous quality not only within but also among countries, whereas in the Ricardian theory it is precisely the differences in the quality of "land" among countries that account for international differences in labor productivity and thus for comparative advantage.

(Vanek 1964, Travis 1964, Melvin 1968), the commodity version, relating net exports of a good to factor endowments of an industry, only holds strictly in the simple two goods–two factor model. However, a stochastic version may be generalized to the case of many products, in the sense that the export of a good is positively correlated with its intensity of the abundant factor (Dixit & Norman 1980, Deardorff 1984).

In the standard model, trade will tend to equalize factor prices. If this process is not complete, the pattern of comparative advantage and trade of countries can be inferred from their factor prices. From the long run increase of Swedish real wages, Ohlsson (1969) concluded that the structure of Swedish comparative advantage in manufactured products (i.e excluding "Ricardo goods") shifted during the 1940s from labor intensive to capital intensive products. The first systematic study of factor proportions and Swedish trade structure was made by Carlsson & Ohlsson (1976). Using coefficients from a detailed input–output table (Höglund & Werin 1964), a regression analysis across some 100 industries (excluding raw materials) of Swedish trade in 1957 did show a tendency for net exports of manufactures to be high in capital intensive sectors. This was, however, true for direct but not for total capital intensity, i.e direct plus indirect capital services embodied in inputs.

The findings of Carlsson & Ohlsson were confirmed by a study of the factor contents of Swedish foreign trade in 1959–1974 by Flam (1981). Measured by capital income (i.e a flow concept), the average direct capital intensity in exports was higher than in imports, and that relation did not change during the period. The same result was obtained for total – direct plus indirect – capital in 1966. When stock measures of capital were used, however, the results were inconclusive: exports were capital intensive only in the end of the period (1974).

However, since industries processing domestic natural resources tend to be capital intensive as well as energy intensive, the trade structure found in these studies may be explained not only by a low cost of capital services relative to wages, but also by cheap raw materials or cheap energy. Thus it is difficult to disentangle the separate influences of natural resource intensity from that of capital intensity[3].

[3]This was pointed out by Carlsson & Ohlsson (1976).

Later studies of Swedish trade structure have largely failed to find any relationship between net exports and capital intensity. In a study of trade in engineering products, Ohlsson (1980) found a weak positive relationship between capital intensity and net exports in 1960, but this relation had disappeared in 1970. The **change** in net exports in 1960–1970, however, was negatively related to capital intensity. A cross–section study by Gavelin (1983) of Swedish manufacturing exports in 1977 actually showed a negative relationship between capital intensity (measured as operating surplus per employee) and net exports. Thus, the Swedish comparative advantage in capital intensive production in the late 1950s seems to have been reduced or even reversed. An alternative interpretation is that the data simply reflect the diminishing role of raw materials and resource based semi–manufactures in Swedish exports.

Neo–factor proportions theories have expanded the number of factors of production, within the framework of the original Heckscher–Ohlin–Samuelson model, by disaggregating labor into subgroups with respect to education or work position (Keesing 1965, 1966, Baldwin 1971). A closely related approach introduces the concept of human capital as a stock of knowledge, accumulated by education or work experience. Treating human capital as an asset yielding a return, analogous to physical capital, the stock of human capital can be measured by the present value of the stream of income in excess of a minimum wage (Kenen 1968), or, in a cross–section analysis, by the average wage in the industry.

In the study by Carlsson & Ohlsson (1976), the proportion of technicians was positively related to Swedish exports (but not to **net** exports). In Ohlsson's (1980) study of trade in engineering products, net exports was positively related to the proportion of skilled manual workers; furthermore, the **increase** in net exports 1960–1970 tended to be large for industries with a high proportion of technical personnel. Ohlsson concluded that the pattern of specialization of Swedish engineering trade changed during the 1960s from capital intensive to skill intensive products.

The conclusion that Sweden's comparative advantage lies in skill intensive and human capital intensive production was confirmed by the results of Gavelin's

(1983) study, where the coefficient for human capital intensity, measured by the discounted value of the excess of the average wage in the industry over a minimum level, was positively and strongly significant in a regression on the net export ratio. According to Flam's study (1981), when capital intensity was interpreted as the sum of human plus physical capital, measured by an income flow concept, Swedish exports were more capital intensive than imports in 1974. In a study of Swedish imports from developing countries Carlsson & Sundström (1973) concluded that Swedish industry had a comparative advantage vis–a–vis the LDCs in human capital intensive production.

2.3 The role of technology and R&D

Factor proportion theories generally assume technology to be given and internationally the same, i.e production functions are the same everywhere. In contrast, another group of theories, the neo–technology or technology gap theories of trade, tend to stress the importance of changes over time, and differences among countries, in technological knowledge for the explanation of international trade (Posner 1961, Hirsch 1967, Vernon 1966, Gruber, Mehta & Vernon 1967, Hufbauer 1970). Superior technology means a strong competitive position on the domestic and world markets. R&D expenditure results in innovations in the form of new products or production processes which improve the competitiveness of the innovating firm.

R&D expenditures, in per cent of sales or value added, may be used to measure the flow of new technology or the rate of turnover of knowledge in an industry. The R&D variable may have a dual role in the explanation of trade flows. On the one hand it may be interpreted in terms of the neo–factor theories. A country where resources for producing R&D, such as scientific personnel, are abundant, and therefore cheap, would have a comparative advantage in R&D intensive production. In this context the level of R&D in an industry, or at least the ranking with respect to R&D, is assumed to be the same in all countries. The relevant measure to classify industries as more or less research intensive would seem to be a world average of R&D costs.

The product cycle hypothesis is a dynamic version of this theory, where the R&D intensity for a certain product is not given but changes over the life cycle. Since the rate of turnover of technology is assumed to be high in the early stages of the cycle, product innovations will emerge in the most advanced countries, well equipped with R&D resources, whereas the production of mature products will gradually shift to less developed countries (Vernon 1966)[4].

