Wolter, Frank

Working Paper

Perspectives for the international location of the steel industry

Kiel Working Papers, No. 60

Provided in cooperation with:
Institut für Weltwirtschaft (IfW)

Suggested citation: Wolter, Frank (1977) : Perspectives for the international location of the steel industry, Kiel Working Papers, No. 60, http://hdl.handle.net/10419/46762

Kieler Arbeitspapiere
Kiel Working Papers

Working Paper No. 60

Perspectives for the International
Location of the Steel Industry

by

Frank Wolter

Institut für Weltwirtschaft an der Universität Kiel

Kiel Institute of World Economics
Department I
2300 Kiel, Düsternbrooker Weg 120

Working Paper No. 60

Perspectives for the International Location of the Steel Industry

by

Frank Wolter

October 1977

Perspectives for the International Location of the Steel Industry

by

Frank Wolter

Introduction

1. Lasting steel crises in Western European and North American countries and increasing efforts of developing countries in establishing national steel industries are contrasting features of today's international steel scene [1]. Has comparative advantage in steel production shifted from the former to the latter countries? Developing countries seem to think so. Their discontent with the structural changes in the world economy which have emerged in the aftermath of World War II have led to demands for a New International Economic Order whose core targets encompass the introduction of an integrated raw material program and the enlargement of the developing countries' share in world industrial production to 25 p.c. in 2000 [2]. To achieve the industrialization target, priority sectors, among which is the steel industry, have been selected. In the present analysis an attempt is made to identify the determinants and to trace the probable shifts of this industry's international location which are to be expected from an economic point of view.

2. Still today, world production and trade in iron and steel originates predominantly in industrialized countries (Table 1). As one of the basic manufactured inputs for quite a number of industries such as

Table 1 - Regional Distribution of World Steel Production, 1966 - 1976 (p.c.)

Region \ Year	1966	1970	1973	1974	1975	1976
Developed Market Economies	66.8	67.2	66.3	65.4	60.3	60.2
of which: EC and North America	51.3	45.3	43.4	43.0	38.2	39.0
Centrally Planned Economies	29.8	29.3	29.6	30.1	34.7	32.4
Developing Market Economies	3.4	3.5	4.1	4.5	5.0	7.4
of which[a]: Latin America[b]	55.0	56.4	61.7	54.4	56.8	54.9
Brazil	21.8	23.3	24.9	23.3	25.8	29.1
World	100	100	100	100	100	100

[a]Developing market economies = 100. - [b]Argentina, Brazil, Mexico, Chile.

Source: Statistisches Bundesamt Wiesbaden, Eisen und Stahl, var. iss. - Own calculations.

construction, shipbuilding, machinery or automobiles, steel was among the first commodities to be produced industrially on a large scale and has remained keeping a prominent place in the production structure of the advanced countries. Since the mid 1960s, however, distinct shifts in the international location of this industry are indicated:

- The developed market economies tended to loose shares in world steel production. This trend, however, mainly was due to the performance of the "old" steel nations, the (enlarged) European Community and North America, whose share went down from about 51 p.c. in the mid 1960s to 39 p.c. in 1976. The younger steel nations

among the advanced countries, such as Japan, South Africa or Spain, still succeeded in increasing their world market shares.

- In contrast to developments in the old steel nations, developing countries significantly enlarged their steel production in relative terms. By now, their importance as a group is similar to that of Japan in the early 1960s. This trend is particularly noteworthly as the developing countries' share in steel production increased distinctly faster than that for overall industrial production (3).

- Modest increases in world production shares are observable for centrally planned economies. In the mid 1970s, these countries supply about one third of world steel production.

Although these trends are masked by cyclical influences, in particular the recent steel crisis in advanced economies, they may imply a longer run international relocation of the steel industry on a large scale.

Determinants of Location

3. The reasons for the changing regional pattern of world steel production may be reasonably traced back to changing demand conditions. Apart from substitution processes which affect the steel industries in all countries, empirical investigations indicate varying degrees of steel intensity in the overall development process. The secular trends from primary (agricultural) production to secundary (industrial) production in the earlier phases of development, and from secundary to tertiary (service) production in the later phase in

economic development which have been revealed [4] imply a decreasing steel intensity in the long-run growth process. This conjecture can be substantiated by an international cross section analysis in which apparent steel consumption per capita is explained by per capita income. In this test, a functional relationship was selected to allow for increasing or decreasing per capita steel consumption with rising per capita income - whatever the empirical data would show. The regressions yielded the following result [5]:

$$\ln \text{APSTCON} = -4.412 - 0.00017\ \text{PCI} + 1.40001\ \ln \text{PCI}$$

$$n = 30 \qquad R^2 = 0{,}92$$

where APSTCON denotes apparent steel consumption per capita in kg

PCI denotes per capita income in 1968 US-$

and r_y = - 0.00017 PCI + 1.40001 is the implicit income elasticity of demand.

The result corroborates the posited relationship: Up to an income level of about US-$ 2400, the development stage of countries like Israel or Japan in the early 1970s, steel demand increases faster than per capita income and afterwards expands progressively slower than overall growth. As the developed market economies (on average) have surpassed this critical income level and the developing countries are still far from having reached it the observed production trends seem to co-incide with respective demand conditions.

4. Although the influence of demand on location should (and will) not be neglected, a relatively slow growth of domestic demand must not necessarily imply worsening supply conditions. For, as a tradable, steel

need not be consumed where it is produced. Indeed, the position of developed market economies in world exports is stronger than their production shares would suggest (Table 2). In the course of time, they even could improve their position on the world market, to the

Table 2 - Regional Distribution of Steel Exports (SITC 67), 1966 - 1975

Region \ Year	1966	1970	1973	1974	1975
Developed Market Economies	81.7	82.6	85.2	88.3	86.5
Centrally Planned Economies	16.3	14.1	11.3	8.2	10.8
Developing Market Economies	0.6	1.1	1.3	1.0	2.7
of which[a]: Latin America	31.0	33.3	36.7	30.0	24.4
Brazil	10.2	17.2	11.3	9.5	.
World	100	100	100	100	100

[a]Developing market economies = 100.

