Weiss, Frank Dietmar; Wolter, Frank

Machinery in the United States, Sweden and Germany: An assessment of changes in comparative advantage

Kiel Working Paper, No. 23

Kieler Arbeitspapiere
Kiel Working Papers

Working Paper No. 23

Machinery in
the United States, Sweden, and Germany -
An Assessment of Changes in Comparative
Advantage

by

Frank Weiss and Frank Wolter

Institut für Weltwirtschaft an der Universität Kiel

Kiel Institute of World Economics

Department I

2300 Kiel, Düsternbrooker Weg 120

Working Paper No. 23

Machinery in the United States, Sweden, and Germany - An Assessment of Changes in Comparative Advantage

by

Frank Weiss and Frank Wolter

September 1974

Machinery in the United States, Sweden, and Germany - An Assessment of Changes in Comparative Advantage

by

Frank Weiss and Frank Wolter*

Introductory Remarks

1. Since the early sixties traditional machinery suppliers, almost exclusively located in highly advanced economies, have been subject to considerable adjustment pressures. Among the most important causes, firstly, was the increasing international penetration of markets among traditional machinery suppliers; secondly, Japan emerged as a vigourous competitor; and thirdly, a number of semi-industrialized countries established mechanical engineering industries of their own which in certain activities even proved capable of successfully competing on the world market. As these events have affected and still affect the international division of labour in the machinery industry, the future rôle of machinery in highly advanced economies may become somewhat uncertain, particularly as the establishment of machinery industries in developing countries continues. In order to obtain an understanding of implications for the high-income countries, we shall focus on the recent development of machinery in the United States, Sweden, and the Federal Republic of Germany. These countries have been selected for investigation because they belong to the most advanced economies in the world but differ in the size of their domestic market and in their structure of production. Analyzing these countries, the purpose of this paper is firstly, to specify determinants of location for the machinery industry as a whole, and secondly to identify individual branches of machinery, if any,

---

*This paper reports research undertaken in the "Sonderforschungsbereich Nr. 86, Weltwirtschaft und internationale Wirtschaftsbeziehungen (Kiel/Hamburg)", with financial support provided by the Deutsche Forschungsgemeinschaft. The paper is a contribution to project IH "Anpassungsprozesse in Industrieländern als Folge der Industrialisierung der Entwicklungsländer" (Director of Project: Prof. Dr. Gerhard Fels). The authors would like to thank Christel Hartz for doing the calculations and Anne-Marie Heissel for typing the manuscript.

in which these highest-income countries are tending to lose their competitiveness. In part I a multi-country cross-section analysis is undertaken to determine a "normal pattern" of development for the machinery industry. For the United States, Sweden, and Germany deviations from this normal pattern are used to diagnosticize country-specific idiosyncracies. Besides this, the normal pattern itself has useful prognostic properties. Part II discusses some determinats of location. Changes in relative factor absorption, as well as economies of scale and national idiosyncracies are examined for their implications on the high-income countries as advantageous locations for the machinery industry. Part III applies the concept of revealed comparative advantage to 36 sub-industries of machinery.

The Pattern of Development

2. Mechanical engineering seems to constitute one of the dynamic sectors of the world economy. This statement is confirmed by recent estimates of the Verein Deutscher Maschinenbauanstalten (VDMA), although systematic information about world production about machinery products does not exist. Between 1966 and 1971, according to this source, world real production of mechanical engineering products increased by 7.0 p.c. annually compared to a 4.5 p.c. increase in manufacturing production[1]. What are the roots of this relatively rapid expansion?

   a) The remarkable quick rehabilitation and growth experienced by almost all advanced western economies after World War II by itself created a booming demand for machinery products as mechanical engineering is an important investment input-sector for all industrial activities and, to a lesser extent, for agriculture. In the course of development mechanical engineering industries were especially favoured by a gradual shift in relative factor prices which occured within these countries since labour markets became tight while the elasticity of capital supply increased. The distinct rise of real

---

1 See VDMA, Weltmaschinenproduction. "Wirtschaftsbild", Frankfurt, 1973, p. 1.

wages relative to real rates of interest caused by this development increasingly forced entrepreneurs to substitute labour by capital goods[1].

b) A second factor contributing to the growth of mechanical engineering concerns the developing countries. The disruption of traditional trade ties with developed areas during World War II for many of these countries was the starting point for vigorous industrialization efforts. The need for machinery equipment which ensued from these efforts opened up a further avenue of growth for world machinery. The demand from developing countries added the more to this growth as industrial output of these countries became more "machinery intensive" than would have been necessary and presumably expedient economically had they exploited their abundant endowment with unskilled labour more intensively. The modernization of the agricultural sector in developing countries meant another market for engineering products.

c) To the extent that the machinery industry can accelerate the pace of innovation, it can create demand for its own supply. Market forces tend quasi-automatically to diffuse new techniques embodied in engineering equipment (with higher total productivity) since new machines largely raise productivity and lower costs. The qucker such technological progress in engineering products the shorter is the economic life-cycle of a given engineering product at given output and relative factor prices.

To sum up, the increasing scarcity of unskilled or lowskilled labour in advanced economies, the industrialization an agricultural development efforts in developing countries and built-in dynamics in machinery seem to be the major factors having determined the expansion path of mechanical engineering.

3. The world's most important suppliers of machinery products (excluding socialist countries) are listed in Table 1; in 1971,

---

1 It is true that in Western Europe the labour-drain from Mediteranean countries smoothened this process compared to what otherwise would have been the case.

these countries are estimated to account for approximately 70 p.c. of total shipments (including socialist countries) in mechanical engineering[1,2]. The dominance of the United States' machinery industry and Germany's strong export position clearly stand out, while Sweden maintains a minor position in the world market[3]. The following items worth mentioning can be derived from Table 1:

a) The rapid expansion of real production (para 2) was accompanied by a rapid increase in shipments. Throughout the observation period the average annual increase in shipments for all countries listed amounted to 8 p.c.; the variation of growth rates, however, is quite substantial[4].

b) Except in the case of the United States and Japan, shipments of engineering products depend heavily on export markets. Not surprisingly, export markets tend to be the more important the smaller the domestic market: An inverse rank correlation between the export to sales ratio and the domestic market as measured by population size reveals a Spearman coefficient of 0.60.

c) Without exception, mechanical engineering exports expanded more quickly than shipments. This indicates an increasing integration of the markets of the countries listed in Table 1, certainly influenced by the Kennedy Round, which is still more marked than it seems: A regional break-down of these countries' machinery exports shows that between 1960 and 1971 the share going to Comecon-countries remained almost constant (about

---

1 See VDMA, Weltmaschinenproduktion, op. cit.

2 The machinery sector of developing countries is still very small. For an appraisal see Exports of Engineering Products from Selected Industrializing Countries. "International Trade 1968". Geneva, 1969, pp. 61 sqq.

3 In terms of sales per capita the rank, however, is quite different. In 1971, Germany is first (307 US-$) followed by Switzerland (293 US-$), the United States (284 US-$) and Sweden (278 US-$).

4 As all figures are converted in US-$ by official exchange rates the rates of growth are influenced by parity changes. In terms of national currencies the rates of growth, e.g. for the United Kingdom and France, are understated whereas the respective rate for Germany is overstated.

Table 1 - Shipments and Exports of Mechanical Engineering Products of Selected Industrialized Countries in 1960 and 1971 (Mio.U.S.-$)

Country[a]	1960			1971		
	Shipments	Exports	p.c. Exports / Shipments	Shipments	Exports	p.c. Exports / Shipments
United States	31 620	3 300	10.4	58 830	8 088	13.7
Japan	2 919	208	7.1	20 850	2 303	11.0
Germany	6 013	2 211	36.8	18 825	8 352	44.4
United Kingdom	6 843	1 687	24.7	11 150	4 208	37.7
France	2 414	562	23.3	6 039	2 489	41.2
Italy	1 415	518	36.6	3 350	2 488	74.3
Sweden	1 204	316	30.0	2 250	1 305	58.0
Switzerland	636	423	66.5	1 845	1 384	75.0
Canada	726	168	23.1	1 811	752	41.5
Netherlands	572	197	34.4	1 375	899	65.4
Belgium-Luxembourg	298	171	57.4	1 132	791	69.9
Denmark	323	156	48.3	726	533	73.7
Austria	279	94	33.7	655	447	67.2
Norway	120	24	20.0	365	151	41.4
Total	55 382	10 080	.	129 203	34 190	.

[a]Ranked by 1971 shipments.

Source: VDMA, Wirtschaftsbild, Die Weltmaschinenproduktion, Frankfurt, 1963 and 1973. - VDMA, Statistisches Handbuch, Frankfurt, var. issues.

5 p.c.) and the share going to developing countries declined from 32 p.c. to 25 p.c.[1].

4. A more systematic insight into the development of mechanical engineering can be derived from an international cross-section analysis, which may also serve as an international standard development pattern ("normal pattern") of mechanical engineering, against which the expansion path of machinery in the United States, Sweden and Germany can be checked. The hypothesis to be tested has been extensively discussed elsewhere and needs no deeper elaboration here[2]. In short, the main idea is that the structure of production of a country systematically changes over the course of development. Hence a functional relationship between an industry's contribution to GDP (or to manufacturing) and per capita income (as a proxy for the stage of development) is presumed. In addition to per capita income, population is introduced as an exogenous variable to account for possible scale effects[3]. The sample consists

---

1 This development dates back to the mid-50s. See Development of World Trade and Export Specialization in Engineering Products Since 1953-54. See "International Trade 1967". Geneva, 1969, p. 34.

2 See Holis B. Chenery, Patterns of Industrial Growth. "The American Economic Review". Vol. 50 (1960), pp. 624 sqq. - United Nations, A Study of Industrial Growth. New York 1963. - Holis B. Chenery and Lance Taylor, Development Patterns: Among Countries and Over Time. "The Review of Economics and Statistics". Vol. 50 (1968), pp. 391 sqq. - Gerhard Fels, Klaus-Werner Schatz und Frank Wolter, Der Zusammenhang zwischen Produktionsstruktur und Entwicklungsniveau - Versuch einer Strukturprognose für die westdeutsche Wirtschaft. "Weltwirtschaftliches Archiv", Vol. 106 (1971), pp. 240 sqq.

3 In the regression analysis a third variable, the relative degree of industrialization, a cath-all for country-specific advantages in industrial production independent of the stage of economic development and the size of the domestic market, e.g. geographical location, endowment with natural resources, and industrial policies, was tested. The relative degree of industrialization was measured by the relation of the actual share of manufacturing of a given country to it's "normal" share. The explanatory power of this variable, however, turned out to be small if not, as in most regressions, insignificant.

of 48 countries; this was the maximum available in the United Nations' Growth of World Industry statistics[1]. Whenever possible the observations are average figures for 1968 to 1970; in several cases, however, the observations date back to 1966 or 1967. Since on a priori considerations one could reasonably argue for different possible expansion paths of mechanical engineering. Linear and logarithmic functions as well as combinations thereof were tested. Out of six different types of functions tested the following fitted best:

$$(1) \quad VAME = -13.613 + 2.465 \ln y + 0.905 \ln P \qquad R^2 = 0{,}681$$
$$(\pm 0.263) \qquad (\pm 0.191)$$

The notation is

VAME : Share of value added of mechanical engineering (ISIC 382) in manufacturing (ISIC 3) in p.c.

y : Gross domestic product per capita in purchaser values (US-$).

P : Population size in millions.

Both coefficients are significant at the 99 p.c. level and show the expected sign.

5. Chart 1 demonstrates the "normal pattern" of mechanical engineering for hypothetical countries with given populations of 1 million, 10 million and 100 million inhabitants, and per capita incomes up to 7000 US-$. As can be seen from this

---

1 The sample includes Australia, Brazil, Canada, Ceylon, China (Taiwan), Colombia, Cyprus, Denmark, Egypt, Finland, Ghana, Greece, Guatemala, Honduras, India, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Luxemburg, Malawi, Malaysia, Malta, Mauritius, Netherlands, New Zealand, Nigeria, Norway, Pakistan, Panama, Peru, Philippines, Singapore, South Africa, Southern Rhodesia, Spain, Sweden, Syrian Arab Republic, Thailand, Tunisia, Turkey, United Republic of Tanzania, United States. The data for the exogenous variables are taken from UN, Monthly Bulletin of Statistics. GDP figures are converted into US-$ by current official exchange rates.

chart, the international sample suggests

- a relatively rapid expansion of mechanical engineering during the early phase of industrialization, which slows down during later phases; relative to manufacturing the machinery sector expands throughout the range of per capita income levels observable in the world economy;

- a distinct influence of market size, which decreases relatively with increasing population and increasing per capita income.