On the other hand, in terms of the **neo–technology** or technology gap theories, trade flows in any particular product group will be influenced by the actual amount of R&D expenditure in each country, which will not in general be the same. Relatively larger R&D efforts may be expected to result in a technology gap that would give at least a temporary advantage for the innovating firm in producing and exporting its product. Depending on the rate of diffusion of new technology (the imitation lag) this situation may be more or less permanent. In this case, it is the **difference** between R&D intensities in the trading partners that matters.

A hypothesis that combines the neo–factor and the neo–technology approaches to R&D (cf Hughes 1986) could be formulated as

$$r = b_0 + b_1 f_w + b_2(f_s - f_w) \qquad (1)$$

where r is market position and f_s and f_w are the actual R&D intensities in the Swedish industry and the rest of the world. According to the technological gap hypothesis, the higher actual R&D expenditures in Swedish industry relative to those of the competitors, the stronger the Swedish market position ($b_2>0$). In the neo–factor framework, $b_1>0$ if Sweden has a comparative advantage in high–tech products.

When actually estimating equation (1) one could use any pair of the variables f_s, f_w and $(f_s - f_w)$. For instance, we may estimate

[4]Empirical tests of the product cycle hypothesis should be made on a very detailed product level, since industries often produce a mix of products in different stages of the life cycle.

$$r = \beta_0 + \beta_3 f_w + \beta_4 f_s \quad (1a)$$

From the estimates of β_3 and β_4 it is easy to derive the values of b_1 and b_2 in equation 1; we have that $b_2=\beta_4$ and $b_1=\beta_3 + \beta_4$

Equation 1 may, however, be specified somewhat differently. The level of R&D expenditure in an industry in a particular country will determine the rate of technical progress, and thus the growth rates of productivity and unit factor costs, in that country. If this is true, a high level of R&D in a certain industry in a country, relative to its competitors, implies a high rate of decline of relative costs, and thus a rapid improvement of international competitiveness for producers in that country. Accordingly, the difference between domestic and foreign R&D will influence Δr rather than r.

2.4 Changing comparative advantage and changes in patterns of trade and specialization.

The 1970s and early 1980s have witnessed shifts in relative international competitiveness and comparative advantage within the manufacturing sectors of the developed market economies (DCs). An important factor in this process has been the emergence of a group of newly industrialized countries (NICs). Exports from the NICs have been increasingly competing with producers in the DCs, both on their export markets and on their domestic market, particularly in mature industries.

The emergence of the NICs in world trade is likely to have shifted the pattern of comparative advantage within the manufacturing sector in the group of advanced market economies towards industries intensive in human capital, skilled labor and advanced technology, and away from activities using relatively much of unskilled labor. This proposition rests on the assumption that human capital and skilled labor are relatively scarce in the NICs compared to the DCs. If this is true, one should expect the changing patterns of international trade and competitiveness within the manufacturing industries of the DCs to be related to various production characteristics in a systematic fashion.

Consider a two factor multi–sector neo–classical model of a small open economy, where commodity prices are determined on the world market. Let the capital stock grow, at constant labor force, while conditions in the rest of the world are unchanged. Since commodity prices will stay constant, factor prices and factor proportions in all sectors will be unchanged, unless capital accumulation is large enough to cause the country to become completely specialized. Corresponding to the Rybczynski effect in the simple two–by–two model, we would expect that capital intensive industries **on average** will expand, whereas labor intensive sectors will decline, i.e that output changes will be positively correlated with capital intensities across industries (Ethier 1984). Since demand patterns do not change, there will be a positive correlation between capital intensity and the change in net exports.

Our hypothesis is thus that as a result of the emergence of the NICs in world trade, Sweden would appear to be still better endowed with capital, especially human capital, relative to the rest of the world, including NICs and LDCs, and unskilled labor would be still more scarce. The effect of this would be an increased international specialization in products intensive in human capital and skilled labor.

Let us define an index of international competitiveness or international specialization in sector i as

$$R_i = \frac{Q_i}{C_i} = \frac{C_i + X_i - M_i}{C_i} = 1 + \frac{X_i - M_i}{C_i} \qquad (2)$$

where C_i is domestic consumption, Q_i domestic production, M_i imports and X_i exports of the products of industry i. If the country is a net exporter in product group i, then $R_i > 1$. The higher R_i, the greater is net export relative to domestic consumption, and the stronger is the international specialization on the i:th product.[5]

We define relative international specialization as

$$r_i = R_i/R \qquad (3)$$

where $R = \Sigma Q_j/\Sigma C_j$ shows the balance of trade in all manufactures (if R<1 there is a deficit on the trade balance in manufactures). Thus we have that r_i is the index for international specialization in industry i, adjusted for the overall surplus or deficit in manufactured products.

Let us now formulate our hypothesis. We assume that

$$\Delta r_i = \beta_0 + \beta_1 h_i + \beta_2 k_i + \beta_3 f_{wi} + \beta_4 f_{si} \qquad (4)$$

where h_i measures human capital intensity or proportion of skilled labor in an industry and k_i physical capital intensity. The changes in relative Swedish factor endowments would imply that $\beta_1>0$, and possibly also that $\beta_2>0$. According to the technology gap hypothesis, $\beta_4>0$. Data on Swedish R&D intensity (OECD 1986) show that expenditure on industrial R&D in per cent of value added in Swedish manufacturing has increased strongly, both absolutely and compared to the U.S. (see figure 1), and is high compared to other countries. This suggest that in equation (1) $b_1>0$, that is, $\beta_3 + \beta_4>0$.