Source: UN, Monthly Bulletin of Statistics, var.iss. - UN, Commodity Trade Statistics, var.iss. - Own calculations.

disadvantage of centrally planned economies. Developing countries emerge as marginal suppliers although their international competitiveness obviously increased during the period under consideration. Of course, these trade patterns are heavily influenced by barriers to international trade, which prevail to a particular extent in the steel industry. Apart from an effective tariff protection which mostly exceeds the average for all industries,

such barriers consist of "voluntary" export restraint agreement and a host of non-tariff barriers to trade which, on balance, are likely to protect the established steel producers vis á vis newcomers [6]. The most recent development in this respect is the cartell of the EC steel producers which inhibits growing imports from other than EC sources. Although it has been established because and for the duration of the severe steel recession, one might wonder whether it will be entirely abolished later on. Additional moves towards increasing protection under the name of "orderly marketing" have been very recently demanded by the U.S. government [7].

5. Such moves towards protection in the old steel nations may be also interpreted as a signal of structural weakness. To elaborate on this conjecture we shall now address ourselves to the question whether there is such thing as a "normal" pattern of development for the steel industry in the overall economic growth process. The hypothesis to be tested posites that the contribution of the steel industry to gross domestic product systematically changes as development - approximated by per capita income - proceeds. As the steel industry belongs to those branches in which scale economies are relevant in mass production, population as proxy for the domestic market size is introduced as an additional explanatory variable. The analysis was carried out by an international cross section for 1973, using the same functional relationship as applied in the demand analysis. Data were available for 53 countries from United Nations' Yearbook of Industrial Statistics. Before coming to the results it should be noted, however, that such cross section analyses for the production structure do not have any normative significance. They simply reveal the average experience of the sample countries which might also have been provoked by inefficient economic

policies. In particular, such analyses should not be used for planning purposes because this procedure might involve "the risk of transforming the misallocations of the past to the future" [8]. Rather these analyses should be looked upon as a tool useful for diagnosis.

6. Graph 1 illustrates the regression results which, indeed, are revealing [9]:

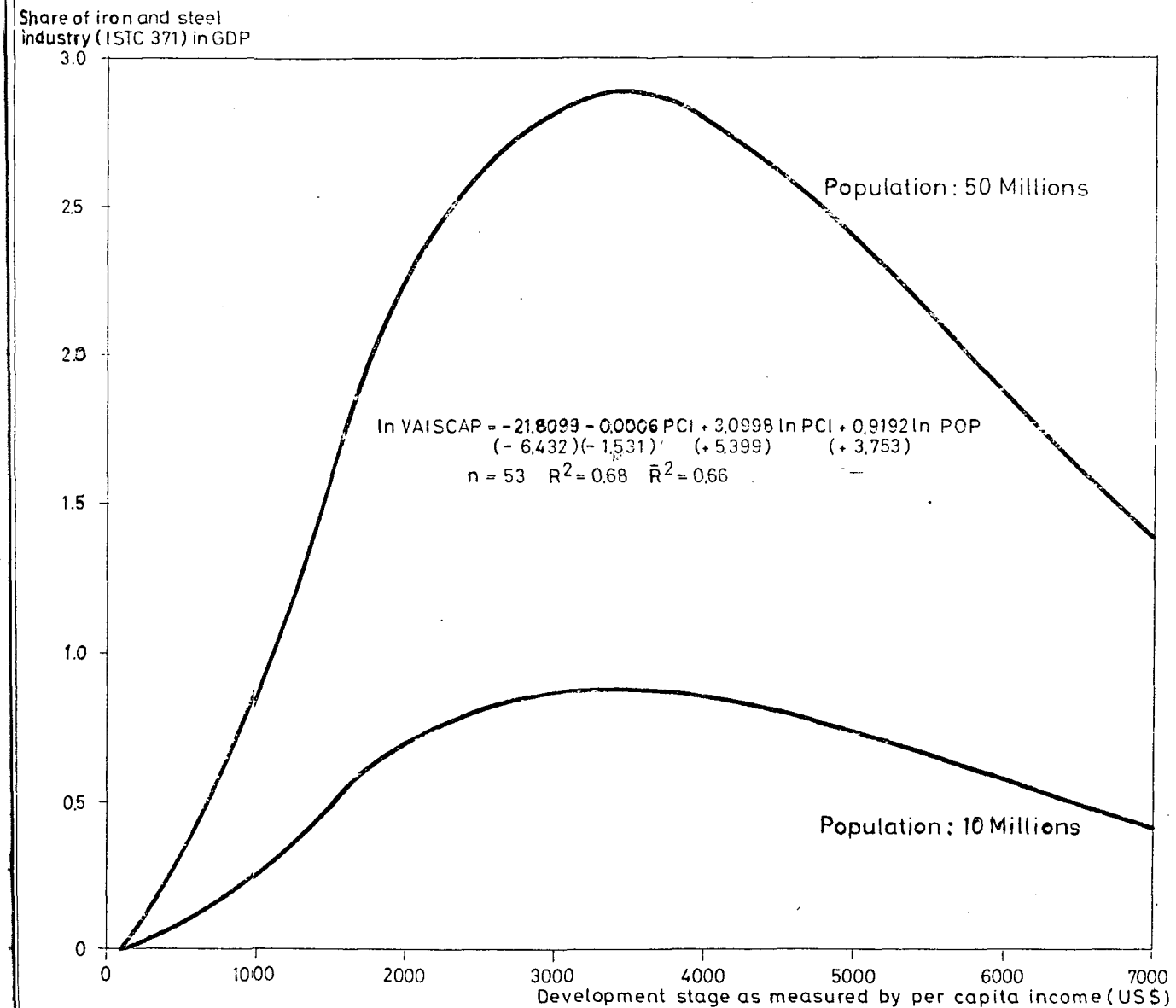
- Accordingly, up to an income level of approximately US-$ 3400 the steel industry can be considered as a growth industry with accelerating relative growth rates in the earlier phases of industrialization and decelerating relative growth rates in later phases. After the "critical" development stage has been passed, steel production becomes a shrinkage branch.

- Domestic market size seems to exert considerable influence on the relative size of the steel industry. The regression results indicate an elasticity of the steel industry's value added per capita with respect to population of 0.9.

- Although the explanatory power of the model is quite satisfactory (as is evident from R^2, 68 p.c. of the steel industry's development path is explained by the exogenous variables employed), the value of the coefficient of determination indicate that additional factors determine the steel industry's location (which will be taken up below).