The increasing share of machinery in manufacturing shown in Chart 1 does not mean, however, that at advanced stages of economic development mechanical engineering remains a growth industry. As has been found elsewhere, starting with a per capita income of about 2000 US-$ the share of value added by manufacturing in gross domestic product tends to decline[1]. Hence, in terms of contribution to GDP mechanical engineering becomes a shrinking branch when its increasing weight in manufacturing is countered by the decreasing weight of manufacturing in gross domestic product. Thus, at an income level such as that of the United States the dynamics of mechanical engineering are likely to be exhausted.

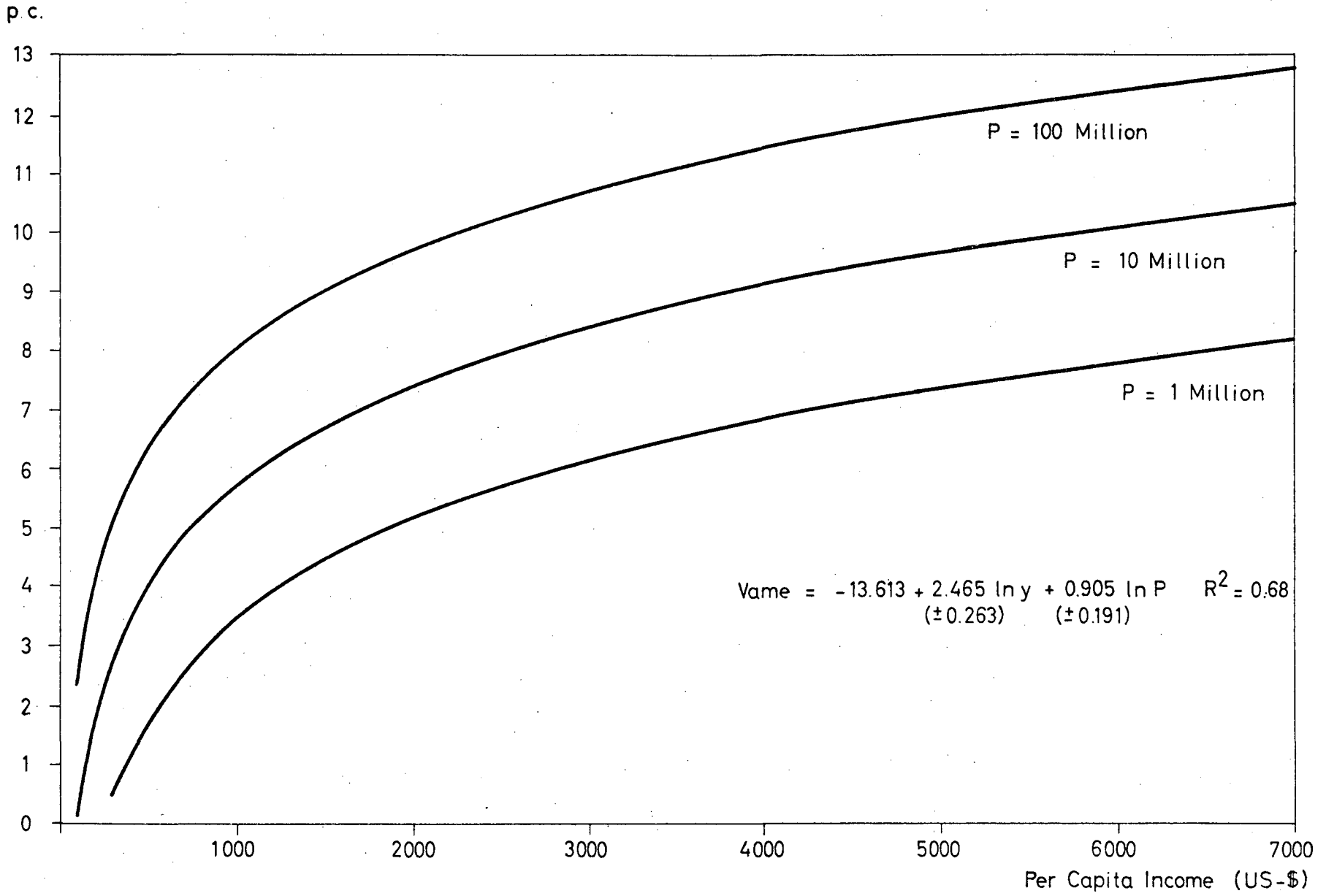
6. Equation (1) can be used to compute for the machinery sector of the United States, Germany and Sweden the machinery share of value added in manufacturing which would be expected at the given values of the exogenous variables for these countries[2].

---

1 See Gerhard Fels, Klaus-Werner Schatz und Frank Wolter, Der Zusammenhang zwischen Produktionsstruktur und Entwicklungsniveau, op. cit., p. 255.

2 Per capita income figures are valued in prices and exchange rates of 1969 which is about the mid-year of the cross-section. Data were taken from United Nations Monthly Bulletin of Statistics and OECD National Accounts Statistics.

Chart 1 - MECHANICAL ENGINEERING IN P.C. OF MANUFACTURING VALUE ADDED



Deviations from the pattern described by equation (1) can be attributed to country-specific idiosyncracies independent of the stage of economic development and the market size. Actual and hypothetical shares of machinery in manufacturing for the three countries being investigated (1955 to 1971) are plotted in Chart 2. The results of the calculations may be summarized as follows[1].

- The most remarkable deviations can be observed in the case of Sweden. The machinery industry in that country possesses a much stronger position than would be expected by international standards. In 1955, the actual share of machinery exceeded the hypothetical share almost twofold. Although this difference has been diminishing over time, in 1971 the actual share still remained more than four percentage points above "normal".

- A pattern similar to Sweden's emerges in the case of Germany. The deviations, however, are much less marked and the gap is closing more quickly. In 1969, the actual share exceeded the hypothetical share by about one percentage point only.

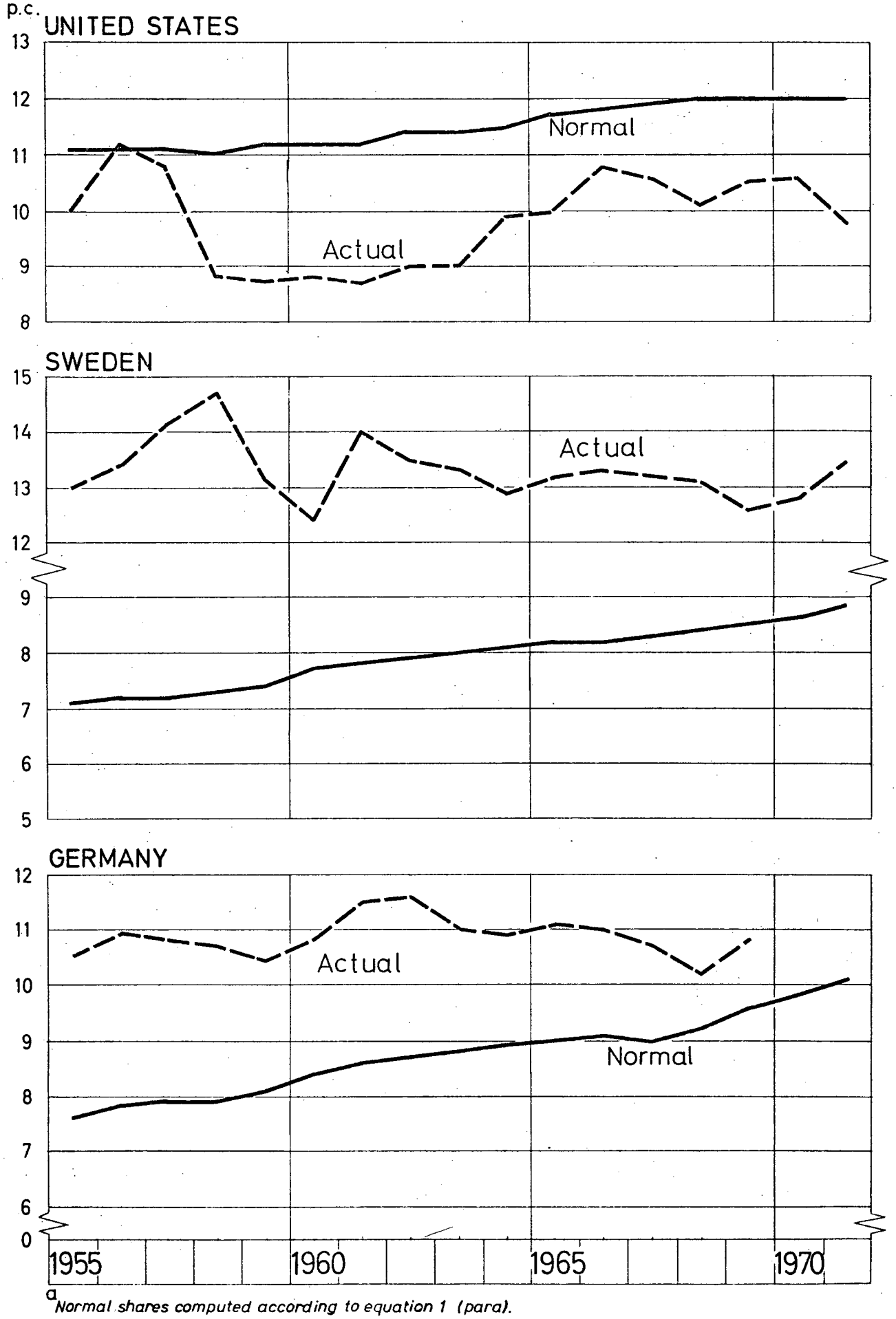
- In contrast to Germany and Sweden, the actual shares of the United States machinery industry fall short of its normal values as of 1958[2]. Through 1966 the actual shares were

---

1 When interpreting Chart 2 the following shortcomings should be noted: The actual figures for the United States refer to the national classification which slightly differs from ISIC. Moreover in 1957 the Standard Industrial Classification scheme was revised (as is true for ISIC), leading to substantial incomparabilities in the machinery time series; the figures to 1957 are not comparable with later years. As the German statistical authorities do not publish value added figures for industrial branches, the actual shares of machinery in manufacturing for Germany were calcualted from unpublished data provided by the United Nations' Economic Commission for Europe, available only until 1969. Swedish value added data according to ISIC have been avilable since 1967. For the preceding years the actual shares are based on the national classification deflated by the ratio of the national to the ISIC classifications in 1967.

2 For earlier years see preceding footnote.

Chart 2 - ACTUAL AND NORMAL SHARE OF MECHANICAL ENGINEERING IN MANUFACTURING, VALUE ADDED - UNITED STATES, SWEDEN, AND FEDERAL REPUBLIC OF GERMANY 1955 TO 1971 (p.c.)[a]



[a] *Normal shares computed according to equation 1 (para).*

gradually approaching the standard values; since that time the gap has been widening somewhat. In 1971, the deviation amounted to about two percentage points.

These observations clearly indicate that national idiosyncracies have played and still play a more prominent rôle in Sweden than in the other countries (para 10).

7. An hypothesis analagous to that for the production structure can be advanced for the employment structure. This implicitly assumes that factor price relations systematically change with the level of development, and that production functions of mechanical engineering for countries at the same level of development are identical. Requiring a 99 p.c. level of significance for the coefficients of the exogenous variables, the regressions testing the above hypothesis yielded the following best fit[1]:

$$(2) \quad EME = -12.211 + 2.405 \ln y + 0.666 \ln P \quad R^2 = 0.639$$
$$(\pm 0.308) \qquad (\pm 0.223)$$

The notation of the exogenous variables is identical to that used in equation (1). EME is the per centage share of machinery employment in manufacturing.

8. Apart from the fact that the type of function which yielded the best fit is identical for VAME and EME, a comparison of the parameters of equations (1) and (2) reveals the remarkable result that - though in the first case less distinct than in the second - the elasticities of EME with respect to both per capita income and to population size for given values of the variable in question are somewhat lower than is true for VAME. This indicates that ceteris paribus labour productivity in machinery relative to the manufacturing average increases the more advanced an economy and the larger its domestic market. The first

---

1 The sample corresponds to that described in para 4 minus Australia, Ireland, Jamaica, Netherlands, Pakistan, Panama, South Africa, Southern Rhodesia, and Tunisia, due to lack of data.

phenomenon points to a relatively rapid increase in capital input per job in mechanical engineering, which may be both the result of an above average increase in capital intensity at the given structure of production and/or a relatively rapid switch to capital intensive branches within mechanical engineering as the economy develops. The second phenomenon seems to indicate relatively large productivity gains from specialization.