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[5]This measure was introduced by Ohlsson (1980) in his study of engineering exports. By re–writing equation 2 (omitting the index) we have that

$$R = 1 - \frac{M}{C} + \frac{X}{W}\frac{W}{C}$$

where W is world consumption. Thus R may increase (given that domestic and world demand grow at the same rate) either by increasing domestic market share or through a rise of the export market share. R differs from the concept of "revealed comparative advantage" as defined by Balassa (1965) as relative export performance, i.e a country's share of world exports of a product relative to its share of world exports of all goods, by taking account of the domestic market.

The usual approach to the statistical analysis of trade patterns is a pure cross–section analysis where data for market position r_{it} for a given year are regressed on data for the explanatory variables x_{it} for the same year. The equation may be written

$$r_{it}=\alpha+\beta x_{it}+u_{it} \qquad (5)$$

where u_{it} is a random error term representing the influence of industry specific factors on the market position.

This equation assumes that actual trade data reflect an equilibrium position. However, the actual production structure, and thus the industrial pattern of net trade, r_{it}, will not adjust instantaneously to changes in factor endowments. In reality, restructuring may take a very long time. To allow for inertia in the adjustment process, we may use a model of partial adjustment, which could be formulated as

$$r^*_{it}=\alpha+\beta x_{it}+u_{1it} \qquad (6a)$$

$$r_{it}-r_{it-1}=\gamma(r^*_{it}-r_{it-1})+u_{2it} \qquad 0<\gamma<1 \qquad (6b)$$

where r^*_{it}, the equilibrium market position, is determined by the combination of relative factor endowments in the trading countries at time t and relative factor requirements by industries x_{it}. Inserting (6a) into (6b) we have

$$r_{it}=\alpha\gamma+\beta\gamma x_{it}+(1-\gamma)r_{it-1}+\gamma u_{1it}+u_{2it} \qquad (7)$$

We have argued that the relative factor endowments in Sweden may have changed during the period 1969–1984. The hypothesis we want to test is that **changes** in output, and thus in market position, are related to capital intensities across industries, or in other words that capital intensive industries have improved their market position.

$$\Delta r_i = r_{it} - r_{it-1} = \beta_0 + \beta_1 h_i + \beta_2 k_i + \beta_3 f_{wi} + \beta_4 f_{si} + u_i \qquad (8a)$$

However, this may be written

$$r_{it} = \beta_0 + \beta_1 h_i + \beta_2 k_i + \beta_3 f_{wi} + \beta_4 f_{si} + \gamma r_{it-1} + u_i \qquad (8b)$$

where $\gamma=1$. This equation is identical to equation (7). Changes in the trade pattern during the period 1969–1984 may thus reflect both lagged adjustments to previously existing patterns of comparative advantage, and adjustments to changing factor endowments during the period. A value of e.g $\beta_1 > 0$ implies that r in period t, given the initial value in period t–1, is high, i.e that is has increased, for observations with high values of h.

2.5 Data, estimations and results.

The dependent variable r_t is the index of relative international specialization in 1984 as defined in equations (2) and (3). The same variable in 1969, r_{t-1}, was included as an independent variable. Trade and production data for 1983 were available for 76 industries at the 4 digit level of the ISIC. All variables take the form of ratios; market shares, factor intensities, cost shares etc. The concepts of human, physical and total (i.e human plus physical) capital intensity are all defined as flow concepts. Physical capital intensity (k) is measured by the amount of value added minus wages per employee. This assumes that returns to capital are equalized across industries.

If differences in skills and amount of embodied human capital are reflected in wage differentials, the average wage in an industry can be used as an index of the stock of human capital per worker (h). Provided that physical as well as human capital earns the same return in all sectors, one may use value added per employee as a measure of total, human plus physical, capital intensity. Here we actually use its inverse, i.e labor requirements per million SEK of value added (a). Unless otherwise specified all data are from the Swedish industrial statistics.

Data for R&D expenditure are only available on a more aggregated level than the other data: in Sweden for 24 sectors, and for 11 OECD countries for 21 sectors (OECD 1986). An average figure for the corresponding sector thus had to be used for the R&D intensity variables (f_s, f_o) in most cases for industries on the 4 digit level. This means that the full variation in the R&D variables will not be taken into account in the regression analysis, and that the results must be interpreted with care.

In a regression analysis across industries one should use R&D intensity (the share of R&D expenditure of value added) rather than R&D in absolute terms, to adjust for differences in industry size (Deardorff 1984). On the other hand, using the difference in R&D intensities as an indicator of the direction of change in international competitiveness neglects economies of scale in R&D. If scale economies are large enough, R&D induced productivity growth could actually be higher, and thus the competitive position improve, in a large producing country relative to a small one, even if the R&D intensity is lower in the large country.

The three capital intensity measures, for human (h), physical (k) and total (a) capital, are strongly correlated, which could be expected (Hufbauer 1970). The R&D variables are also correlated, though not quite as strongly. Since measurement errors are likely to be magnified for the difference $f_s - f_o$, we have used the original variables f_s and f_o (cf equation 1a). The R&D variables are not correlated with the capital intensity variables.

The results of estimating various versions of the basic regression equation (8b) are shown in table 1. t–values adjusted for heteroscedasticity using White's (1980) estimator of the covariance matrix are indicated by [], while those obtained by conventional OLS are shown in ().

TABLE 1

Regression coefficients for the determinants of relative international specialization in Swedish manufacturing industries 1984.