In summary, the regression results strongly suggest that comparative advantage in steel production is associated with earlier development stages than those that the most advanced countries in the world economy presently enjoy. Apart from relatively unfavourable (domestic) demand conditions for steel, producers in

Graph 1 - THE PATTERN OF DEVELOPMENT OF THE IRON AND STEEL INDUSTRY, INTERNATIONAL CROSS SECTION ESTIMATE,[a] 1973



[a] *For definitions see para. 6 and footnote 9.*

Source: UN, Yearbook of Industrial Statistics 1974. - UN, Statistical Yearbook 1975. - Monthly Bulletin, var. iss. - Own calculations.

these countries might well suffer from unfavourable and worsening supply conditions. In turn, this would imply that comparative advantage has shifted to the young steel nations and, hence, that in the longer-run these countries will emerge as the dominant steel producers. For an examination of this hypothesis the product cycle model seems to be particularly useful.

7. According to the product cycle model highly advanced countries enjoy comparative advantage in innovative (R&D intensive) and skill intensive activities, semi-industrial countries in standardized production lines and less developed countries in labour-intensive mature industries [10]. Apart from income elasticities of demand and the degree of standardization three more factors exert major influence on the international location of industry. First, the availability of natural resources in individual countries may offer comparative advantage for those industrial activities which intensively use such raw materials [11]. Second, in industrialized countries environment has become a scarce production factor, reflected by increasingly strict environmental protection laws there. Such developments offer advantageous location for emission intensive industries in those economies which still possess a relatively cheap environment [12]. And third, scale economies accrue to a number of industries favouring their location in countries with a large domestic market. This latter influence, however, looses in importance in a more open world economy [13].
Calculations of relative factor requirements for the West German steel industry which may be considered representative [14] reveal the following characteristics (Table 3):

Table 3 - Indicators for Factor Requirements of West Germany's Steel Industry (Manufacturing = 100)[a]

Industry Characteristic	Relative Intensity
Physical Capital Intensity[b]	194.0
Skill Intensity[c]	90.1
Innovativeness[d]	17.2
Raw Material Intensity[e]	122.7
Energy Intensity[f]	264.9
Pollution Intensity[g]	137.4

[a]Data refer mainly to 1970. - [b]Capital stock per employee. - [c]Skilled employees in p.c. of total employees. - [d]R&D expenditures in p.c. of sales. - [e]Input from agriculture, forestry and mining in p.c. of value added. - [f]Input of fuel, electricity, gas and water in p.c. of value added. - [g]Costs of environmental protection measures in p.c. of sales. Data refer to the U.S.

Source: Statistisches Bundesamt, Fachserie D, Reihe 4. - H. Mai, Input-Output-Tabelle 1970. In: "Wirtschaft und Statistik", 1974/3. - ... R. Krengel u.a., Produktionsvolumen und -potential. Produktionsfaktoren im Gebiet der Bundesrepublik Deutschland einschließlich Saarland und Berlin (West). Berlin lfd. Jgg. - H. Echterhoff-Severitt, Forschung und Entwicklung (FuE) in der Wirtschaft 1973. Beilage zu "Wirtschaft und Wissenschaft", Heft 4/1975. - I. Walter, The Pollution Content of American Trade. "Western Economic Journal", Vol. 11 (1973). - Own calculations.

- A slightly below average skill-, and distinctly below average research and development intensity;

- An above average physical capital-, raw material-, energy- and "pollution"-intensity.

Judged from these figures, and quite in line with the result of the normal pattern analysis, steel seems not to belong to those sophisticated or knowledge intensive industries which have their proper location in high-wage countries. It has to be noted, however, that the skill intensity of this branch seem to vary in the individual sub-sectors; in particular, research and development departments, rolling mills and plants for special steels seem to be characterized by above average skill intensity [15]. Hence, the comparative disadvantage of the old steel nations may mainly refer to mass steel production.

8. The worsening competitiveness of steel plants located in the advanced countries is mainly effected by two factors. First, as steel is a highly standardized commodity whose production technology is universally available these producers are exerted to increasing competition from semi-industrial countries which can produce steel with lower wages [16]. As a consequence, steel producers of highly advanced countries successively loose world market shares and, unless highly protected, also shares on the domestic market. Concerning world market shares, this effect is readily observable for the old steel nations, the European Community and North America (Table 4). Second, and even more important, the relatively slow growth of domestic demand (para. 3) and concomittant slow production expansion in the advanced countries has unfavourable effects on average production technology. When technology is embodied in new equipment a negative vintage effect can be expected for the slow growing of stagnating steel industries in highly advanced countries as compared to the young steel nations with quickly expanding production (para. 6).

Table 4 - World Market Shares in Rolled Steel, European Community and North America, 1966 - 1975 (p.c.)

Region \ Year	1966	1970	1973	1974	1975
EC, North America	60.1	55.6	54.1	54.8	50.3
World[a]	100	100	100	100	100

[a]Including Intra-EC trade.

Source: Wirtschaftsvereinigung Eisen- und Stahlindustrie, Statistisches Jahrbuch der Eisen- und Stahlindustrie 1976.

9. In order to test this proposition, the average technology of the steel industry has been calculated on a regional basis for steel producers of the European Community and North America, other developed market economies (mainly young steel nations), centrally planned economies, developing countries and Brazil (Table 5). Technology is measured by production processes; at prevailing price levels oxygen converters and electric furnaces are regarded as relatively efficient processes [17]. In turn, the share of "other" production processes in total can be considered as a useful tool to indicate the vintage of technology: the larger this share the older average technology. The results of the calculations, first of all, reveal that over time the "more efficient" processes have been increasingly adopted in all regions. Significant differences for the level of average technology, however, are observable which fit nicely to the above hypothesis:

Table 5 - Raw Steel Production by Process and Region, 1965, 1970, 1975

Region	Year	Process			Continous Casting[a]
		Oxygen	Electric	Other	
EC and North America BRD	1965	18.3	11.1	70.6	.
	1970	44.4	15.4	40.2	.
	1975	41.5	14.5	44.0	8.6
Other MDCs[b]	1965	46.9	21.9	31.2	.
	1970	71.0	19.6	9.4	.
	1975	74.5	20.3	5.2	27.5
Centrally Planned Economies[c]	1965	3.4	9.6	87.0	.
	1970	16.8	9.4	73.8	.
	1975	24.4	10.7	64.9	4.9
Developing Countries[d]	1965	5.9	7.7	86.4	.
	1970	13.1	16.8	70.1	.
	1975	23.0	24.8	52.2	.
Brazil	1965	25.5	17.4	57.1	.
	1970	36.6	20.2	43.2	.
	1975	43.9	24.2	31.9	5.7

[a]In p.c. of raw steel production. - [b]Austria, Japan, Finland, Norway, Portugal, Sweden, Spain, South Africa, Turkey, Yugoslavia. - [c]Bulgaria, Eastern Germany, Hungary, Poland, Romania, USSR. - [d]Argentina, Brazil, Chile, Colombia, India, Mexico, Peru, Uruguay, Venezuela

Source: Wirtschaftsvereinigung Eisen- und Stahlindustrie, Statistisches Jahrbuch, var.iss. - Own calculations.