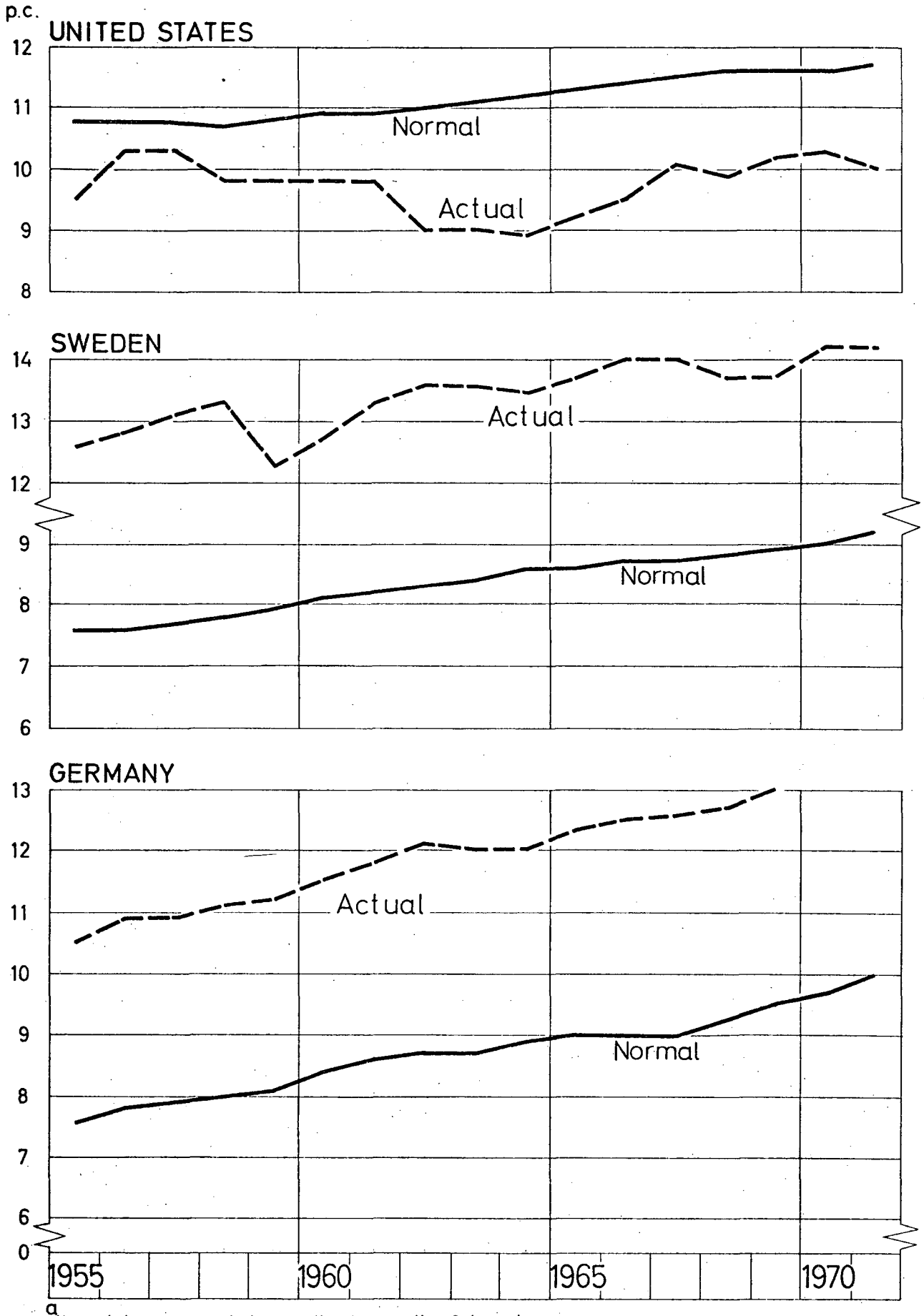
9. The actual and normal employment shares of machinery in manufacturing for the United States, Germany and Sweden are plotted in Chart 3. The period of observation covers the years 1955 to 1971 (for Germany 1955 to 1969). The development pattern, both normal and actual, which emerges is very similar to that of the production structure (Chart 2). There are, however, slight differences. Firstly, the development of the actual employment shares is more smooth than the development of value added shares; the reason presumably is the relatively large fluctuation of profits in mechanical engineering over the business cycle. Secondly, and more important, actual employment shares almost parallel the increasing normal shares whereas increasing normal value added shares had coincided with by and large stagnant actual shares in the case of Germany and Sweden; in contrast, in the case of the United States these shares developed almost in parallel fashion. This implies that the relative income position of the German and Swedish mechanical engineering industries has deteriorated. This is possibly due to a relative increase in labour-intensity, or to a relative decline in factor rewards.

The Determinants of Location

10. In the following we shall focus on these and other decisive factors in determining present and future locational conditions for machinery in the countries investigated. The above analysis suggests three items for deeper investigation, namely an inquiry into

- the development of relative factor absorption in machinery,

Chart 3 - NORMAL SHARE AND ACTUAL SHARE OF MECHANICAL ENGINEERING IN MANUFACTURING, EMPLOYEES - UNITED STATES, SWEDEN, AND FEDERAL REPUBLIC OF GERMANY 1955 TO 1971 (p.c.)[a]



[a] *Normal shares computed according to equation 2 (para).*

- the relevance of economies of scale in machinery relative to manufacturing, and

- the relevance of national idiosyncracies which are indicated by the observed deviations between normal and actual shares and which may be due to a relatively rich (poor) endowment with branch-specific factors ofproduction, namely engineers; the presence (absence) of external economies stemming from an industrial complex (linkages); or favourable (unfavourable) protective policies.

Information on factor rewars and investment behavior can be used to corroborate tendencies observed in factor intensities. The analytical procedure adopted is to compare a particular factor intensity in machinery with the corresponding intensity for manufacturing as a whole, revealing which factor(s) machinery uses relatively intensively[1]. Comparing two such ratios, each observed at different points in time, indicates whether machinery is increasing or decreasing its locational advantage relative to manufacturing in a country.

11. The above list of factor intensities and product characteristics can be usefully organized with the help of a recent contribution by Hirsch[2]. He proposes dividing the universe of traded goods into subsets, each subset requiring a separate theory of trade. Trade in primary products, called

- Ricardo Goods, is determined by international differences in production functions caused by differences in natural resource endowments

- mature product cycle goods, called Heckscher-Ohlin Goods, is determined by physical capital/raw labor intensity.

---

1 Of course, manufacturing is not the ideal reference system. The choice of reference system was dictated mainly by considerations of data availability.

2 Seev Hirsch, Hypotheses Regarding Trade Between Developing and Industrialized Countries, in: Herbert Giersch, ed. The International Division of Labor - Problems and Perspectives, Tübingen, 1974.

- new product cycle goods, called New Goods, depends upon skill endowments. New Goods are produced in and exported from countries in which high skill levels prevail. The production technology is not universally know due to prohibitive transfer costs.

The implications for a study of the potential of the most highly developed economies as future locations of the machinery industry then depend upon which of these categories the industry falls into.

Resource Intensity

12. Natural resource intensity is one determinant of location for any industry. This has been established indirectly in the aftermath of the research on factor intensity reversals by Arrow et. al.[1]. Machinery, however, is not at all resource intensive, at least as for as direct requirements are concerned[2]. Therefore, natural resource location would not seem to be a factor conducive to machinery location.

Innovativeness; R & D Intensity

13. Gruber, Mehta, and Vernon pointed out that innovativeness,

---

1 Kenneth J. Arrow, Hollis B. Chenery, Bagicha Singh Minhas, and Robert Solow, Capital Labor Substitution and Economic Efficiency. "Review of Economics and Statistics". XLIII, (1962). In this regard, note the "improvement of results" obtained by excluding resource intensive industries from tests of the Heckscher-Ohlin Theorem. Robert Stern, in his Testing Trade Theories, pp. 15-16 and notes 8-10, pp. 67-68, University of Michigan, 1974 (unpublished) provides an excellent survey of recent developments in this field.

2 Raw material intensity is particularly low in machinery, even compared to manufacturing. The percentage primary inputs out of gross output is 1.89 p.c. in machinery and 6.37 p.c. in manufacturing in Germany (1966). Respective figures for the US (1967) are 0.03 p.c. and 7.96 p.c.; for indirect requirements see footnote 1 on page 34.

as measurable by R & D intensity, is an important determinant of industry location[1].

Findings for the United States indicate that while machinery is a major U.S. Export performer, its relative R & D intensity, measured in various ways, is also high, though not at the top[2]. Our findings, presented in Table 2, lead to the same conclusions and further reveal an element of instability in R & D intensity of machinery:

- In Germany, R & D intensity is barely on the manufacturing average in 1971.

- In Sweden, R & D intensity was below average in 1967, and increased to 1971, but by one measure is still below average.

- In the U.S., R & D intensity seems to be declining by both measures, is unstable, and still above average.

This suggests that R & D intensity should not be construed as an insurmountable barrier to entry especially to the extent that R & D activities are physically separable from the production process. Other industries would seem to be more protected in their current locations in the high income countries. Furthermore, given the heterogeneity of machinery the suspicion

---

1 William Gruber, Dileep Mehta, and Rayomond Vernon, The R & D Factor in International Trade and International Investment in United States Industries. "Journal of Political Economy", Vol. LXXV, (1967). William Gruber and Raymond Vernon, The Technology factor in a World Trade Matrix in: Raymond Vernon, ed., The Technology Factor in International Trade, New York, 1970, Donald Keesing states this conclusion somewhat more emphatically in his The Impact of Research and Development on United States Trade. "Journal of Political Economy", Vol. LXXV (1967).

2 For example, Gruber, Mehta and Vernon form a group of five R & D intensive industries, which barely includes machinery.

Table 2 - Indices of R & D Intensity in the United States; Sweden's, and Germany's Machinery Industry Relative to Manufacturing, 1958, 1967, 1971[a] (100 = Equality)

Ratio of	United States			Sweden		Germany
	1958	1967	1971	1967	1971	1971
R & D Expenditure						
- to Shipments	135.5	105.8	121.7	145.5	140.6	100.7
- to Value Added	106.8	86.6	103.6	98.9	116.8	.
R & D Scientists and Engineers						
- to Total Employees	139.1	109.2	115.3	91.5	95.4	.

[a]For choice of years see footnote 1 on page 26.

Source: National Science Foundation, Research and Development in Industry 1971, Washington, 1973. - U.S. Bureau of the Census, Annual Survey of Manufactures, 1971, Industry Profiles, Washington, 1973. - Swedish Central Bureau of Statistics, Statistiska Meddelanden, Series V, 1970:27 and 1973:19. - Swedish Central Bureau of Statistics, Industri, Stockholm, various years. - Stifter Verband der Deutschen Wirtschaft, Wirtschaft und Wissenschaft, Beilage zu Heft 2 und 3, 1973. - Statistisches Bundesamt, Statistisches Jahrbuch für die Bundesrepublik Deutschland, Wiesbaden, 1971. - Own calculations.

Human Capital

14. Human capital intensity has been found to be powerful in explaining trade flows. This power is enhanced when trade is regionalized as between developing and industrialized countries[1].

1 See Hirsch, The product Cycle Model of International Trade-Multi-Country Cross-Section Analysis, The Israel Institute of Business Economics, Tel Aviv, 1973 and especially Gerhard Fels, The Choice of Industry Mix in the Division of Labor Between Developed and Developing Countries. Weltwirtschaftliches Archiv, Vol. 108 (1972).

Furthermore, the three countries included in this study are presumably those where human capital is relatively most abundant[1]. Therefore, human capital is particularly relevant to the rôle these countries will play in the international division of labor.

Several measurement concepts with which to estimate human capital exist. Wage differentials can be capitalized to arrive at a human capital stock ("stock concept") or the flow of wage value added per employee (Lary concept) may be used[2]. The stock concept is preferable because non-human capital phenomena, such as market structure and effective protection cannot be distinguished from human capital by the Lary concept. Also, the Lary concept implicilty assumes no inter-industry differences in disutility to unskilled labor. In spite of this, human capital intensity was calculated according to both concepts because of lack of sufficient data in the case of Sweden, and to permit the possibility of double checking in the cases of the United States and Germany.