Dependent variable r(1984)
Independent variables:

r(1969)	labor requir.	human capital	physical capital	Swedish R&D	OECD R&D	$\bar{R}^2$
.858 (11.94) [14.63] ***	–.134 (–2.13) [–2.14] **				–.003 (–.47) [–.39]	.676 (51.16)
.852 (12.14) [15.59] ***	–.130 (–2.12) [–2.11] **			.021 (2.12) [2.34] **	–.014 (–1.64) [–1.29]	.691 (42.96)
.850 (12.06) [15.12] ***		.0052 (2.09) [2.27] **		.019 (1.92) [2.29] **	–.019 (–2.13) [–1.84] *	.691 (42.85)
.890 (12.70) [15.20] ***			.0002 (1.98) [4.47] ***	.023 (2.30) [2.59] ***	–.014 (–1.61) [–1.29]	.689 (42.47)
	DUM					
.791 (10.70) [11.85] ***	.286 (3.09) [3.16] ***		.0003 (2.21) [4.93] ***	.027 (2.84) [2.88] ***	–.013 (–1.54) [–1.28]	.722 (39.95)

Table 1 shows that the index of relative international specialization seems to be very stable, even for such a long period (15 years) as is used in this paper. This is shown by the strongly significant value of the coefficient for r(1969) in all equations.

The negative and significant value for the coefficient for labor requirements per million SEK of value added means that the international market position, given the intial value in 1969, tends to be high in 1984, i.e it has improved in 1969–84, for industries with high values of total – human plus physical – capital intensity, as measured by value added per employee. This supports our hypothesis about the changing structure of comparative advantage in world trade.

By decomposing value added into wages and gross profits we can test if human or physical capital intensity or both has affected the specialization index. As shown in table 1, the market position seems to have improved for industries that are intensive in human capital, as well as for those intensive in physical capital. The coefficients for average wage and gross profit per employee are both positive and significant when separately included into the regression; when used simultaneously they are not, because of multicollinearity[6].

There is a possibility that the significant effect of physical capital intensity in the regressions simply reflects an increasing specialization in the processing of domestic natural resources. To take account of this a dummy variable was included in the regression such that DUM=1 for all forest based industries. According to table 1 it is indeed true that there has been an increasing specialization in forest based industries. However, the coefficient for gross profits per employee is still strongly significant.

From the first equation in table 1 it seems that we are not able to establish any clear effect of R&D expenditure whatsoever on the market position. However, we have argued that according to the 'neo–technology' theories, international competitiveness in an industry will be affected not only by the degree of technical sophistication of the industry in general, but also by the amount actually spent on R&D relative to competitors.

The estimated coefficients in table 1 may be interpreted in terms of equations (1) and (1a). The coefficient for Swedish R&D, β_4 in equation (8b), equal to b_2 in equation (1), the coefficient for the effect of R&D expenditures **relative** to competitors, is positive and significant (on the 5% level or higher) in all equations. This supports the simple technology gap hypothesis: the higher

[6]Exclusion of one variable means, of course, that the coefficient for the other will be biased. Thus it is not possible to answer the question whether specialization has increased in industries with a high value added per employee because such industries are intensive in human or physical capital.

actual Swedish R&D expenditures, **given** the R&D expenditures by competitors, the stronger is the improvement of the market position from 1969 to 1984.

On the other hand, the hypothesis that the Swedish economy, because of abundant and/or cheap facilities for producing R&D, should have a comparative advantage in R&D intensive industries, or that the market position has improved in such industries, is not confirmed by the results. This hypothesis implies (cf equations 1 and 1a) that $b_1 = \beta_3 + \beta_4 > 0$, where β_3 and β_4 are the coefficients for R&D in OECD and in Sweden. This was tested by reestimating the equations in table 1 with the restriction that $\beta_3 + \beta_4 = 0$ (which represents the null hypothesis). An F test of the change in the residual sum of squares indicates that the null hypothesis cannot be rejected for any of the equations. Thus there is no evidence that Swedish industry has improved its market position in high technology sectors.

3. The "new" theories of international trade.

3.1 Economies of scale and product differentiation as determinants of international specialization.

How important is the principle of comparative advantage for explaining the structure of Swedish trade and specialization? Part of the answer to this question is given by the proportion of the total variation in the specialization index r that is left unexplained by variables measuring factor requirements of industries and the initial value of the index. According to table 1 this proportion is around one third, even when the initial specialization pattern is taken into account. Thus it seems that indicators of factor requirements can only give a very general explanation of the basic pattern of international specialization; we cannot hope to explain this pattern in all its details.

There are two important facts about Swedish trade that do not fit well within the standard theories of comparative advantage. Contrary to the predictions of such theories that the largest trade flows should occur between countries which differ with respect to resource endowments, the major proportion of Swedish trade (80% of exports in 1985) consists of trade with other developed market economies.

Moreover, a large and increasing part of the Swedish foreign trade consists of an exchange of "the same products", i.e the simultaneous import and export of the same product group, even at very detailed levels of classification. Let us define gross trade G_i, net trade N_i and intra–industry trade I_i in a product group i as $G_i = X_i + M_i \quad N_i = |X_i - M_i| \quad I_i = G_i - N_i$ (9)

where X_i and M_i are exports and imports. The intra–industry proportion of a country's total foreign trade (Grubel & Lloyd 1975) is

$$I = 1 - \frac{\Sigma|X_i - M_i|}{\Sigma(X_i + M_i)} \qquad (9a)$$

In a study of Swedish trade in a long run perspective, Petersson (1984) has shown that the share of Swedish foreign trade accounted for by intra–industry trade has been increasing steadily from the late 19th century. Measured at the most detailed level of industrial classification, the 6 digit SNI, about two thirds of total Swedish trade in manufactures is intra–industry trade (Hansson 1989). Intra–industry trade is most frequent with other developed economies, in particular with EEC and EFTA countries, where trade in manufactures is free from tariffs, but it has increased strongly in trade with the NICs.

Table 2. The share of intra–industry trade in Swedish manufacturing trade with selected country groups in 1970 and 1983. Per cent.

	1970	1983
EEC + EFTA	60.1	71.2
Other developed countries	48.1	48.2
Centrally planned economies (Europe)	29.8	22.2
Asian NICs	5.2	25.4
Other developing countries	7.4	11.0

Source: Hansson (1989). The grouping of countries follows the Swedish trade statistics. Asian NICs include Hongkong, Macao, Taiwan, Republic of Korea and Singapore.