V. + CSSR!

- Most strikingly, developed market economies other than the old nations possess the most productive steel industries. Also, Brazil, which is a relatively young steel nation as well, seems to have a technologically more efficient steel industry than average EC and North American producers.

- Developing countries as a group still prove to be less efficient than the old steel nations, although over time the modernization of their steel industries seems to have been proceeding at a faster rate.

- Centrally planned economies in spite of relatively quick expansion have rather inefficient steel industries in international comparison. In 1975, they still produce two-thirds of their production with relatively old technologies; over time, the relative position vis á vis market economies deteriorated. This example, however, is not apt to falsify the vintage hypothesis. Rather, systemic incentives to risk aversion and rigidities in central planning in these countries seem to inhibit the rapid diffusion of new technology.

10. In addition to the evidence offered in Table 5, a more systematic analysis strongly supports the vintage hypothesis [18]. An international cross section analysis reveals that between 1958/60 and 1967/69 (1969 being the last year for which data were available)

- individual countries' world market shares for steel increased the more, the more rapidly these countries adopted the oxygen steel process, and

- that individual countries adopted the oxygen steel process the more rapidly the stronger their steel industries expanded.

This can be inferred from the following regression results yielded (n = 28):

$$dWMSS = 0.270 + 0.802\ dROX \quad (+\ 7.097) \qquad R^2 = 0.89$$

$$dROX = 0.037 + 0.814\ dRP \quad (+\ 9.576) \qquad R^2 = 0.87$$

where dWMSS denotes increase in world market shares of steel;

dROX denotes relative (as compared to the sample's average) change of oxygen steel production

and dRP denotes relative change of total crude steel production of the sample countries between 1958/60 and 1967/69.

As steel production expanded particularly quickly in semi-industrial and young industrial countries (Table 1, Graph 1), the observed vintage effect (Table 5) has resultet. The estimates also underline that the inroads young suppliers - mainly Japan in the 1960s and early 1970s; recently also countries such as Spain, South Corea and South Africa - made into the European Communities' and United States' steel markets is based on comparative advantage rather than on "unfair" business practices.

11. Recent developments in steel technology will additionally influence the future regional pattern of steel production as they open up efficient production possibilities on a smaller scale. Electric furnace operations can and will be established economically for the processing of locally available scrap. As a worldwide increase in electric furnace operations, in the longer-run, will inevitably drive up relative scrap prices (although the elasticity of scrap may improve due to better collection and recycling techniques) the competitive application of the conventional electric furnace process, however, presumably will be limited. Nevertheless, the increasing application

of this process will tend to lead to a regionally more evenly distributed steel production. Larger impacts may be expected from the combination of direct reduction - electric furnace - continous casting operations. As it is the most energy-intensive steel technology [19] it will be most efficiently adopted in countries with an elastic natural gas supply.

12. Finally, raw material availability is a further source of bringing about changes in the international location of the steel production, developing countries are particularly well endowed except for coking coal (Table 6). As technological developments have brought and presumably will bring coke rates down, partly by substituting it as fuel and reductant, the relatively inelastic coke supply might not be too much of a bottleneck for establishing steel industries in these countries. Considering the characteristics of the steel industry (Table 3) and the factor-price relations in developing countries, it is, however, at least open to doubt whether the steel industry is a suitable activity for countries in the early stage of industrialization as a general rule. In most developing countries, steel production will have high opportunity costs both in terms of potential growth and employment. Therefore, the general identification of the steel industry as one of the priority sectors of industrialization in developing countries (Lima Declaration and Plan of Action on Industrial Development, Second General Conference of UNIDO, March 1975) may be looked upon as the beginning of a costly path of development. To substantiate, Graph 2 shows calculations of "revealed" comparative advantage [20] of total developing countries', Latin America's and Brazil's iron and steel industries vis á vis those of developed market economies. As a reference

Table 6 - Regional Distribution of Estimated World Reserves of Natural Resources Relevant for Steel Production[a]