The relative human capital intensity of the machinery indu-

---

1 See Karl Roskamp and Gordon McMeekin, Factor Proportions, Human Capital and Foreign Trade: The Case of West Germany Reconsidered. "Quarterly Journal of Economics", Vol. LXXXII (1968) for the case of Germany. Donald Keesing Labor Skills and the Structure of Trade in Manufactures, in: Peter B. Kenen and Robert Lawrence, eds., The Open Economy, New York 1968, for evidence on several countries. - Stern, Op. cit. p. 16, concludes that the abundance of human capital in the U.S. is well established.

2 See Peter B. Kenen, Nature, Capital, and Trade. "Journal of Political Economy", Vol. LXXIII, (1965) p. 456. - And Hal Lary, Imports of Manufactures from Less Developed Countries. New York, 1968, p. 22; and Gerhard Fels, ibid. Fels has also suggested that the stock concept is more useful for prediction of structure whereas the Lary concept is better for planning restructuring. See: Gerhard Fels, ibid., p. 84-85.

stry and its development over time is presented in Table 3[1]. It reveals:

- Above average but distinctly declining relative human capital intensity for machinery in Germany and the U.S. according to the stock concept.

- Above average but declining human capital intensity for Sweden and the United States, at least recently, according to the Lary concept.

- Conflicting trends in Germany as between the stock and Lary concepts[2].

15. To double check the above developments skill data can be used, at least for the U.S., where direct skill data are available. The possibility for a double-check is given by the high correlation among various indicators of human capital intensity[3]. Table 4 presents four relative skill indexes for U.S. machinery in 1960 and 1970, the most recent years in which a Census of

---

1 The year 1971 was in general the most recent year for which all series were available, while 1958 was the earliest year which is comparable to all later years in the United States. The choice of 1967 as a middle year was dictated by the fact that Sweden changed to ISIC in the year, but data for both the former national classification and for the ISIC are available for that year only. Conveniently, a Census of Manufacturing was held in the U.S. in 1967. But this year was not chosen for Germany because of the striking and abnormal recession there.

2 This is explained by the faster increase of an unskilled labourer's wage than the average wage in machinrry compared to manufacturing.

3 Kenen has observed the high correlation among all variables indicating high skill levels, which are presumably required in the production of new goods. Since more general human capital estimates must reflect skill differences, this would apply to the more general measures as well. See Peter B. Kenen, Skills, Human Capital and Comparative Advantage, in: W. Lee Hansen, ed., Education, Income, and Human Capital, New York, 1970, pp. 204-5, and Anne Krueger, Comment on Kenen, ibid., p. 231.

Table 3 - Indices of Factor Intensities in the United States', Sweden's, and Germany's Machinery Industry Relative to Manufacturing, Selected Years[a] (100 = Equality)

Factor	United States			Sweden				Germany		
	1958	1967	1971	(1958)[b]	(1967)[b]	1967[c]	1971[c]	1958	1965	1971
K/L I[d]	.	90.2[x]	92.2	.	.	.	.	76.4	70.6	66.6
K/L II[e]	86.1	97.5	85.0	94.6	84.4	80.7	83.3	88.0	65.5	20.8[f]
HK/L I[g]	.	137.5	125.8	.	.	.	.	127.6	126.8	119.3
HK/L II[h]	113.1	114.3	112.5	116.6	111.5	106.4	105.0	106.3	106.3	107.1[f]
TK/L I[i]	.	120.4[x]	110.7	.	.	.	.	78.9	74.2	71.0
TK/L II[j]	100.2	105.4	97.6	102.8	95.6	94.8	94.7	97.2	90.9	83.6[f]

[a]For choice of years, see footnote 1 on page 26. - [b]National classification. - [c]ISIC. - [d]Stock of physical capital per employee. - [e]Non-wage value added per employee. - [f]1969. - [g]Capitalized diverential between actual payroll and total employee man-hours fictitiously renumerated at an unskilled labourer's wage, per employee. - [h]Payroll per employee. - [i]Total capital per employee, human and physical, as measured in footnotes d and g. [j]Total capital intensity - value added per employee. - [x]1963.

Source: U.S. Bureau of the Census, op. cit. - U.S. Dept. of Labor, Bureau of Labor Statistics, Industry Wage Survey: Machinery Manufacturing mid-1966, Washington, 1967. - U.S. Dept. of Labor, Bureau of Labor Statistics, Handbook of Labor Statistics 1972, Washington, 1972. - Swedish Central Bureau of Statistics, Industri, op. cit. - Rolf Krengel and Associates, Productionsvolumen and -potential der Bundesrepublik Deutschland, 12., 13., und 14. Folge, Berlin, 1972 and 1973. - U.N. Economic Comission for Europe, Sumstat 1, Geneva, 1971 (unpublished). - Own calculations.

Table 4 - Indices of Skill[a] in the United States Machinery Industry Relative to Manufacturing, 1960 and 1970 (100 = Equality)

Index	1960	1970
Keesing A[b]	174.1	150.4
Keesing B[c]	224.6	195.3
Wachrer[d]	158.2	141.6
Hufbauer (Hi-skill)[e]	124.5	134.3

[a]The comprehensive indices are constructed using categories of occupations used by the U.S. Bureau of the Census, Hufbauer uses the ISCO classification, but the Hi-skill class is equivalent in the two classifications. The categories are I = Professional and Technical; II = Managerial; III = Sales; IV = Craftsmen and Foremen; IVa = Machinists, Electricians, Tool and Die Makers; V = Clerical; VI = Operatives; VII = Service Workers; VIII = Laborers. - [b](2 x I) + IVa) ÷ VI + VIII. - [c](I + II + IV) ÷ (VI + VIII). [d](I + II + III + IV + V + VII) ÷ (VI + VIII). ÷ [e]I ÷ sum of all categories.

Source: U.S. Bureau of the Census, U.S. Census of Population, 1960 and 1970, Vol. I, Characteristics of the Population, Washington, 1964, and 1973. - The formulae for the skill indices are in: Donald Keesing, Labor Skills and the Structure of Trade in Manufactures, in: The Open Economy, op. cit. - Donald Keesing, Labor Skills and International Trade: Evaluating Many Trade Flows With a Single Measuring Device. "The Review of Economics and Statistics" Vol. XLVII (1965). - Helen Waehrer, Wages Rates, Labor Skills and United States Foreign Trade, in: The Open Economy, op. cit. - Gary Hufbauer, The Impact of National Characteristics and Technology on the Commodity Composition of Trade in Manufactured Goods, in The Technology Factor in International Trade, op. cit. - Own calcualtions.

Population was taken. All have appeared in the literature previously, and are named after their initiators in Table 4. The first three are comprehensive skill indices; the last is the ratio of the very highest skilled employees to industry employment. The table reveals that

- in U.S. machinery, skill levels are increasing more slowly in machinery than in manufacturing but are still comfortably above average; this result is obtained from the first three (comprehensive) indicators.

- the highest skilled personnel are being used increasingly more intensively than in manufacturing; this is measured by the Hufbauer "skill ratio"

- the development of Hufbauers' skill ratio does not contradict the change in the other skill indexes; together, they imply a polarization of skills in machinery.

The results of the skill changes corroborate the findings for the level and direction of change of human capital intensity in the machinery industry - it is above average, though declining.

This means that machinery still has a strong locational advantage in these high income countries. No dramatic change in location can therefore be expected for the machinery industry as a whole. But because of the decisive importance of this factor intensity, the direction of change casts serious doubt upon the capability of the highest income countries to offer the machinery industry a completely safe haven. Indeed, in Sweden and Germany a deterioration of machinery's relative income position has been observed already (para. 10).

Physical Capital Intensity

16. Physical capital intensity is a crucial variable in the context of locational advantages of high income countries for

a reason opposite to that for human capital. Whereas high income countries are uniquely well endowed with human capital, physical capital is internationally the most mobile factor. Again, to the extent that the immediate production process is separable from other activities, such as headquarters activities, and to the extent that the production activities are becoming relatively less human capital intensive, even rising physical capital intensity need not be a bar to new entrants. This is especially so if physical capital intensity in machinery is below average in the first place.

Calculations for physical capital intensity are presented in Table 3. It reveals

- distinctly below average and relatively declining physical capital intensity in Germany, as measured by both concepts

- below average and relatively declining physical capital intensity in Sweden over the period 1958-1970, as measured by the Lary concept. The rise from 1967-1971 based on the ISIC classification is probably due to the severe recession. The 1968 relative intensity is 83.5, and so indicates rather stable development, though it is destinctly below average

- below average, but conflicting directions of change, in U.S. machinery physical capital intensity. The stock concept, based on bookvalue of assets, shows a slight relative rise.

The results reveal that physical capital intensity is less likely to be a barrier to new entrants into machinery than human capital intensity. Indeed, in the case of Germany, the results are striking. One wonders whether increasing relative labor intensity combined with decreasing relative human capital intensity is adequate to the future development of factor endowments in a highly developed country.

Investment Behavior; Factor Rewards

17. The nature and success of the investment strategy, i.e. the "strategy" of factor absorption, can be tested by examining rates of return on fixed capital, rates of increase of the capital stock, investment motives, and productivity data. Such a test is important because though the emerging pattern of factor absorption may have been better than other alternatives, it need not have been successful. Sufficiently comprehensive data for this examination are available for the United States and Germany, but not for Sweden. The relevant data are presented in Table 5, which shows that

- profits in machinery are above average in Germany and the United States, but in Germany they are declining relatively and in the U.S. they are increasing relatively
- the rate of increase of the capital stock was at or below average in both countries. Consistently more investment in the machinery industry is for rationalization and replacement than it is for manufacturing in both Germany and the United States.
- in Germany the already below average labor productivity declined further; capital productivity declined and is still above average.

This casts some doubt upon the success of the German machinery industry's relative labor intensification. Though this industry was not required to expand its capital stock particularly rapidly, its relative position with respect to the return on physical capital declined. The investment destined for rationalization and replacement was unable to increase labor productivity fast enough to hold down total costs. In spite of indications that an effort to utilize more unskilled workers (suggested by the steady increase in female employment relative to manufacturing, from 46.5 in 1958 to 63.7 in 1970),

Table 5 - Indices of Factor Rewards and Investment Behavior in the United States' and Germany's Machinery Industry Relative to Manufacturing, Selected Years[a] (100 = Equality)

Category	United States			Germany		
	1958	1967	1971	1958	1965	1971
Return on Fixed Capital	.	101.6[x]	104.9[b]	119.4[c]	125.6[c]	109.3[b,c]
Investment/Capital	.	85.4[x]	88.2	87.2	96.6	100.0
Replacement and Rationalization Investment	133.9	125.0	122.6[d]	101.6[e]	146.7	131.4
Labor Productivity	.	.	.	96.4	81.4	67.9
Capital Productivity	.	.	.	128.0	118.0	104.6

[a]See footnote 1 on page 26 for choice of years. - [b]1970. - [c]Relative to total industry. - [d]1972. - [e]1960. - [x]1963.

Source: U.S. Dept. of Commerce, "Survey of Current Business", Washington, July issues of various years. - McGraw-Hill Annual Survey "Business Plans for New Plants and Equipment", New York, various years. - Jürgen Donges, Gerhard Fels, Axel Neu, and others, Protektion und Branchenstruktur der westdeutschen Wirtschaft, Tübingen, 1973, p. 105. - Rolf Krengel and Associates, op. cit. - IFO-Institut für Wirtschaftsforschung, "Wirtschaftskonjunktur", Sonderbeilagen 20:4 and 25:4, Munich, 1968 and 1973. - Own calculations.

average wages per production worker in this labor intensive industry increased relatively to manufacturing, from 104.6 in 1958 to 107.2 in 1971.

The United States machinery industry presents a somewhat different picture. First of all by the performance of profits, it was successful in its presumptive strategy of relative physical capital intensification. Relatively more invretment in the machinery industry was for replacement and rationalization investment in that country, as well, but the rate of expansion of the capital stock could remain comfortably below average. There was also no need to increase female employment more than did manufacturing, (around 50.0 in all years), and wages per production worker, experiencing a slight relative decline (from 114.6 in 1958 to 113.3 in 1971), did not cut into profits.

This suggests that the German machinery industry in contrast to the U.S.'s banked on an elastic supply of unskilled labor, which simply was not forthcoming at prevailing relative wage rates. Moreover, the machinery industry was certainly favored by the undervaluation of the Deutsche Mark as well. That phenomenon began to end in 1969. What might have been a rational strategy in the face of increasing immigrant labor and an undervalued home currency must now be viewed in another light.