To some extent this kind of trade may be explained within the paradigm of the "traditional" trade theory by categorical aggregation of products with different factor requirements. Even if it is true that there is large variation within industries with respect to factor requirements among products (Finger 1975), it seems scarcely possible to explain **all** intra–industry trade in this way. Thus it seems that new theoretical developments were in fact required.

The "new" theories of international trade that emerged in the late 1970s differ from the "traditional" theory mainly by introducing imperfect competition. This is done by taking account of economies of scale and product differentiation, horizontal or vertical[7]. Consumer preferences may be modelled either as containing a preference for variety among products available in the market (Dixit & Stiglitz 1977) or such that each consumer prefers a certain product specification (Lancaster 1979). In combination with economies of scale this leads to a situation where a number of firms, determined by the size of the market, are engaged in monopolistic competition, selling products that are close but not perfect substitutes (Krugman 1979).

In such models trade will occur even if costs are the same in the trading countries (Krugman 1979). This trade, which is purely intra–industry trade, is driven by differentiation in demand, in combination with economies of scale on the supply side, and not by comparative advantage[8].

The assumption of differentiated products and monopolistic competition may be introduced into the neo–classical production framework by separating the economy into two sectors, one producing a homogeneous good, the other differentiated products (Lancaster 1980, Dixit & Norman 1980, Helpman 1981). In this model there may be inter– as well as intra–industry trade. The more

[7]Intra–industry trade may occur even in homogeneous goods, as a result of oligopolistic competition in segmented markets (Brander 1981). However, casual observation suggests that in most manufactured goods markets the role of product differentiation cannot be neglected.

[8]Though intra–industry trade in investment goods and intermediate products is as common as in consumer goods (Culem & Lundberg 1986), most if not all models based on product differentiation describe markets for consumer goods.

factor endowments of the trading countries differ, the less will be the proportion of intra–industry trade.

These models predict international specialization of production, in the sense that certain product varieties are produced in one country and others in another, but they cannot predict which country will export a particular product. Such predictions may be obtained in models with vertical product differentiation by assuming either that one country has a comparative advantage in higher quality goods (Flam & Helpman 1987), or that higher quality goods are produced by more capital intensive methods (Falvey & Kierzkowski 1987). The country where capital is abundant – "the North" – will have a comparative advantage in high quality products, which are exported to "the South" in return for cheaper products of lower quality.

It is natural to assume that the quality demanded is a function of consumer income. The role of demand in explaining trade patterns was emphasized already by Burenstam–Linder (1961). Since local demand usually is a precondition for production, and foreign demand for exports, it follows that large trade flows will occur between countries with the same level of per capita income, and thus with overlapping demand patterns. This, in a sense, contradicts the prediction of the traditional theory that trade flows will be larger the more different countries are with respect to factor endowments, since income per capita will be positively correlated with the stocks of human and physical capital per employee.

Most of the "new" models of trade do not predict trade patterns across industries. However, such predictions may be obtained by introducing product differentiation of a very simple kind into a neoclassical multi–sector model of trade between countries with different factor prices (cf Deardorff 1979). If products of different origin are not identical (cf Armington 1969), there will be intra–industry trade even in product groups where costs and prices differ, as well as net trade. However, the intra–industry share of trade will be low in industries with extreme factor requirements, i.e very labor intensive and very capital intensive goods. Because of the large differences in cost and prices for products of different origin, there will mostly be net trade and inter–industry specialization in such sectors. Intra–industry trade will occur mostly in sectors with intermediate capital intensity. Given international cost differences, intra–industry trade will be larger, the lower the elasticity of substitution among products in an industry, i.e the higher the degree of product differentiation (Lundberg 1988, Hansson 1989).

3.2 The country pattern of Swedish trade.

With what kind of countries does Sweden trade? Which trade theory – if any – is capable of explaining the country pattern of trade? These questions will be addressed in this section, using data for Swedish trade in manufactures in 1983 with 78 countries for which data on the explanatory variables were available.

Gross trade (G) in manufactures with each country – the sum of exports and imports – has been separated into net trade (N) and intra–industry trade (I) according to equations (9) and (9a). The reason is that we expect intra–industry trade to be caused by different factors than net trade. The characteristics of the trading countries that generate large intra–industry flows are not necessarily the same as those that generate net trade.

Our model is a simple extension of the basic gravity model of trade (Tinbergen 1962, Linnemann 1966). We assume that the gross trade flow between two countries varies in proportion to the size of the countries and inversely with transaction costs. Size may be measured by population (L) and per capita income (y), and transaction costs approximated by geographic distance (d).

$$G = AL^{\alpha}y^{\beta}d^{\gamma} \qquad (10)$$

where $\alpha>0$, $\beta>0$ and $\gamma<0$.

The basic gravity factors – size and distance – are assumed to affect both N and I, the components of G. However, in the spirit of the traditional theory we assume that Swedish net trade is larger, the more factor endowments of the trading partner differ from the world average (i.e the average of the countries in the sample, cf Lundberg & Hansson 1987). According to the "new" trade theories we would expect large amounts of trade, mainly of the intra–industry kind, among countries on the same level of per capita income. Moreover, the

Burenstam Linder theory predicts that the largest trade flow will occur among such countries. Since per capita income may be used as a proxy for the stock of human and physical capital per capita, we expect I to vary negatively, and N positively, with the absolute value of the per capita income difference between Sweden or the world and each trading partner.

$$N = AL^{\alpha}d^{\gamma}|y - y_w|^{\delta} \quad (11)$$

$$I = AL^{\alpha}d^{\gamma}|y - y_s|^{\rho} \quad (12)$$

where, as before, $\alpha>0$, $\gamma<0$, and we expect that $\delta> 0$ and $\rho< 0$.