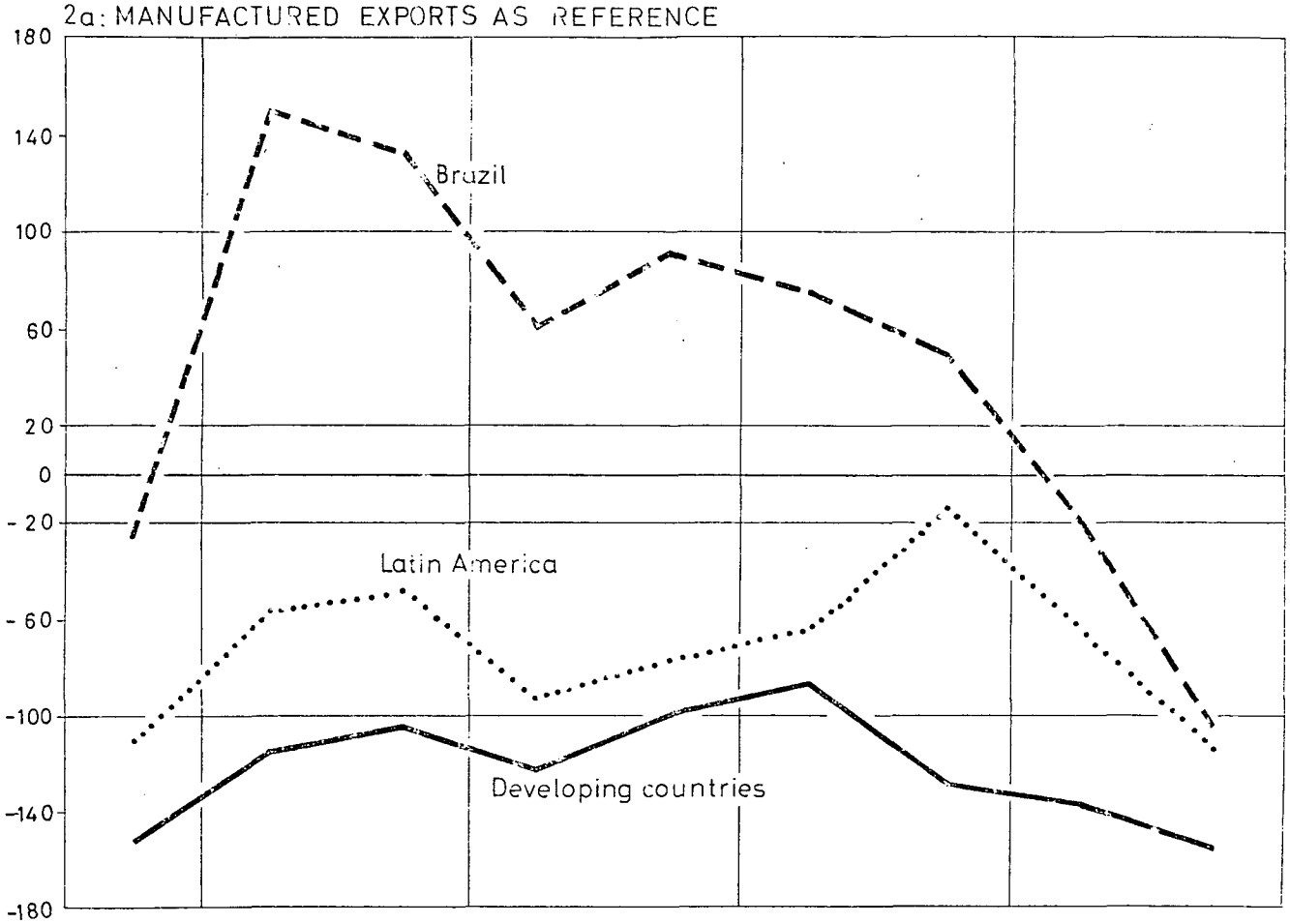
Natural Resource of	Dimension	World		Developing Countries		
			of which:		of which:	
		Total	LDCs	Total	Lat in America	Brazil
Coal	Mio. tons	8134374	1193293	1193293	35570	n.a.
	p.c.	100	14.7	100	3.0	.
Coking Coal	Mio. tons	429732	22167	22167	2530	150
	p.c.	100	5.2	100	11.4	0.7
Natural Gas	Bill. m^3	62846	28846	28846	2355	27
	p.c.	100	45.9	100	8.2	0.1
Oil	Mio. tons	74280	58679	58679	4049	101
	p.c.	100	79.0	100	6.9	0.2
Hydraulic Reserves	GW	2261	1419	1419	329	90
	p.c.	100	62.8	100	23.2	6.3
Growing Stocks in Forest	Mio. m^3	395020	122267	122267	82195	76375
	p.c.	100	31.0	100	67.2	62.5
Iron Ore	Mio. tons	689000	209827	209827	121886	72000
	p.c.	100	30.5	100	58.1	34.3
Manganese Ore	Mio. tons	3000	1206	1206	453	250
	p.c.	100	40.2	100	37.6	20.7

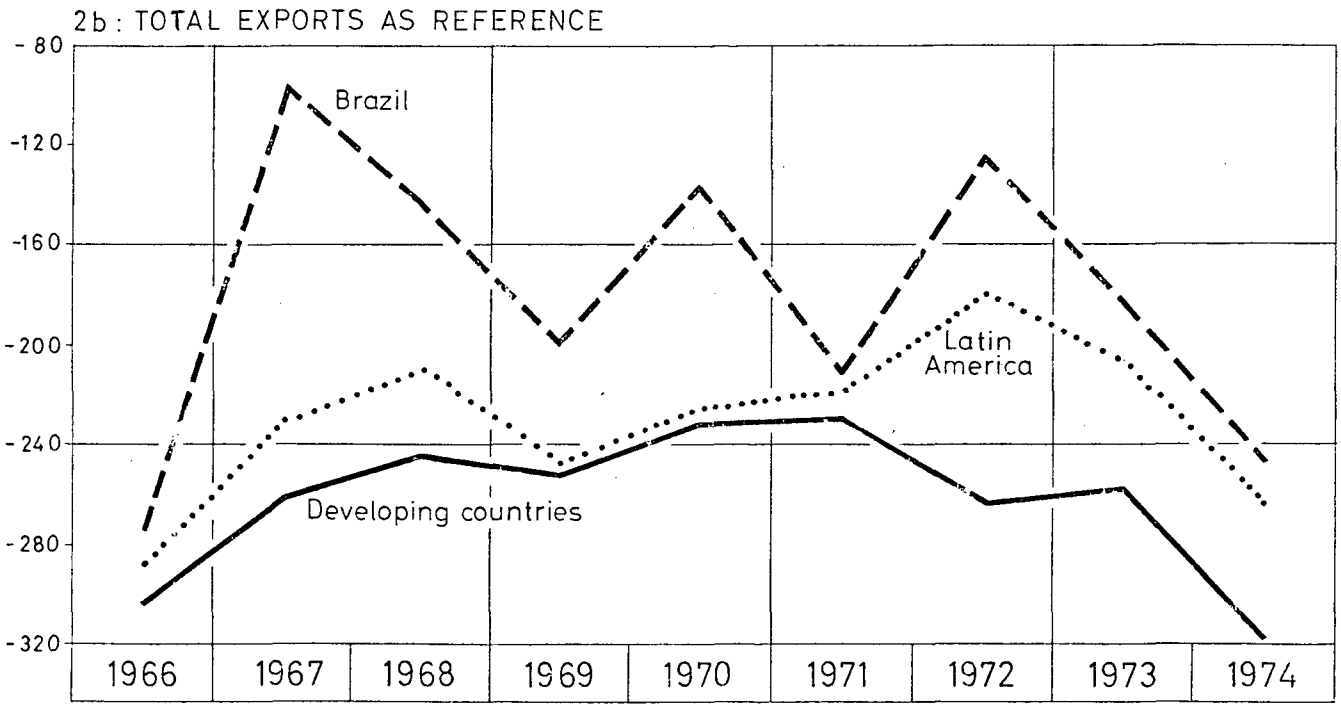
[a]Data refer to estimates mostly around 1970.