Economies of Scale

18. Another set of circumstances which may influence the location of productive activities is the nexus of scale economies. The presence of scale economies in an industry makes it more difficult for newcomers to enter, and makes traditional locations of an industry more immune to changes in competitiveness. To assess the importance of scale economies, several regessions were run, four of which are shown in Table 6.

Table 6 - Economies of Scale in Machinery and Manufacturing for an International Cross Section around 1968

Industry	Constant		Coefficient	R^2
Eq.1 Machinery:	ln VAPEM = 5.950	+	0.414 ln VAPES ($\pm$ 0.064)	0.55
Eq.2 Manufacturing:	ln VAPEM = 6.600	+	0.309 ln VAPES ($\pm$ 0.049)	0.54
Eq.3 Machinery:	ln VAPEM = 7.0931	+	0.206 ln EMPES ($\pm$ 0.129)	0.07
Eq.4 Manufacturing:	ln VAPEM = 7.224	+	0.247 ln EMPES ($\pm$ 0.091)	0.18

Key: VAPEM = Value Added per Employee. - VAPES = Value Added per Establishment. - EMPES = Employees per Establishment.

Sample: As in paragraph 4 minus India, Ireland, Italy, Jamaica, Japan, Jordan, Korea, Netherlands, Pakistan, Southern Rhodesia, Tunisia, Tanzania, U.S., plus Algeria and Equador for 1969 and 1970, and 1966 in individual cases.

Source: United Nations, The Growth of World Industry, 1971 Edition, Volume I, New York 1973. - Own calculations.

The first two equations were those which fit best[1] and show that in machinery the elasticity of value added per employee with respect to value added per establishment is higher than in manufacturing. This indicates that scale economies may be more important for the machinery industry than for manufacturing, and consequently adjustment pressure will be less there.

On the other hand, the cross section data on average plant sizes used for the regressions and the data shown in Table 7 indicate that the average plant size is lower in machinery than in manufacturing[2]. This means that economies of scale may be realized at a lower level of output in the machinery industry, and makes entry and attainment of an optimal sized plant easier there. Furthermore, the possibility of maintaining smaller sized firms means that the machinery need not be regionally concentrated.

19. The directions of change in factor absorption in general, the level of relative labor intensity, the questionable degree of success of labor intensification in German machinery, and the level of output at which scale economies can be realized imply that the highly industrialized countries will not retain a monopoly of machinery production in the future. This becomes especially plausible in view of the wide heterogeneity of the industrys' output, which, if it indicates a heterogeneity in factor intensities of each machinery sub-branch, makes some of these sub-branches much more suitable candidates for re-location.

---

1 The second two equations were specified with employees per establishment as the explanatory variable. This specification explains less variation than the first because value added per establishment is an indicator for total inputs at an establishment - physical and human capital, as well as labor. Employees per establishment gives no information on non-labor inputs.

2 In the majority of cases average plant size is lower in machinery than in manufacturing, measured both according to value added per establishment and to employees per establishment.

Table 7 - Average Plant Size and Regional Distribution of Machinery and Manufacturing in the United States, Sweden and Germany, Selected Years

Category	United States 1967[a]	Sweden 1971	Germany 1971[b]
Employees per Establishment			
- in Machinery	49	68	219
- in Manufacturing	60	97	148
	1971	1971	1971
Index of Regional Distribution, Machinery Relative to Manufacturing[c]	34.2	.	21.9

[a]1967 is the most recent year for which data are available. - [b]The German data are upward biased because establishments with less than 10 employees are excluded. - [c]Variation coefficient of machinery proportion of manufacturing employment in each region: for Germany - 11 Bundesländer; for the U.S. - 9 Census Regions. The coefficient equals zero when machinery and manufacturing are equally distributed.

Source: Statistisches Bundesamt, Statistisches Jahrbuch...., op. cit. - Swedish Central Bureau of Statistics, Industri, op. cit. - U.S. Dept. of Commerce, Annual Survey of Manufactures 1971, Industry Profiles, op. cit. - Own calculations.

National Idiosyncracies

20. Besides general factor intensities and internal economies of scale studied til now, the determinants of location include country-specific idiosyncracies. These account for deviations between normal and actual development patterns, and inter alia can be sought among special factors of production which machinery uses relatively intensively. Evidence gathered for the mechanical engineering industry in the United States and Germany (occupation - by - industry data for Sweden are not available) indicates that the machinery operates very "engineer intensively" relative to the manufacturing average (Table 8). This is observable not only in relation to total employment, but even in relation to high-skill employment. Then, if Germany and Sweden had an ample supply of engineers as compared to other industrialized countries, machinery would be particularly favoured (and vice versa for the United States)[1].

Though only a limited number of countries could be compared and though the available figures date far back, the facts tend to support this hypothesis (Table 9). For Sweden, the evidence is particularly striking. Sweden has the largest deviation from the normal pattern and has the highest ratio of engineers to both total high skilled employees and to total employees of all the countries for which data were available. Concerning the United States, the supply of engineers for machinery may be even less elastic than can be deduced from the table since in comparison to other industrialized countries,

---

1 The chicken- and egg-argument against this reasoning would be somewhat beside the point. Irrespective of its history and of its reproducibility, a relatively rich endowment with a specific factor of production, such as engineers, at a point in time constitutes a comparative advantage in activities which extensively absorb this factor. If reproducible, comparative advantage based on this factor may, of course, change over time.

Table 8 - Employees in Selected Occupations in Machinery and Manufacturing in the United States and Germany, Selected Years[a] (p.c. of Total Respective Industry Employment)

Occupation	Machinery		Manufacturing	
	United States			
	1960	1970	1960	1970
Engineers	4.2	5.2	2.7	3.3
Technicians	0.8	3.1	1.2	2.1
Scientists	0.2	0.1	0.5	0.4
	Germany			
	1950	1961	1950	1961
Engineers	8.2	8.6	3.6	4.8
Technicians	1.8	2.5	1.2	1.3
Scientists	0.0	0.1	0.2	0.2

[a]Years in which a Census of Population was conducted

Source: U.S. Bureau of the Census, U.S. Census of Population, op. cit. - Institut für Arbeitsmarkt- und Berufsforschung. "Mitteilungen", October 1968. - Own calculations.

Table 9 - The Endowment with Engineers in Selected Countries, Selected Years

Country	Year	Engineers in p.c. of high skilled[a] employees						Engineers in p.t. of total employees					
		Civil	Electr.	Mechan.	Chemical	Mining Others	Total	Civil	Electr.	Mechan.	Chemical	Mining Others	Total
United States	1950	1,26	1,09	1,29	0,32	1,41	5,37	2,17	1,88	2,23	0,55	2,43	9,26
United States	1960	1,25	1,45	1,66	0,33	2,16	6,85	2,43	2,81	3,23	0,63	4,19	13,29
United States	1970	0,98	1,59	1,30	0,29	2,96	6,81	2,26	3,67	2,32	0,68	6,85	15,77
Sweden	1960	8,29	4,86	11,41	2,39	9,38	36,33[c]	11,33	6,64	15,61	3,27	12,82	49,67[c]
Germany	1961	2,97	1,71	1,98	0,22[b]	6,27	13,15	5,35	3,07	3,55	0,39[b]	11,27	23,63
Canada	1951	1,30	1,06	1,39	0,43	0,34	4,52	1,47	1,20	1,58	0,49	0,39	5,13
Canada	1961	1,22	0,90	0,83	0,31	1,15	4,41	1,84	1,35	1,26	0,46	1,74	6,65
France	1962	0,62	0,74	0,91	0,56	3,46	6,29	0,73	0,89	1,09	0,67	4,12	7,50
United Kingdom	1961	1,19	1,55	1,79	3,22		7,75	1,34	1,75	2,02	3,64		8,75
Netherlands	1960	0,29	0,25	0,33	0,21[b]	0,08	1,16	0,35	0,30	0,40	0,26[b]	0,10	1,41
Finland	1960	6,82	2,65	5,64	8,56		23,67	6,71	2,60	5,55	8,45		23,31
Japan	1960	2,94[c]	1,48	1,81	0,56	1,17	7,96[c]	2,12[c]	1,07	1,31	0,41	0,85	5,76[c]
Israel	1961	0,92	0,47	0,35	1,51		3,25	1,59	0,81	0,60	2,61		5,61
Iran	1958	2,48	1,38	1,87	0,54	1,07	7,34	0,46	0,26	0,35	0,10	0,20	1,37
Jordan	1961	0,44	0,25	0,30	0,90		1,89	0,21	0,12	0,14	0,42		0,89
Panama	1960	0,80	0,21	0,11	0,70		1,82	0,66	0,17	0,09	0,59		1,51
Puerto Rico	1960	1,28	0,29	0,25	0,59		2,41	2,36	0,53	0,46	1,09		4,44
Ghana	1960	0,57	0,20	0,50	.	.	1,27	0,16	0,06	0,14	.	.	0,36
Zambia	1965/66	1,20	1,42		3,96		6,58	1,02	1,21		3,37		5,60

[a]ISCO groups 0 and 1.- [b]Including metallurgical engineers.- [c]Including architects.

Source: OECD, Statistics of the Occupational and Educational Structure of the Labour Force in 53 Countries. Paris 1969.- United States Department of Commerce, Bureau of the Census, US Census of Population 1970, Vol. I, Washington 1972.- Own Calculations.

technical skills are more likely to be attracted by the rapidly developing modern engineering sector, such as electronics and aerospace industries, as well as by non-industrial organizations such as NASA, DOD and the like.

An additional explanation for the above normal share of Sweden's mechanical engineering industry can be found in the concept of the "industrial complex", in this case the strong linkage between machinery and the steel industry. As an examination of input-output tables of the United States and Germany reveals, next o value added and machinery itself, the steel industry is the most important direct input sector of mechanical engineering (Table 10)[1]. Indeed, all three of these highly industrialized countries enjoy the benefits of an industrial complex relevant to the machinery industry; a difference among the three countries, however, lies in the nature of output of their respective steel industries. Based upon high quality iron ore deposits but suffering from a lack of coal resources, the Swedish steel industry from the very beginning of industrial production has concentrated its efforts in producing high quality, high value steel. In Sweden there would seem to be a relative abundance of the kind of steel heavily used as an input in machinery[2].

It also follows from Table 10 that machinery depends upon the whole engineering sector for the bulk of its inputs. This suggests that success in specialization in any one engineering sector, including machinery, requires success in the whole engineering sector. Indeed, those countries which have entered this market successfully, have done so in a number of

---

1 To the extent that machinery benefits from a national steel industry, and the efficiency of the steel complex depends upon the availability of iron ore and coal, machinery is indirectly resource intensive. For example, in the U.S. (1967) indirect natural resource requirements in machinery sub-industries ranged from 2.45% to 4.05%, which is much higher than the corresponding direct requirements.

2 See Skandinaviska Enskilda Banken, Some Data about Sweden 1974-75. Växjö 1974, p.23.

Table 10 - Machinery in an Industrial Complex, the United States 1967, and Germany in 1966

% Contribution to Gross Output of Machinery	United States 1967	Germany 1966
Value added	42.4	42.3
Machinery	15.2	15.7
Iron and Steel[a]	9.1	7.1
Electrical Machinery	6.3	4.5
Fabricated etal	4.4	2.3
Imports	2.5	6.9

[a]Casting has been added to Iron and Steel for Germany to attain greater comparability to U.S. data.

Source: Reiner Stäglin und Hans Wessels, Input-Output Tabelle für die Bundesrepublik Deutschland 1966, Vierteljahreshefte zur Wirtschaftsforschung 3/1971, Berlin, 1971, pp. 215 sqq. - U.S. Dept. of Commerce, Interindustry Economics Division, The Input-Output Structure of the U.S. Economy: 1967. Survey of Current Business, Washington, 1974:4. - Own calculations.

engineering sectors[1].

Given the currently prevailing domestic production structures in developing countries, this in turn suggests that entry into the bulk of machine producing activities is restricted to the already semi-industrialized countries, and that the possibilities for a broader international division of labor in machinery is limited.

1 See Hollis B. Chenery and Helen Huges, Industrialization and Trade Trends: Some Issues for the 1970s in: Helen Hughes, ed., Prospects for Partnership, Baltimore 1973; p. 25.