Table 3. Regression coefficients for the determinants of Swedish trade with a sample of countries in 1983.

dependent variable	independent variables log L	log y	log d	$\log\|y - y_s\|$	$\bar{R}^2$
log G	0.94 (12.7) ***	1.13 (12.1) ***	–0.64 (–5.6) ***		0.83
log N	0.72 (6.5) ***		–1.01 (–6.8) ***	0.28 (1.5) *	0.57
log I	1.37 (8.3) ***		–1.29 (–4.0) ***	–2.94 (–5.6) ***	0.64

Notes. t value of coefficients in (). * significant on 10%, ** on 5% and *** on 1% level. In the second equation y_w was used instead of y_s.

According to table 3, Swedish trade in manufactures tends to be larger, the larger the trading country (L) and the shorter the geographic distance (d). This holds for gross trade as well as for net and intra–industry trade. However, intra–industry trade seems to be more sensitive both to size and distance. Gross trade increases with the level of per capita income in the trading country. These results are, of course, consistent with the simple gravity model. The distance variable might capture other factors than transport costs, such as cultural differences that causes consumer tastes to be different.

Intra–industry trade seems to decrease with the absolute size of the difference in per capita income between Sweden and the trading partner. This result confirms the Burenstam Linder theory, if equality of income level is a proxy for overlapping demand. It is also consistent with the Lancaster (1981) and Helpman (1981) type of model, where intra–industry trade will be large between countries with similar factor endowments, since per capita income is also a proxy for capital stock per capita. On the other hand, net trade shows a tendency to **increase** with the absolute deviation in per capita income of the partner country from the world average, though the coefficient is not significant. Thus there is some weak support for the "traditional" theory as well.

3.3 Determinants of the product and industry pattern of intra–industry trade.

Which factors can explain why intra–industry trade is more frequent in some industries and product groups than in others? This issue is addressed here by means of a cross–industry regression analysis. As the dependent variable we use (cf Grubel & Lloyd 1975)

$$z_i = 1 - \frac{|X_i - M_i|}{(X_i + M_i)} \qquad (13)$$

the intra–industry proportion of gross trade in a product group.

The first study of Swedish intra–industry trade was made by Ohlsson (1974, 1975, 1980). Based on an assumption that export unit values reflect the quality of vertically differentiated products, Ohlsson concluded that the Swedish engineering industry was specialized in 1970 in high quality products. Though this study was not based on an explicit model, the results may be interpreted in the context of the models of Falvey and Kierzkowski (1987) and Flam and Helpman (1987).

Later studies have mostly addressed the question why there is more intra–industry trade in some industries than in others, without going into the question of which country exports which products. The hypothesis that the proportion of intra–industry trade is high in industries where products are differentiated has been confirmed by results from these studies (Lundberg 1982, Gavelin & Lundberg 1983).

We will develop the relationship between inter– and intra–industry trade, factor proportions and product differentiation in a simple trade model, based on the standard neo–classical two–factor multi–sector production framework (Deardorff 1979) together with the assumption that products are differentiated by place of production (Armington 1969). The model is presented in figure 2.

Let A and B be two countries with fixed supply of two factors of production, labor L and capital K, which are perfectly mobile within but not among countries. There are 5 sectors or industries, each producing a homogeneous good under constant returns to scale. Perfect competition prevails in all markets, and production functions are identical in A and B.

We assume now that A and B are trading but, for some reason, relative factor prices in equilibrium are not equalized; we assume that $w_A > w_B$, where w is the wage/capital rental ratio. The slopes of the isocost lines AA and BB in figure 2 reflect the factor price ratios.

In the example, the costs of goods 1 and 2 are higher in B than in A. If goods produced in A and B are identical, goods 1 and 2 will be produced only in A; country B will import 1 and 2, and export 4 and 5, good 3 being produced by both. Obviously there will be only net trade and no intra–industry trade.

Let us assume instead that a certain good produced in A is a close but not perfect substitute for the same good produced in B. In that case, all products may well be produced in both countries, even if costs and prices differ. Expensive products such as good 1 produced in B or good 5 produced in A will still be demanded in both countries, though in small amounts.

It can be shown (Hansson 1989) that the relative unit costs and prices of products from A and B in a certain industry, on the assumption of Cobb–Douglas technology, depend only on relative factor prices in A and B and on the capital intensity of the industry. In industries with intermediate capital intensity, costs and prices will tend to be equal in A and B, and the market in both countries will tend to be shared equally. This means that exports of A and B in that product group will tend to be equal, i.e there is mostly intra–industry trade (z_i approaches one). On the other hand, in sectors with very high (good 1) or very low (good 5) capital intensity, price and cost differences between products from A and B will be substantial, and trade will be dominated by net trade. Given the price differences, the market share of products from A and B will be more equal, and thus the proportion of intra–industry trade higher, the more differentiated the products are (Hansson 1989).

This hypothesis will be tested on trade data for Swedish manufacturing industries on the lowest level of the industrial statistics (158 industries) in 1983. The energy intensity (e), power of machinery per employee, and the proportion of technical personnel in the labor force (t), were used as measures of physical and human capital intensity. The proportion of sales personnel in the labor force (s), and the unit value of exports (u), were used to reflect product differentiation. This was based on the assumptions that sales and marketing efforts are higher for differentiated products, and that products with low unit values are mainly semi–manufactures with a high raw material content. The non–linear relationship between intra–industry trade and factor proportions could be described by a second degree polynomial or by the absolute deviations from the mean.

However, the variables e and t may not only represent cost differences, but also reflect the degree of product differentiation. A high value of e will occur in highly mechanized process industries, such as paper or steel, with a rather homogeneous output, where net trade dominates. The t variable may reflect a high stock as well as a high rate of turnover of technical knowledge. Since new technology resulting from R&D efforts by a firm is available only for that particular firm, and since parallel R&D activities by different firms will most likely result in different technical solutions and thus in differentiated products, there will be a large potential for intra–industry trade.