Source: UN, Statistical Yearbook 1975, New York 1976. - Data collected by UNIDO.

system both manufacturing (Graph 2a) and total tradables (Graph 2b) have been chosen. Of course this measure is a crude guide to supply conditions as it also reflects industry-specific commercial and trade policies, obligopolistic practices and demand conditions both in developing and developed countries. With these reservations in mind, it is obvious that

Graph 2 - REVEALED COMPARATIVE ADVANTAGE[a] OF THE DEVELOPING COUNTRIES', LATIN AMERICA'S AND BRAZIL'S IRON AND STEEL INDUSTRIES IN TRADE WITH DEVELOPED MARKET ECONOMIES, 1966-74





[a] *Measured as RCA = 100 · ln [(X_ijt · M_jt) : (m_ijt · X_it)], where X_jt and m_jt refer to region j's esports and imports of iron and steel products (SITC 67), and X_jt and M'_jt refer to region j's exports and imports in manufactures (SITC 5-8; graph 2a) or total exports and imports (SITC 0-9; graph 2b) at period t, respectively.*

Source : UN, Monthly Bulletin of Statistics, var. iss. - UN, Commodity Trade Statistics, var iss. - Own Calculations.

the calculations do not offer any clue for comparative advantage in steel production of developing countries as a whole or developing countries of Latin America as a group. A different result, however, emerges for Brazil's steel industry which for both reference systems and at any point in time reveals a superior performance to that of the other country groups. While compared to total tradable (and due to the abundant endowment with natural resources) a relative disadvantage in steel production is indicated, the reverse is true if compared with manufacturing [21] . This observation is consistent with results arrived at in other studies which apply international price comparisons and the much more sophisticated domestic resource cost concept to determine comparative advantage [22].

Conclusions

13. From the above analysis the following perspectives for long-term shifts in the international competitiveness of the steel industry seem to be warranted:

a) Steel producers in the United States and Western Europe increasingly will loose in international competitiveness of mass steel production. At prevailing relative wage levels (and their expected changes) they do not possess a comparative advantage in the production of such standardized commodities as steel. In addition to worsening supply conditions, relatively unfavourable demand conditions, environmental protection measures, and the relative scarcity of steel relevant natural resources add to adjustment pressure. Such pressure will be less pronounced in rolling mill operations where, apart from higher skill requirements, proximity to customers yield economic advantages. The competitive edge of the most advanced countries will remain in the production of "specialities", the development of

new steel technology (continous processes at all stages; direct reduction; iron ore preparation; soft coke; nuclear energy as alternative energy input), in the development of special steel products and their applications, in the development of capital goods for the steel industry; and in the international selling and construction of steel plants.

b) While comparative advantage in steel production is not associated with high-income levels in international comparison, it is neither with very low ones. Particularly due to its skill requirements, its physical capital intensity and its requirements for infrastructure, the steel industry is no first best candidate to start industrialization. Hence, the bulk of developing countries can reasonably be expected not to become competitive internationally in steel production on a larger scale. The same applies to centrally planned economies - albeit for other reasons (para. 9; [23]).

c) Semi- or young industrial countries will enjoy increasing international competitiveness in mass steel production. Basicly, their competitiveness stems from their wage advantage, given the universal availability of steel technology. It is reinforced by relatively rapid capacity expansion which is based on their capability to attract international demand as well as on relatively income elastic domestic markets for steel. By vintage effects such expansion results in a relatively efficient average technology which adds to competitive advantage [24] . Such semi-industrial economies include also some countries at a still rather low level of per capita income but provided with a relatively elastic supply of capital, industrial skills and an abundant endowment of natural resources and energy. Here, among others (particularly Middle-East countries) Brazil seems to be a case in point.

d) Large domestic markets tend to become less important for the establishment of steel production due to the availability of new steel technologies. A slight trend towards a regionally more even distribution of steel production can be expected from the increasing establishment of mini mills. A longer term upward movement of relative scrap prices may, however, limit this process.

14. It can be hardly doubted that the steel industries under adjustment pressure will try hard to defend their location. Defensive investment such as the recently envisaged modernization program sponsored by the European Community's Commission will be one strategy; moves towards more effective protection will surely be the second line. Especially here, the young steel nations should try to counter-act by international negociations - not only in their own interest but also in that of the consumers everywhere.

References

[1] Unless otherwise stated, throughout the paper developing countries refer to Latin America, Asia and Oceania except Japan, New Zealand and Australia and Africa except South Africa; centrally planned economies refer to Comecon Countries, North Korea, North Vietnam, Mongolia, P.R. of China and Albania; and developed market economies refer to all other countries.

[2] For an evaluation see H.H. Glismann, P. Juhl and B. Stecher, Ökonomische Implikationen der "Neuen Weltwirtschaftsordnung". Kiel Discussion Papers, No. 46. Kiel, 1976.

[3] Between 1965 and 1975 the developing market economies' share in world industrial production rose from 7.0 p.c. to 8.5 p.c. (1970 prices).

[4] G. Fels, K.-W. Schatz, F. Wolter, Der Zusammenhang zwischen Produktionsstruktur und Entwicklungsniveau. "Weltwirtschaftliches Archiv", Vol. 106 (1971), pp. 240 sqq.

[5] The estimate is taken from F. Wolter, Strukturelle Anpassungsprobleme der westdeutschen Stahlindustrie - Zur Standortfrage der Stahlindustrie in hochindustrialisierten Ländern. Tübingen, 1974, pp. 100 sqq.

[6] H.H. Glismann, Wettbewerbsbeschränkende Maßnahmen im Außenhandel. Exportkartelle und Selbstbeschränkungsabkommen mit deutscher Beteiligung. Tübingen, 1975. - UNIDO, Draft World-Wide Study of the Iron and Steel Industry: 1975 - 2000. Prepared by the International Centre for Industrial Studies. Vienna, Dec. 1976, pp. 124 sqq.

[7] Metal Bulletin, February 22, 1977.

[8] G. Fels, The Choice of Industry Mix in the Division of Labour between Developed and Developing Countries. "Weltwirtschaftliches Archiv", Vol. (108), p. 101.

[9] In the regression function the following abbreviations habe been employed: VAISCAP for value added of iron and steel industry per capita (in 1973 US-$); PCI for per capita gross domestic product (in 1973 US-$); POP for population (in mill.). The exogenous variables have been regressed on value added per capita for technical convenience. The per capita value added figures can be easily transformed into shares of the steel industry in GDP as given in Graph 1.

[10] S. Hirsch, Hypotheses Regarding Trade between Developing and Industrial Countries. In: H. Giersch (ed.), The International Division of Labour - Problems and Perspectives. Tübingen, 1974, pp. 65 sqq. - R.M. Stern, Testing Trade Theories. In: P.B. Kenen (ed.), International Trade and Finance: Frontiers for Research. Lexington, 1975.