Government structural policy, or actions taken in lieu of structural policy, can be also be construed as a national idiosyncracy. Machinery, being among the most successful export industries in the three highly industrialized countries included here, has apparently never felt the need to press very strenously for protection from foreign competition. As Table 11 shows, effective rates of protection are below the manufacturing or industrial average in all cases, i.e. the machinery industry is being discriminated against.

Of course, protective policy constitutes a national idiosyncracy only in so far as it deviates from the protecive structure "usual" in those countries included in the acrossection. Whether this is true for the countries investigated is an open question. What can be said, is that further across-the-board liberalization of trade in industrial products by any of thes countries would tend to improve the machinery industries' competitive position there

The Structure of Comparative Advantage

21. From the last section the impact of changing world market conditions on the structure of the machanical engineering industries of the countries investigated should be evident. In the future this impact is likely to increase since the engineering sector of many industrializing countries is still at the threshold of development and since the dislocation of labour-intensive segments of this industry from high-wage to low-wage countries as experienced in many other branches is still in its infant stage of development. Notwithstanding this, the competition from industrializing countries in machinery is already being felt. By the time the limitations of inward-oriented development policies became apparent at the end of the 1960s, many developing countries had already turned to manufactured exports to finance their development. The average annual growth rates of manufactured exports from the developing countries was climbing throughout the 1960s, with individual countries achieving and/or

Table 11 - Nominal and Effective Rates of Protection in the United, States, Sweden and Germany, Selected Years

Branch	United States[a] 1962		Sweden[a] 1962		Germany[a,b] 1962	
	Nom.	Eff.	Nom.	Eff.	Nom.	Eff.
Agricultural Machinery	0.4	-6.9	10.0	16.0	13.4	19.6
Machinery	11.0	16.1	8.8	11.6	10.3	12.2
Manufacturing	11.6	20.0	6.8	12.5	11.9	18.6

	Germany[b,c] 1964		1970	
	Nom.	Eff.	Nom.	Eff.
Machinery	9.6	3.5	7.9	3.3
Industry Total[d]	11.0	14.8	8.8	11.9

[a]Calculated by Balssa using world trade weights on tariffs. - [b]Vis à vis non-members of Common Market. [c]Calculated by Donges, Fels, Neu and others using gross output weights on tariffs. - [d]Includes mining and mineral industries.

Source: Bela Belassa, Tariff Protection in Industrial Countries - An Evaluation. " The Journal of Political Economy", Vol. 73, (1965). - Frank Wolter, Strukturelle Anpassungsprobleme der westdeutschen Stahlindustrie. Tübingen 1974, p. 98. - Jürgen Donges, Gerhard Fels, Axel Neu and others, op. cit., pp. 24,25,80.

maintaining spectacular growth rates. Furthermore, individual product groups fared rather differently, machinery and transport equipment and miscellaneous manufactures leading such traditional exports as cotton textiles by a wide margin[1].

1 See Hollis B. Chenery and Helen Hughes, op. cit., pp. 10-12, 29.

The significance of these developments for the United States, Sweden and Germany can be seen from Table 12, in which the machinery and manufactured goods trade between the developing countries and each of the three countries is depicted. On the import side a clear pattern of increasing competitiveness of developing country machinery exports is discernable; this is particularly true with respect to the United States. The share of machinery imports of the three country originating in developing countries is minute, but it is growing rapidly, and is growing more rapidly than total manufacturing imports from developing countries. On the export side a similar pattern emerges for the United States only; growth rates of German and Swedish exports of machinery to developing countries have generally been higher than growth rates for manufactured exports destined there. It must be rememberd at the present time that the levels of these country's imports of machinery from the developing countries alone is too small to be of concern to their machinery industries seen as a whole. The respective rates of growth, however, indicate that in the future adjustment may be needed in individual sub-branches of the machinery industry in the highly industrialized countries. This calls for a careful analysis of each countries' comparative advantage within mechanical engineering.

22. In Hirsch's Product cycle model machinery is classified as a labour-intensive new good from which it follows that comparative advantage in this activity must remain with the most advance economies[1]. Presumably, this classification does not hold true for the universe of engineering products. As mentioned earlier mechanical engineering is a very heterogeneous sector consisting of many sub-branches which differ substantially in supply as well as demand conditions. In

---

1 See Seev Hirsch, Hypotheses Regarding Trade between Developing and Industrial Countries. op. cit, p. 74.

Table 12 - United States', Sweden's and Germany's Foreign Trade in Manufactured and Machinery Commodities with the World and the Developing Countries[a] in US-$ and p.c. (1962 to 1971)

		United States			Sweden			Federal Republic of Germany[b]		
		1962	1971	1971/62	1962	1971	1971/62	1962	1971	1971/62
Machinery										
Imports (World)	Mio.US-$	537.3	3412.8		382.5	1046.4		767.5	2130.6	
	p.c.			22.80			11.80			12.01
p.c. from LDC	p.c.	0.21	2.19		0.02	0.06		0.09	0.33	
	p.c.			59.01			25.00			29.40
Exports (World)	Mio.US-$	3846.5	8494.2		551.1	1344.8		2945.7	8015.0	
	p.c.			9.20			10.40			11.78
p.c. to LDC	p.c.	37.41	29.83		11.76	11.67		17.67	16.08	
	p.c.			6.50			10.30			10.59
Manufacturing										
Imports (World)	Mio.US-$	7303.8	30415.5		2071.4	5142.4		7524.2	26953.9	
	p.c.			17.20			10.60			15.23
p.c. from LDC	p.c.	13.22	10.48		2.67	2.76		10.21	6.95	
	p.c.			14.20			11.00			10.42
Exports (World)	Mio.US-$	13841.0	30454.5		1992.9	5788.6		12292.4	39417.9	
	p.c.			9.17			12.60			13.83
p.c. to LDC	p.c.	33.73	27.70		14.22	9.75		16.56	12.42	
	p.c.			6.80			8.00			10.26

[a]For definition see table A1. - [b]According to national classification. Figures converted from national currency by DM 4.00 per US-$ in 1962 and DM 3.27 per US-$ in 1971.

Source: UN, Commodity Trade Statistics, Series D, New York, var.issues. - OECD, Trade by Commodities, Series C, Paris, var. issues. - Statistisches Bundesamt Wiesbaden, Fachserie G: Außenhandel, Reihe 7: Sonderbeiträge, Außenhandel nach Ländern und Warengruppen und -zweigen des Warenverzeichnisses für die Industriestatistik, Stuttgart, var. issues.

consequence, any attempt to evaluate the prospects of this industry in a given country is somewhat shaky unless a disaggreated approach is chosen. Whatever the determinants of international specialization, one would expect a rather differentiated picture as to the future viability of the various sub-branches of machinery advanced countries. True, on a priori considerations a lasting competitive edge of industrialized countries would be supposed in the New Good segments of this industry be they capital-intensive or labour-intensive. It is reasonable to assueme, however, that some branches of mechanical engineering are Mature,

giving rise to increasing competition from low-wage countries once their supply potential is established[1]. Moreover static or dynamic economies of scale may outweigh or reinforce disadvantages or advantages based on relative factor-absorption in production. Natural resources such as iron ore d posits may do so as well if an industrial complex of the iron and steel, and machinery industries establishes cost advantages. Finally, notwithstanding real cost advantages, any kind of barriers to trade may hinder or postpone rational international specialization[2].

23. A proper assessment of comparative advantages would require the formulation and testing of hypotheses as outlined above.

---

1 This may even prove correct for some capital-intensive Mature Goods, since some of these countries, namely oil-rich countries, do not suffer from capital scarceness.

2 In this context a crucial question concerns the diffusion of technological know-how in engineering. Patent rights, which in principle are apt to make technological know-how tradeable are often used restrictively and thereby hinder rather than promite an efficient division of labour. For a discussion of this point see UNCTAD, Problems and Prospects in the Export of Manufactured Goods from Less Developed Countries (E/CONF. 46/P/2).

Because disaggregated statistical information about factor absorption, economies of scale or trade barriers is extremely scarce, this procedure runs into great difficulties. Therefore we shall content ourselves with an indirect approach, namely "revealed" comparative advantage[1]. In short, this concept claims that comparative advantage is reflected in actual international trade flows. Thus, the foreign trade position of a specific branch compared to a relevant reference system indicates its international competitiveness. Though this concept is manageable, it has shortcomings: Firstly, any distortions caused by trade barriers are measured as real cost advantages or disadvantages; secondly, it fails to distinguish betweeen supply and demand factors. Therefore the results obtained in this section have to be interpreted with caution.

24. Revealed comparative advantage can be assessed both by a gross concept, relative export performance, and by a net concept, relative net export performance. In the former case the term "relative" refers to other countries' export performance in the same commodity; in the latter it refers to the same country's net export performance in other commodities. The general qualifications made above affect the validity of both concepts though to a different extent depending on the degree of differences in export subsidies, in tariff and non-tariff trade barriers and in consumer preferences for the branch-specific exports or imports relative to the respective reference system. Apart from this, the concepts differ both

---

1 See H. H. Liesner, The European Common Market and British Industry. "The Economic Journal", Vol. LXVIII (1958), pp. 302 sqq. - Bela Balassa, Trade Liberalization and "Revealed" Comparative Advantage. "The Manchester School of Economic and Social Studies", Vol. XXXIII (1965), pp. 99 sqq. - Bela Balassa etal., Studies in Trade Liberalization - Problems and Prospects for the Industrial Countries Baltimore 1967.

in their applicability and in their analytical sharpness. From the point of view of data the gross concept is superior in that export statistics are generally more detailed than import statistics. Also, international comparison on the basis of the net concept suffers, because US import data are fob whereas Swedish and German import data are cif[1]. Another shortcoming of the net concept concerns the netting of experts with imports: Regardless of the level of aggregation, cross-price elasticities between export and import products of a given item of the classification scheme may be rather low due to the heterogenity of machinery; in so far as import commodities of a given category are non-competing with export commodities of the same category the results of the calculations of net export ratios are biased. The decisive difference between the two concepts, however, is related to their analytical power. In fact, the concepts answer different questions: The gross concept states advantages or disadvantages of a given country in comparison to the reference countries in third markets, whereas the net concept measures advantages or disadvantages in trading a specific commodity with the reference countries. Thus, the latter concept seems to be more adequate for assessing comparative advantage and will be applied here.

25. The revealed comparative advantage (RCA) of the United States, Sweden and Germany within mechanical engineering was computed according to:

$$RCA = \frac{X_{ij} - M_{ij}}{X_{ij} + M_{ij}} \cdot \frac{\sum_i X_{ij} - \sum_i M_{ij}}{\sum_i X_{ij} + \sum_i M_{ij}} - 1 \quad \begin{cases} \cdot\ 100 \text{ for } \sum_i X_{ij} - \sum_i M_{ij} \geq 0 \\ \cdot\ -100 \text{ for } \sum_i X_{ij} - \sum_i M_{ij} < 0 \end{cases}$$

---

1 Evidently this discrepancy is relevant only to the extent that the ratio of cif and fob values differs as between the commodity in question and the reference commodities.

where

X = Exports
M = Imports
i = Commodity subscript (four-digit SITC-groups)
$_{i}$ = SITC-groups 5-8 [1]
j = Country subscript

Hence, a comparative advantage in activity i is indicated if the net trade balance, weighted by the relative trade volume, with the countries of reference for this activity surpasses the respective value for all manufacturing activities. In order to eliminate short-term influences, the calculations are based on a three-year average; the computations were carried out for the years 1961 to 1963 and 1969 to 1971, allowing an inter-temporaral comparison as well. Since we are especially interested in the division of labour between industrialized and developing countries, the relative trade performance was computed both against the world and against total developing countries.

26. The results of the calculations are presented in Table A1. In interpreting this table it has to be noted that the availability of statistics differed between the observation periods and among the countries; accordingly several gaps exist. Moreover, in the case of comparative advantage vis à vis developing countries a number of sub-branches were excluded from the analysis because some trade connections with developing countries still seem too sporadic to be able to reveal comparative advantage; therefore,

---

1 Trade in agricultural commodities and in raw materials (Ricardo-goods) was excluded from the reference system as the former is subject to extraordinary protectionistic measures and the latter depends on the availability of natural resources.

in Table A1, RCA-values for these sub-branches are shown in brackets[1].