The equations estimated, together with the expected signs of the coefficients, are given below.

$$\log z = a_0 + a_1 \log e + a_2(\log e)^2 + a_3 \log t + a_4(\log t)^2$$
$$+ a_5 \log s + a_6 \log u \qquad (13a)$$

$a_1 > 0,\ a_2 < 0,\ a_3 > 0,\ a_4 < 0,\ a_5 > 0,\ a_6 > 0$

$$\log z = b_0 + b_1 \log e + b_2 |\log e - \log \bar{e}| + b_3 \log t + b_4 |\log t - \log \bar{t}|$$
$$+ b_5 \log s + b_6 \log u \qquad (13b)$$

$b_1 < 0,\ b_2 < 0,\ b_3 > 0,\ b_4 < 0,\ b_5 > 0,\ b_6 > 0$

Table 4. Determinants of the share of intra–industry trade of the gross trade of Swedish manufacturing industries in 1983.

log e	(log e)^2	log t	(log t)^2	log s	log u	$\bar{R}^2$
. 424	–.145	1.55	–.185	.154	.101	.447
(3.18)	(–5.04)	(4.99)	(–4.15)	(2.83)	(2.32)	
/3.67/	/–4.68/	/2.54/	/–2.27/	/2.13/	/1.98/	
***	***	***	**	**	**	
–.147	–.354	.226	–.226	.173	.106	.388
(–1.99)	(–4.29)	(3.62)	(–1.96)	(3.07)	(2.32)	
/–1.89/	/–4.05/	/2.75/	/–1.13/	/2.36/	/2.09/	
**	***	***		***	**	

t–values of coefficients according to OLS in (), t–values adjusted for heteroscedasticity (White 1980) in //.* coeffient significant on 10%, ** on 5% and *** on 1% level. In the second equation $|\log e - \log \bar{e}|$ and $|\log t - \log \bar{t}|$ are substituted for $(\log e)^2$ and $(\log t)^2$.

According to table 4, industries with a high proportion of sales personnel and a high unit value of exports have a high proportion of intra–industry trade. There seems to be little intra–industry trade in industries where the energy intensity and the share of technicians in labor force deviates strongly from the average (though in the case of the t variable the coefficent is not significant). Alternatively, the relationship between factor proportions and intra–industry trade may be described by a second order polynomial where the first order term is positive and the second negative. Thus the results confirm the hypothesis that intra–industry trade occurs mainly in industries with intermediate factor proportions and where products are differentiated.

4. Summary and conclusions.

Which theories can explain the structure of Swedish international trade and specialization? There seems to be no single model, emphasizing a limited set of factors, that is capable of explaining historical as well as current trade and specialization patterns in all details. Instead, different models, stressing different factors, must be applied to different sectors and types of goods. These models may be seen as complementary rather than conflicting. However, there seems to have been changes in the relative importance of such models over time.

In the early stage of industrialization, Swedish exports were dominated by raw materials, and later by semi–processed goods based on domestic natural resources. Though the share of resource based products of total exports has been declining, Ricardian and "availability" theories still have a role to play.

The post–war changes in the structure of Swedish trade and specialization in manufactured products indicate a trend towards increasing comparative advantage, first in (physical) capital intensive production, and later towards products intensive in human capital and skilled labor. This stresses the explanatory role of national factor endowments within a neo–classical, Heckscher–Ohlin framework.

In this paper, the pattern of changes in international specialization within the Swedish manufacturing industry in 1969–1984 was examined in order to test the hypothesis that international specialization changed in 1969–1984, as a consequence of changes in comparative advantage. It was found that the market position of Swedish producers improved in capital intensive industries; this was true for industries intensive in human capital as well as in physical capital. This indicates that the comparative advantage of the Swedish economy may have shifted during the period towards capital intensive products, and away from sectors intensive in the use of unskilled labor.

The results confirmed the 'technology gap' hypothesis that a high level of R&D expenditure in Sweden, relative to competitors, improved the Swedish market position. On the other hand, no indication was found of an increasing international specialization for Swedish producers in R&D intensive goods as such.

Thus differences in factor endowments seem to contribute to the explanation of the pattern of net trade and specialization according to the principle of comparative advantage. However, as shown in this paper, the country pattern of Swedish trade is explained by similarities of demand as well as by differences in resource endowments and relative costs. Furthermore, a large and increasing part of trade is intra–industry trade – i.e. exchange of "the same products" – which indicates that other explanations are required. Empirical studies show that a preference for variety in demand, in combination with economies of scale, may be important in this respect.

The conclusion that the "old" and "new" theories may be complements rather than substitutes is confirmed by the results of an examination of the product pattern of intra–industry trade. It appears that the intra–industry share of gross trade depends both on the degree of product differentiation within the product group and on relative costs as determined by factor endowments.

What kind of theoretical framework would be needed for a better understanding of Swedish trade and international specialization? It seems that such a framework would have to include the phenomenon of firm specific knowledge. Since such knowledge is increasingly internationally mobile, this means that it is necessary to incorporate foreign direct investment and production into the analysis of trade. The result would be a theory where a combination of competitive advantages of firms and comparative advantages of countries determines the structure of production, localization and ownership.

Furthermore, it seems that it would be necessary to incorporate a more realistic description of technological development into the models for competition and trade. This means that a dynamization of the theory as well as analysis on the level of the firm would be necessary.