[11] From the example of the Japanese steel industry one might deduct that the availability of natural resources is no necessary success condition for establishing raw material intensive industries. Rather, the product cycle hypothesis seems to be the governing principle. See also below.

[12] This is not to say that developing countries should imitate the advanced countries' example concerning pollution. However, in most developing countries environment is in such abundance that polluting industries might produce for many years to come without much harm. Also, there is a trade off between growth and employment on the one hand and pollution on the other hand.

[13] A further determinant of industrial location is preference similarities which partly explain the intra-industry trade among developed countries. S. Burenstam-Linder, An Essay on Trade and Transformation, Leiden, 1962. - H.G. Grubel, P.J. Lloyd, Intra-Industry Trade - The Theory and Measurement of International Trade in Differentiated Products. London, 1975. Preference similarities, however, are hardly relevant for the international location of the steel industry.

[14] G.C. Hufbauer, The Impact of National Characteristics and Technology on the Commodity Composition of Trade in Manufactured Goods. In: R. Vernon (ed.), The Technology Factor in International Trade. New York, London 1970.

[15] Kommission der Europäischen Gemeinschaften, Entwurf eines Memorandums über die allgemeinen Ziele der Eisenhüttenindustrie der Gemeinschaft für die Jahre 1978 - 1980. Bruxelles, 1970 (mimeo).

[16] It has been shown elsewhere that prices on steel are determined externally, i.e. by the world market, and wages in the steel industry internally, i.e. by wage developments in other industrial branches. F. Wolter, Strukturelle Anpassungsprobleme, op. cit., pp. 76 sqq.

[17] Of course, this is a rough, but reasonable approximation, only. For the relative advantages of the several production processes see UNIDO, Draft World-Wide Study, op. cit., pp. 135.

[18] The results are taken from F. Wolter, Strukturelle Anpassungsprobleme, op. cit., pp. 69 sqq.

[19] According to a recent IISI study the cumulative energy requirements (in 10^3 Kcal) per ton of crude steel are 3700 for the BF-BOF Process, 1400 for the Scrap of EF Process and 4900 for the DR-EF-Process.

[20] B. Balassa, Trade Liberalization and "Revealed" Comparative Advantage. "The Manchester School of Economic Studies", Vol. 33 (1965). The measurement chosen here differs from that originally proposed by Balassa and is advantageous because it is at the same time continous, unbounded and symmetric. Positive values of the applied measure indicate comparative advantage, negative values comparative disadvantage.

[21] The negative RCA-values for 1973 and 1974 seem rather to be due to temporary bottlenecks in domestic steel capacity than to indicate comparative disadvantage.

[22] J.R. Mendorica de Barros et al., Sistema Fiscal e Incentivos às Exportacoes. November, 1973 (mimeo.) quoted in W.C. Tyler, Manufactured Export Expansion and Industrialization in Brazil. Tübingen, 1976. See also Tyler, op. cit., pp. 101 sqq.

[23] This is not to say that these countries might not try to reverse their declining world market share. If so, it must, however, be doubted whether such efforts would be in line with comparative costs.

[24] Of course, this does not imply that all countries at a development stage of, say 1000 to 3400 US-$ do provide advantageous locations for steel production as the domestic market size, natural resource endowment, energy supply etc. have to be properly taken into account. Rather, the analysis suggests such countries as first best candidates for advantageous steel locations.

Kieler Arbeitspapiere - (Kiel Working Papers):

1. M. Girgis, Labor Absorptive Capacity of Export Expansion and Import Substitution in Egypt, 1954 to 1970. Kiel, July 1973, 32 pp.

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

3. W. Koschorreck, Antidumpingrecht im Bereich der Bundesrepublik Deutschland. Kiel, November 1973, 26 S.

4. H.R. Krämer, The Changing Principles of International Trade Policy. Kiel, November 1973, 17 pp.

5. S. Heldt, Exportförderung in Lateinamerika, insbesondere in den Andenländern. Eine Bestandsaufnahme. Kiel, November 1973, 31 S.

6. U. Hiemenz and K. v. Rabenau, Effective Protection of West German Industry. Kiel, December 1973, 47 pp.

7. W. Koschorreck, Die paratarifären Handelshemmnisse bei Einfuhr in die Bundesrepublik. Kiel, December 1973, 24 S.

8. H.R. Krämer, "Technische Hemmnisse" bei Einfuhren in die Bundesrepublik Deutschland. Gesundheitsschutzbestimmungen, Sicherheitsvorschriften, Normen und Maßnahmen zum Schutz der Umwelt. Kiel, Dezember 1973, 44 S.

9. R.J. Langhammer, Der Integrationsprozeß in Zentralafrika. Kiel, Dezember 1973, 31 S.

10. J.B. Donges, The Economic Integration of Spain with the E.E.C. - Problems and Prospects. Kiel, December 1973, 28 pp.

11. W. Koschorreck, Nichttarifäre Handelshemmnisse durch Prämien, Subventionen und Ausgleichszölle. Kiel, Januar 1974, 32 S.

12. R.J. Langhammer, Common Industrialization Policy in Small Integration Schemes. The Central African Approach. Kiel, February 1974, 34 pp.

13. K. Bieda, Export Performance and Potential of Singapore. Kiel, March 1974, 78 pp.

14. G. Fels, Assistance to Industry in West Germany. Kiel, March 1974, 42 pp.

15. H.R. Krämer, Nichttarifäre Handelsschranken im öffentlichen Auftragswesen der Bundesrepublik Deutschland. Kiel, März 1974, 48 S.

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

17. S. Heidt, Die zentralamerikanische Integrationsbewegung, ein Erfolg? Kiel, Mai 1974, 40 S.

18. R.J. Langhammer, Probleme und Perspektiven von Gemeinschaftsunternehmen im Rahmen einer regionalen Integration von "least developed countries". Kiel, Mai 1974, 29 S.

19. S. Heidt, Zur Messung von Integrationseffekten im zentralamerikanischen gemeinsamen Markt. Kiel, Juni 1974, 40 S.

20. J. Riedel, Factor Proportions, Linkage and the Open Development Economy. Kiel, July 1974, 20 pp.

21. H.-R. Krämer, The Principle of Non-Discrimination in International Commercial Policy. Kiel, July 1974, 63 pp.

22. R. Pomfret, Israeli Policies Towards Manufactured Goods. Kiel, August 1974, 70 pp.

23. F. Weiss and F. Wolter, Machinery in the United States, Sweden and Germany - An Assessment of Changes in Comparative Advantage. Kiel, September 1974, 56 pp.