One systematization of the results is given in Table 12. It offers an insight into the (unweighted) degree of diversification of revealed comparative advantage for each country and each period of investigation. As the number of sub-branches for which data were available differed, the computations were based on a consistent as well as on the respective maximum sample. Judged from the consistent sample, the results of Table 13 may be summarized as follows:

- An inter-country comparison reveals that all three countries maintain a strong position in the vast majority of machinery sub-branches. Germany, with only one branch of comparative disadvantage in 1969-1971 (construction and mining machines vis á vis world) performs best. Both other countries are close to that performance, except for Sweden in 1961-1963.

- The competitiveness of the United States', Sweden's and Germany's mechanical engineering industries is still more marked if analyzed over time: Comparative advantage becomes more diversified in all cases except the United States vis à vis world.

- In comparing the degree of diversification according to

---

1 Admittedly, the criteria for selecting these branches are somewhat arbitrary. We eliminated those four-digit activities whose share in the trade volume (X+M) with developing countries compared to the trade volume with the world was less than half of the respective share for total machinery (1971). In this way, three of the United States' sub-branches (agricultural machinery for harvesting, statistical machines, and sewing machines), five of Sweden's sub-branches (steam engines and turbines, aircraft engines, office machines n.e.s., sewing machines, and part and accessories of machines n.e.s.), and three of Germany's sub-branches (aircraft engines, statistical machines, and office machines n.e.s.) were excluded.

Table 13 - The Diversification of Revealed Comparative Advantage in the Mechanical Engineering Industries of the United States, Sweden and the Federal Republic of Germany in 1961/1963 and 1969/1971 (per cent)[a]

Country vis a vis Region	United States 1961/63	United States 1969/71	Sweden 1961/63	Sweden 1969/71	Germany 1961/63	Germany 1969/71
			Consistent Sample[b]			
World	87.5	87.5	68.8	81.3	87.5	93.8
Developing Countries	87.5	93.8	75.0	100.0	100.0	100.0
			Maximum Sample[c]			
World	84.6	79.4	68.2	61.3	80.0	86.1
Developing Countries	99.9	95.8	85.0	100.0	100.0	100.0

[a]Measured as number of branches of revealed comparative advantage in percentage of the number of all branches of the respective sample. - [b]16 out of the 36 sub-branches of mechanical engineering. This was the maximum available to allow for a consistent intertemporary and inter-country comparison. - [c]Maximum sample available for each year and each country.

Source: Table A 1.

region the high-income countries do equally well or better vis à vis developing countries than vis à vis the world. Moreover, if a country possesses a comparative advantage (or disadvantage) vis à vis the world at a point in time, it normally also possesses one vis à vis the developing countries at the same point in time. This was true in 84 out of 96 cases.

Favourable as it remains, this picture becomes a bit less bright if judged from the maximum sample:

- For all three countries the number of branches of comparative disadvantage vis à vis the world is higher than in the consistent sample, notably for Sweden in 1969-1971.

- Over time, the same is true for the United States vis à vis both regions and for Sweden vis à vis the world.

27. Yet, this conclusion is premature, since from the point of view of structural adjustment requirements the change in comparative advantage rather than crossing the dividing line between comparative advantage and disadvantage is relevant. Indeed, based upon this test, the outcome is far less favourable to the countries in question. In Table 14 we have compiled these sub-branches, the comparative position of which deteriorated over time or did not improve as much as for the machinery average[1]. The latter category (bracketed) may be interpreted as next best candidates for deteriorations of comparative advantage, although this must not necessarily

---

1 Obviously, this procedure suffers from the impossibility of distinguishing between demand and supply effects. Apart from changes in comparative costs at a given structure of protection, the relative trade performance of a commodity depends on the income elasticity of its domestic import demand in relation to respective values for the refernce system. Demand factors, however, also cause structural adjustment pressure.

Table 14 - The United States', Sweden's and Germany's Mechanical Engineering Industries: List of Candidates Suffering from Decreasing Competitiveness[a,b]

United States	Sweden	Germany
vis à vis world		
Internal Combustion eng.	Internal Combustion eng.	(Agric. mach. for harvesting)
Agric. mach. for harvesting	Calcul. and acc. mach.	Typewriters etc.
Typewriters etc.	Statistical mach. cards etc.	Statistical mach. cards etc.
Statistical mach. cards etc.	Mach. for working hides	Office machines n.e.s.
(Mach. tools for work. metals)	Food processing mach.	(Metalworking machinery)
Textile machinery	Construction and mining mach.	(Mach.for working hides)
Mach. for working hides	Glass working mach.	(Paper mill and pulp mill mach.)
Sewing machines	Heating and cooking equ.	(Printing and bookbind. mach.)
(Paper mill and pulp mill mach.)	Pumps and centrifuges	(Food processing mach.)
Domestic appl., non-electrical	Domestic appl., non-electrical	(Glass working mach.)
(Ball roller and needle roll. bear.)	Powered tools n.e.s.	(Heating and cooling equ.)
	Ball roller and needle roll., bear.	(Mechanical handl. equ.)
		(Domestic appl., non-electrical)
vis à vis developing countries		
Typewriters etc.	Typewriters etc.	(Internal Combustion eng.)
(Calcul. and acc. mach.)	(Calcul. and acc. mach.)	(Typewriters etc.)
Office machines n.e.s.	(Statistical mach. cards etc.)	(Mach. tools for work, metals)

[a]For method of selection see para 27. - [b]Sub-branches in brackets show decreasing competitiveness relative to the machinery average.

Source: Table A 1.

happen. The most striking deteriorations occurred in Sweden, matching nicely with the adjustment process observed above (para. 6). In the United States as well, quite a spectrum of branches is hit by decreasing competitivenes, whereas in Germany this phenomenon is limited to office machines. Again, the competitive pressure seems to stem mainly from other industrialized countries: except in the field of office machines, the competition from developing countries is not relevant yet.

28. Given a relatively similar factor endowment in the countries of investigation and assuming identical production functions in each country for every branch of the four-digit SITC level one should expect a uniform pattern of comparative advantage to emerge in these countries. A first glance at Table A1 tempts one to reject this hypothesis. Indeed, taking the 1969/71 calculations, there are only twelve out of the thirty possible cases in which all countries happen to show a comparative advantage vis à vis the world and there are none, in which all show a mutual disadvantage. Vis à vis developing countries the evidence however, is much more consistent: seventeen out of the eighteen possible cases show mutual comparative advantage. Still, the picture remains rather unsystematic when ranking the industries for each country and each period according to their RCA-values (Table 15):

- Vis á vis the world, the structure of comparative advantage within each country over time is fairly stable, whereas the coefficients of rank correlation between each pair of countries completely fail to be convincing - either positively or negatively.

- Vis à vis the developing countries, the patterns of comparative advantage, neither within each country over time, nor between any pair of countries at points in time show any high correlation. Germany's structure over time and the pair United States and Sweden in 1960/71 are exceptions.

Table 15 - Spearman Coefficients of Rank Correlation between the Structure of Revealed Comparative Advantage for the Mechanical Engineering Industries of the United States, Germany and Sweden[a]

Countries of Investigation	United States 1961/63	United States 1969/71	Sweden 1961/63	Sweden 1969/71	Germany 1961/63	Germany 1969/71
	vis à vis world					
United States 1961/63	1.00	0.67	-0.13	-0.09	-0.14	-0.25
United States 1960/71	0.41	1.00	-0.04	-0.20	-0.27	-0.16
Sweden 1961/63	-0.08	-0.46	1.00	0.71	0.04	-0.07
Sweden 1969/71	0.32	0.61	0.03	1.00	0.07	0.06
Germany 1961/63	0.21	0.03	0.48	0.04	1.00	0.86
Germany 1969/71	-0.08	0.29	-0.05	0.31	0.62	1.00
	vis à vis total developing countries					

[a]The rank correlations have been computed by ranking the maximum amount of identical SITC four-digit groups for each pair of countries and periods.

Source: Table A 1.

To begin with, the latter result may mainly reflect the fact that it was only during the period of investigation that some low-income countries made the first steps towards developing an engineering sector. Based on the performance vis à vis the world, the general impression from this analysis is that there exists a considerable intra-branch specialization in machinery among the advanced economies. This seems to be predominantly caused and maintained by dynamic economies of scale stemming from the structure of domestic demand (e.g. United States' aircraft engines, Sweden's paper mill and pulp mill machines, and of Germany's internal combustion engines). Another lesson to be drawn from the analysis is that apart from a narrow range of distinctly labour-intensive engineering activities, developing countries seem to be capable of potentially developing comparative advantages only in those activities which are both supported by domestic demand and neglected by suppliers in the advanced economies.

Concluding Remarks

30. The initial dynamic impression of the machinery industry gained from viewing its rapid post-war growth and export performance has been shown to be no longer valid for the highest income countries. Since we can base our judgement only on developments in the United States, Sweden and Germany, we can hardly claim that it applies to all highly industrialized countries. Nevertheless, it seems plausible that such countries, when they attain a similar level of development, may very well share the experience of the three countries investigated. The evidence is highlighted by the following characteristics:

- at the level of development of the countries investigated, the machinery industry as a whole seems to be attaining its peak share of GDP;

- the trend of relative factor absorption in machinery as a whole indicates that highest income countries offer other industries equal, if not better locational advantages;

- the competitiveness of machinery sub-branches varies widely both among countries and activities.

31. The conclusion that machinery's share in GDP peaks at the level of development af about US$ 4,500 per capita (1969 US$) is supported by the results of the cross-section analysis and the historical experience of the United States[1,2]. Although Sweden and Germany have not yet shared this experience, certain indications point in the same direction. For one thing, Germany and Sweden are approaching the income range in which the United States' machinery industry peaked: for another, national idiosyncracies, as observed in desdeviations from normal patterns, are dwindling the more rapidly, the greater the deviation.

32. Machinery is still one of the most successful export industries of these countries. Only for Sweden did revealed comparative advantage for machinery as a whole decline. In contrast to its general export success, the development of machinery's relative factor absorption is not consistent with a factor absorption pattern expected from an industry with future locational advantages in high income countries. Human capital and skill intensity, the factors relatively most abundant in these countries, is declining. Furthermore, physical capital intensity, presumably the next most relatively abundant

---

1 The mid-sixties seem to have been the peak for the U.S. machinery share of GDP (p.c.):

1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
2.7	3.0	2.8	2.7	2.9	2.9	3.2	3.3	3.6	3.5

1968	1969	1970	1971
3.3	3.4	3.2	2.9

2 For development of manufacturing share of GDP see para 5.

factor, is below average in the first place. Therefore, the high income countries cannot be expected to offer the machinery industry immunity from new competition in the future.

33. The source of this new competition seems to be the recently industrialized countries rather than the developing countries proper. Though a host of Swedish and United States machinery sub-branches suffered from declining competitiveness vis à vis the world, they did not suffer to nearly this extent vis à vis the developing countries. Indeed, only office machinery experienced any significant decline in competitiveness against this group of countries. It must be considered, however, that the developing countries are only now entering the engineering sector.

34. What about future developments? To gain a rough quantitative impression of the impact these developments will have on the three countries investigated, we calculated machinery shares of manufacturing value added and employment for 1985. Forecasts of the exogenous variables, per capita income and population, were drawn from previously published sources, though the forecast period in general had to be extended to 1985 (Table A2).

With these exogenous data and the cross-section estimates, the respective normal shares were forecast. Two alternative assumptions concerning the development of the deviations between normal and actual shares were made. First, it was assumed that the deviations would remain as they were in 1971, or in 1969 for Germany (No Approach Case); second, it was assumed that the observed trend of the actual-normal share ratio would continue to 1985 (Trend Approach Case)[1].

---

1 The trend regressions are shown in Table A4.

The forecast values are given in Table 16. It shows that:

- in the United States, under both assumptions, a rather smooth adjustment process is indicated by the trend approach. This is the more likely case.
  First, the relatively declining importance of the aerospace and defense activities leads to a more elastic supply of engineers. Second, the December 1971 realignment and ensuing developments favor the relatively export intensive branches such as machinery.

- In Sweden the alternative assumptions lead to two quite different machinery shares of manufacturing value added, whereas the employment shares are fairly close. The Trend Approach implies a relative factor income squeeze so severe that a sharp adjustment is indicated. Yet, the Trend Approach Case seems the one more likely to occur. This is because Sweden exhibits more machinery sub-branches suffering from declining competitiveness than the other two countries. Also, Sweden's machinery industry is the sole case which exhibits declining competitiveness as a whole.