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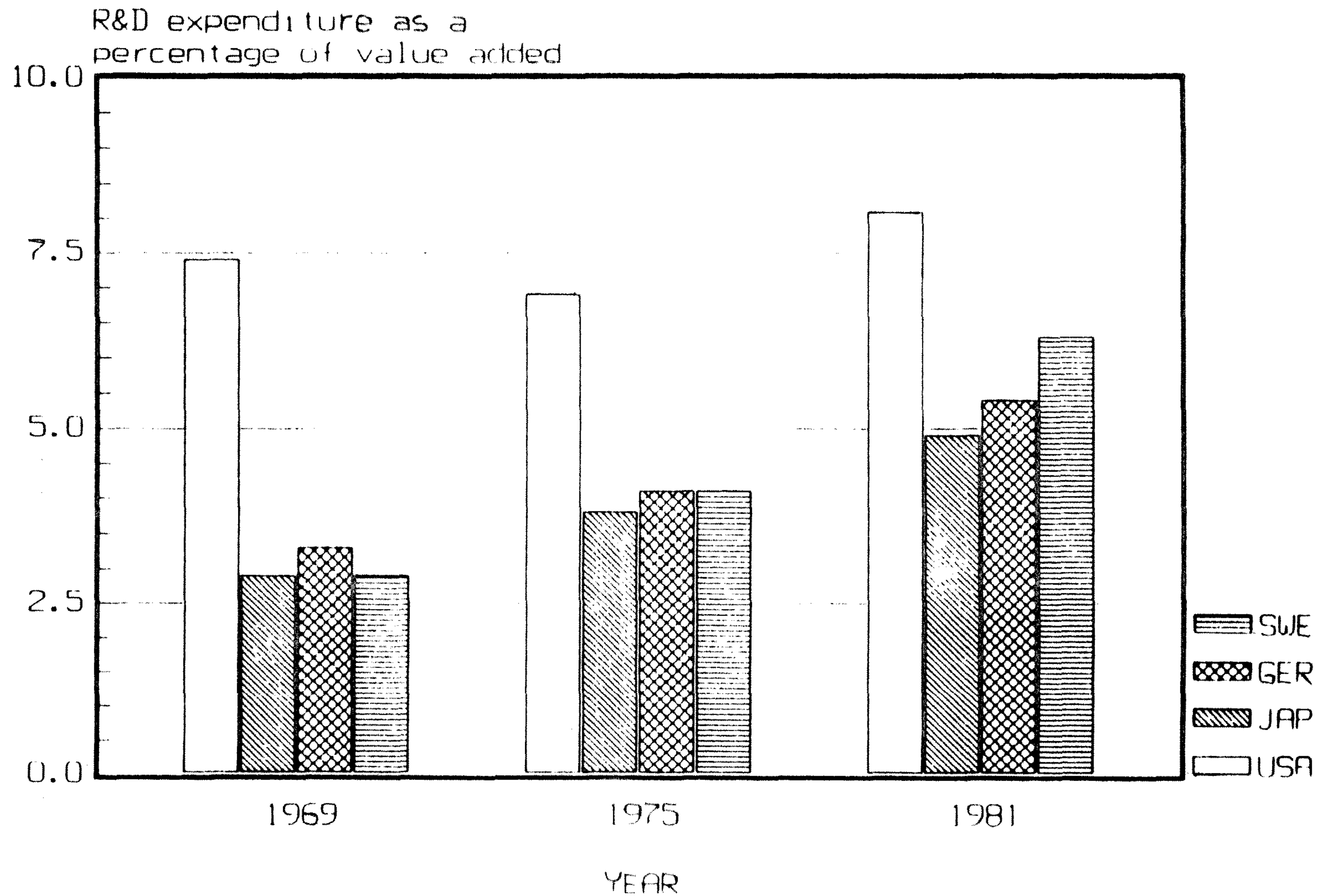
Figure 1



Source: OECD (1986)

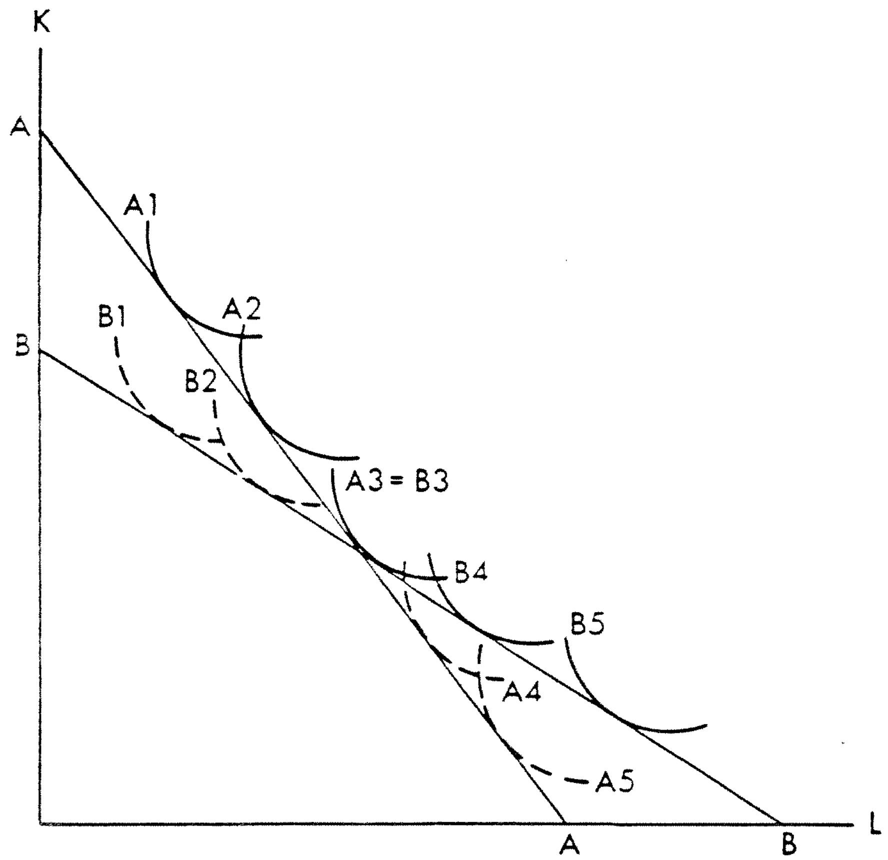


Figure 2