24. J.B. Donges, R. Banerji, The Domestic Resource Cost Concept - Theory and an Empirical Application to the Case of Spain - , Kiel, November 1974, 38 pp.

25. H. Vögele, Die Entwicklung der Wirtschaftsstruktur und des Arbeitsplätzeangebots in den Ländern der Bundesrepublik Deutschland bis 1985. Kiel, Januar 1975, 78 S.

26. C.R. Chittle, The Industrialization of Jugoslavia under the Worker's Self-Management System: Institutional Change and Rapid Growth. Kiel, January 1975, 71 pp.

27. R.W.T. Pomfret, Export Policies and Performance in Israel. Kiel, February 1975, 88 pp.

28. C.R. Chittle, Yugoslavia under the Worker's Self-Management System: Growth and Structural Change in the External Sector. Kiel, March 1975, 59 pp.

29. F. Wolter, Engineering Exports of Less Developed Countries. Kiel, March 1975, 50 pp.

30. R. Vaubel, Neglected Aspects of the Parallel-Currency Approach to European Monetary Unification. Kiel, March 1975, 66 pp.

31. J.P. Wogart, Import Substitution and Export Diversification in Colombia. Kiel, April 1975, 83 pp.

32. R.J. Langhammer, "Ungleich" verteilte Kosten und Nutzen aus der regionalen Integration zwischen Entwicklungsländern. Erscheinungsbild und Bewältigungsversuche dargestellt am Beispiel der Zentralafrikanischen Zoll- und Wirtschaftsunion (UDEAC). Kiel, April 1975, 38 pp.

33. S. Heldt, Gemeinschaftliche Industrialisierungspolitik als Instrument des Ausgleichs von Nutzen und Kosten in Integrationsgemeinschaften zwischen Entwicklungsländern: Die Erfahrung des Zentralamerikanischen Gemeinsamen Marktes (CACM). Kiel, Juni 1975, 30 S.

34. S. Nehring, Zur theoretischen Einordnung impliziter Handelstransfers. Kiel, September 1975, 71 S.

35. G.B.S. Mujahid, Export Behaviour of Pakistani Firms - An Evaluation of Interviews. Kiel, September 1975, 55 pp.

36. S. Nehring, Theoretisch-empirische Probleme der Berechnung von internationalen impliziten Transfers. Kiel, September 1975, 36 S.

37. S. Heldt, Gemeinschaftliche Regelungen für ausländische Investitionen im Rahmen des Andenpaktes. Kiel, Oktober 1975, 45 S.

38. U. Hiemenz, K.-W. Schatz, Employment Creation in Less Developed Countries - A Cross Section Analysis. Kiel, December 1975, 47 pp.

39. R. Vaubel, Real Exchange-Rate Changes in the European Community: The Empirical Evidence and Its Implications for European Currency Unification. Kiel, January 1976, 31 pp.

40. R. Pomfret, Intra-Industry Trade in Israel: Level, Explanation and Implications. Kiel, January 1976, 14 pp.

41. J. Riedel, Tariff Concessions in the Kennedy Round and the Structure of Protection in West Germany: An Econometric Assessment. Kiel, March 1976, 14 pp.

42. S. Heldt, Förderung der internationalen Arbeitsteilung mittels regionaler Zusammenschlüsse? Das Beispiel des CACM. Kiel, April 1976, 21 S.

43. J. Roth, Internationale Konjunkturübertragungen und nationale Stabilisierungspolitiken bei flexiblen Wechselkursen - Ein Zwei-Länder-Totalmodell. Kiel, April 1976, 32 S.

44. R. Dick, Maschinenbau unter Wettbewerbsdruck aus Entwicklungsländern? - Ergebnisse einer Befragung westdeutscher Maschinenbauunternehmen. Kiel, Mai 1976, 37 S.

45. J.B. Donges, Zur Neuordnung des Rohstoffhandels zwischen Entwicklungs- und Industrieländern. Kiel, Mai 1976, 38 S.

46. H. Lehment, Die komensatorische Finanzierung von Exporterlösschwankungen - Eine Kritik bestehender Systeme. Kiel, Juni 1976, 11 S.

47. S. Nehring, Einige Rahmenüberlegungen zum internationalen Ressourcentransfer - Dargestellt an Thesen zum "integrierten Rohstoffprogramm". Kiel, Juli 1976, 15 S.

48. S. Nehring, R. Soltwedel, Probleme der Beschäftigungspolitik. Kiel, Juli 1976, 30 S.

49. J.B. Donges, J. Riedel, The Expansion of Manufactured Exports in Developing Countries: An Empirical Assessment of Supply and Demand Issues. Kiel, June 1976, 58 pp.

50. R. Banerji, Technology Economies of Scale and Average Size of Industrial Plants: Some Further Cross-Country Evidence. Kiel, July 1976, 28 pp.

51. R. Pomfret, The Consequences of Free Trade in Manufactures Between Israel and the EEC. Kiel, July 1976, 111 pp.

52. J.P. Agarwal, Reflections on Foreign Investment in Natural Resources of Developing Countries. Kiel, August 1976, 25 pp.

53. F. Wolter, Factor Proportions, Technology and West German Industry's International Trade Patterns - Worldwide and Regional. Kiel, September 1976, 42 pp.

54. R.J. Langhammer, Estimating the Stock of Foreign Direct Investments in the Manufacturing Sector of Francophone Subsaharian African Countries, 1963-1975. Kiel, February 1977, 23 pp.

55. H.R. Krämer, Europäische Integration. Ein Überblick. Kiel, Februar 1977, 20 S.

56. H.H. Glismann, H. Rodemer, Bufferstocks als Mittel zur Stabilisierung konjunkturbedingter Preisschwankungen auf den Weltrohstoffmärkten. Kiel, März 1977, 20 S.

57. S. Heldt, Towards the Attainment of Self-Sustaining Growth: Ghana and the Ivory Coast. Kiel, April 1977, 30 pp.

58. M. Bruch, Die regionale Struktur der verarbeitenden Industrie in Brasilien und Mexiko. Kiel, Juli 1977, 44 S.

59. B. Lebert,

60. F. Wolter, Perspectives for the International Location of the Steel Industry , Kiel, October 1977, 28 pp.