- In Germany, the alternative forecast suggest a problem similar to that in Sweden, though less dramatic than Sweden's. Again, if the trend development occurs, a severe factor income squeeze would result. But in Germany the Trend Approach Case seems more likely, also. Though German machinery proved extraordinarily competitive internationally, this performance was markedly supported by the long-lasting undervaluation of the Deutsche Mark, which was done away with only in the beginning of the 1970s.

All this evidence warrants the conclusion that by the middle of the 1980s the Swedish and German machinery industrie will have given up their position among the growth industries and will have become relatively shrinking branches. This stage has already been reached in the United States.

Table 16 - Alternative Developments of Machinerys' Value Added and Employment Shares of Manufacturing in the United States, Sweden (1971 to 1985), and Germany (1969 to 1985), (p.c.)

Machinery Shares of Manufacturing	United States		Sweden		Germany	
	1971[a]	1985	1971[a]	1985	1969[a]	1985
Alternative I[b] No Approach						
Value Added	9.8	10.4	13.5	15.4	10.8	12.5
Employment	10.0	10.6	14.2	16.0	13.0	15.1
Alternative II[c] Trend Approach						
Value Added	9.8	12.6	13.5	10.8	10.8	9.7
Employment	10.0	11.7	14.2	14.8	13.0	15.4

[a]Actual shares except for Alternative I. - [b]Calculated by assuming no further approach of actual to normal share. - [c]Calculated by assuming past trend approach (table A3) to normal share.

Source: Tables A2 and A3. - Own calculations.

Table A1 - Revealed Comparative Advantage of the Mechanical Engineering Industries of the United States, Sweden and the Federal Republic of Germany 1961 to 1963 and 1969 to 1971

SITC NO.	Commodity Group	United States vis a vis				Sweden vis a vis				Fed. Rep. of Germany vis a vis			
		World		Dev. Countries[b]		World		Dev. Countries[b]		World		Dev. Countries[b]	
		1961/63	1969/71	1961/63	1969/71	1961/63	1969/71	1961/63	1969/71	1961/63	1969/71	1961/63	1969/71
7111	Steam Generation Boilers	.	1589	.	.	.	96	.	.	.	196	.	.
7112	Boiler Home Plant	.	1685	.	.	.	-1516	.	.	.	124	.	.
7113	Steam Engines and Turbines	.	-121	.	155	.	1816	.	(89)	.	105	.	45
7114	Aircraft Engines	106	1844	44	149	.	-2975	(-121)	(51)	-179	-124	(-140)	(-27)
7115	Intern. Combustion Engines	164	39	38	128	-292	-3109	32	91	57	123	40	54
7116	Gas Turbines	.	1057	.	.	.	-669	.	.	.	-35	.	.
7117	Nuclear Reactors	.	.	.	.	.	-3237	.	.	.	97	.	.
7118	Engines, n.e.s.	.	174	.	.	.	-426	.	.	.	25	.	.
7121	Agric. Mach. for Cult. the Soil	.	195	.	133	.	.	.	.	.	58	.	47
7122	Agric. Mach. for Harvesting	45	-435	(41)	(134)	.	.	.	.	79	117	42	66
7123	Milling Machines etc.	160	.	39	.	.	.	.	.	28	100	40	.
7125	Tractors	121	1446	38	157	-901	.	13	.	14	96	42	69
7129	Agricultural Machinery, n.e.s.	.	1196	.	.	.	.	.	.	.	32	.	.
7141	Typewriters	-240	-1548	-49	-83	786	1099	58	74	74	51	41	49
7142	Calculat. and Account. Mach.	-21	1043	41	119	2135	833	62	98	-41	6	44	64
7143	Statistical Mach. cards etc.	191	92	(41)	(107)	1393	611	30	56	-86	-163	(35)	(7)
7149	Office Machinery, n.e.s.	196	1418	38	9	-2468	-1028	(56)	(97)	-164	-100	(39)	(49)
7151	Machine Tools for Work. Metals	141	744	37	118	-813	-708	26	89	54	115	37	48
7152	Other Metalwork. Machinery	195	1355	35	148	-1261	295	-16	96	100	141	41	65
7171	Textile Machinery	88	-485	34	120	-1191	474	35	85	47	141	41	66
7172	Machinery for Working Hides	-13	-341	34	.	1439	-980	64	.	117	195	46	.
7173	Sewing Machines	-136	-1257	(-129)	(76)	662	1203	(16)	(98)	39	108	28	52
7181	Paper Mill and Pulp Mill Mach.	163	395	38	146	701	884	-52	100	96	155	41	64
7182	Printing and Bookbinding Mach.	55	594	30	145	-656	-133	44	98	104	161	41	66
7183	Food Processing Mach.	118	992	35	140	674	-131	43	96	111	177	42	67
7184	Construction and Mining Mach.	231	1878	44	148	1024	625	31	98	-45	-19	39	61
7185	Glass Working Mach.	185	1529	41	148	2826	2157	42	98	94	143	41	64
7191	Heating and Cooling Equip.	210	1675	38	148	2570	1229	38	98	73	87	41	64
7192	Pumps and Centrifuges	185	1436	38	146	744	353	42	89	46	86	40	60
7193	Mechanical Handling Equip.	191	1560	38	146	101	981	-21	98	81	91	39	62
7194	Domestic. Appl., Non-Electrical	50	-1314	40	.	3617	1976	42	.	99	163	40	.
7195	Powered Tools, n.e.s.	154	1017	37	140	2490	1852	32	96	66	127	37	59
7196	Other Non-Electrical Mach.	.	1518	.	144	.	312	.	96	.	137	.	65
7197	Ball Roller and Needle Roller Bear.	89	194	-1	145	4021	2430	44	100	1	46	15	63
7198	Mach. and Appl., n.e.s.	.	964	.	143	.	79	.	96	.	149	.	66
7199	Parts and Acc. of Mach., n.e.s.	.	1235	.	125	.	-1720	.	(88)	.	57	.	46
71	Mechanical Engineering	137	949	43	132	731	391	53	96	47	86	43	60

[a] For method of calculation see para . Comparative disadvantage is indicated by negative figures; figures in brackets refer to branches which are excluded from the analysis (see para).- [b] Africa, Asia excluding Japan and socialist countries, Latin America, Greece, Portugal, Spain, Turkey, Yugoslavia.

Source: OECD, Statistics of Foreign Trade, Trade by Commodities, Series C, several issues.

Table A 2 - Forecast of GDP per Capita[a] and Population for the United States, Sweden and Germany, 1971 to 1985[b]

	Unit	United States		Sweden		Germany	
		1971[c]	1985	1971[c]	1985	1971[c]	1985
GDP/capita	US-$	4 643	5 879	3 817	5 932	2 856	4 946
Population	Mio.	207.0	234.7	8.1	8.6	61.6	59.1

[a]In purchaser prices and exchange rates of 1969. - [b]Calculated by applying recent estimates of longer-term growth-rates from various sources to the period 1971 to 1985. - [c]Actual values.

Source: OECD, National Accounts Statistics, var.issues. - UN, Monthly Bulletin of Statistics, var. issues. - Estimates of C.Almon et.al., University of Maryland (for the United States). - OECD, The Growth of Output 1960 to 1980 - Retrospect, Prospect and Problems of Policy, Paris, 1970 (for Sweden). - Gerhard Fels und Klaus-Werner Schatz, Sektorale Entwicklung und Wachstumsaussichten der Westdeutschen Wirtschaft bis 1980, Die Weltwirtschaft 1974, Heft 1 Tübingen, 1974 (for Germany).

Table A 3 - Normal Share of Machinery's Value Added and Employment for the United States, Sweden (1971 to 1985), and Germany (1969 to 1985), (p.c.)[a]

Machinery share in Manufacturing	United States		Sweden		Germany	
	1971	1985	1971	1985	1969	1985
Value Added	12.0	12.7	8.6	9.8	9.7	11.1
Employment	11.7	12.3	9.1	10.1	9.7	11.0

[a]Calculated according to equations (1) and (2) of paras and exogenous variables given in table A 2.

Source: Own calculations.

Table A 4 - Trend Regressions of the Deviations Between Actual nad Normal Shares of Machinery's Value Added (DVA) and Employment (DEM) in Manufacturing,[a] 1955 to 1971

							R^2	n
United States								
DVA	=	0.7769	+	0.0076 t			0.456	14[b]
				(± 0.0022)				
DEM	=	0.7926	+	0.0056 t			0.587	14[b]
Sweden								
DVA	=	1.9318	-	0.0269 t			0.746	17
				(± 0.0040)				
DEM	=	1.6756	-	0.0070 t			0.487	17
				(± 0.0017)				
Germany								
DVA	=	1.3698	-	0.0161 t			0.837	15[c]
				(± 0.0017)				
DEM	=	1.3215	+	0.0026 t			0.413	15[c]
				(± 0.0000)				

[a]Measured as ratio of actual to normal shares. - [b]1958 to 1971. - [c]1955 to 1969.

Source: Own calculations

Kieler Arbeitspapiere - Kiel Working Papers:

Kiel Working Papers make available to interested persons preliminary versions of papers originating from work done at the Kiel Institute of World Economics. Distribution rests with the authors.

1. M. G i r g i s , Labor Absorptive Capacity of Export Expansion and Import Substitution in Egypt, 1954 to 1970. Kiel, July 1973, 32 pp.

2. A. D. N e u , Adjustment in the Textile and Clothing Industry. The Case of West Germany. Kiel, November 1973, 32 pp.

3. W. K o s c h o r r e c k , Antidumpingrecht im Bereich der Bundesrepublik Deutschland. Kiel, November 1973, 26 S.

4. H. R. K r ä m e r , The Changing Principles of International Trade Policy. Kiel, November 1973, 17 pp.

5. S. H e l d t , Exportförderung in Lateinamerika, insbesondere in den Andenländern. Eine Bestandsaufnahme. Kiel, November 1973, 31 S.

6. U. H i e m e n z and K. v. R a b e n a u , Effective Protection of West German Industry. Kiel, December 1973, 47 pp.

7. W. K o s c h o r r e c k , Die paratarifären Handelshemmnisse bei Eifuhr in die Bundesrepublik. Kiel, Dezember 1973, 24 S.

8. H. R. K r ä m e r , "Technische Hemmnisse" Bei Einfuhren in die Bundesrepublik Deutschland. Gesundheitsschutzbestimmungen, Sicherheitsvorschriften, Normen and Maßnahmen zum Schutz der Umwelt. Kiel, Dezember 1973, 44 S.

9. R. J. L a n g h a m m e r , Der Integrationsprozeß in Zentralafrika. Kiel, Dezember 1973, 31 S.

10. J. B. D o n g e s , The Economic Integration of Spain with the E. E. C. - Problems and Prospects. Kiel, December 1973, 28 pp.

11. W. K o s c h o r r e c k , Nichttarifäre Handelshemmnisse durch Prämien, Subventionen und Ausgleichszölle, Kiel, Januar 1974, 32 S.

12. R. J. L a n g h a m m e r , Common Industrialization Policy in Small Integration Schemes. The Central African Approach. Kiel, February 1974, 34 pp.

13. B. B i e d a , Export Performance and Potential of Singapore. Kiel, March 1974, 78 pp.

14. G. F e l s , Assistance to Industry in West Germany. Kiel, March 1974, 42 pp.

15. H. R. K r ä m e r , Nichttarifäre Handelsschranken im öffentlichen Auftragswesen der Bundesrepublik Deutschland. Kiel, März 1974, 48 S.

16. A. D. N e u , Ökonomische Implikationen einer Reform des Strafvollzuges. Kiel, April 1974, 27 S.

17. S. H e l d t , Die zentralamerikanische Integrationsbewegung, ein Erfolg? Kiel, Mai 1974, 40 S.

18. R. J. L a n g h a m m e r , Probleme und Perspektiven von Gemeinschaftsunternehmen im Rahmen einer regionalen Integration von "least developed countries". Kiel, Mai 1974, 29 S.

19. S. H e l d t , Zur Messung von Integrationseffekten im zentralamerikanischen gemeinsamen Markt. Kiel, Juni 1974, 40 S.

20. J. R i e d e l , Factor Proportions, Linkage and the Open Development Economy. Kiel, July 1974. 20 pp.

21. H. - R. K r ä m e r , The Principle of Non-Discrimination in International Commercial Policy. Kiel, July 1974, 68 pp.

22. R. P o m f r e t , Israeli Policies Towards Manufactured Goods. Kiel, August 1974. 70 pp.

23. F. W e i s s and F. W o l t e r , Machinery in the United States, Sweden, and Germany - An Assessment of Changes in Comparative Advantage. Kiel, September 1974. 56 pp.