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LDCs MOVE INTO HUMAN CAPITAL INTENSIVE INDUSTRIES: THE CASE OF BRAZIL'S NONELECTRICAL MACHINERY SECTOR

by

Jan Peter Wogart

Institut für Weltwirtschaft an der Universität Kiel

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Abbreviations and Acronyms

ABDIB	Associação Brasileiro para o Desenvolvimento das Indústrias de Base (Brazilian Association for the Development of Basic Industries)
ABIMAQ	Associação Brasileira de Indústria de Maquinas (Brazilian Association of the Machinery Industries)
ALADI	Associação Latino Americana de Integração (Association for Latin American Integration)
BEFIEX	Benefícios Fiscais a Programas Especiais de Exportação (Fiscal Benefits for Special Export Programs)
BNDES	Banco Nacional de Desenvolvimento Económico e Social (National Bank for Economic and Social Development)
CACEX	Carteira de Comércio Exterior, Banco do Brasil (Foreign Trade Office, Bank of Brazil)
CEPAL/ECLA	Economic Commission for Latin America
CDI	Conselho de Desenvolvimento Industrial (Industrial Development Council)
EMBRAMEC	Empresa-Brasileira de Indústria Mecânica (Brazilian Mechanical Industry Enterprise)
FIBGE	Fundação Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics)
FGV	Fundação Gétulio Vargas (Getulio Vargas Foundation)
FIESP	Federacão da Indústrias do Estado de São Paulo (São Paulo Industry Federation)
FINAME	Agencia Especial do Finançamento de Equipamento Indústrial (Special Agency for Industrial Equipment Financing)
FUNCEX	Fundação Centro de Estudos do Cómercio Exterior (Center of International Trade)
ICM	Importa sobre Comercialização de Mercadorias (Commodities Circulation Tax)
IOF	Imposto sobre Operões Financeiras (Financial Operations Tax)

IPEA/INPES	Instituto de Planejamento Econômico Applicado e Social/ Instituto de Pesquisas Ecónomicas e Sociais (Institute of Applied Economic and Social Planning/Research Institute)
IPI	Imposto de Produtos Industrializados (Federal Industrial Product Tax)
ISIC	International Standard of Industrial Classification
LAFTA	Latin American Free Trade Association
NBM	Nomenclatura Brasileira de Mercadorias (Brazilian Commodity Classification for Foreign Trade)
NICs	Newly Industrializing Countries
NTB	Non-tariff Barrier
RCA	Revealed Comparative Advantage
SITC	Standard International Trade Classification
TAB	Tarifa Aduaneira do Brazil (Brazilian Customs Duty)
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization

A. INTRODUCTION

1. In the 1987 study "On the Determinants of Brazilian Exports", two hypotheses figured prominently. First, it was stated that Brazil's comparative advantage was in unskilled labor intensive products and secondly that policy interventions rather than internal factors were responsible in fostering Brazil's capital intensive exports[1]. By following the advice to investigate these issues in more detailed studies for individual sectors of industry, this essay is challenging those two postulates and will provide evidence to come to different conclusions.

2. In pursuing answers to the above questions this study continues the line of analysis undertaken earlier in the Kiel Institute by examining another crucial sector of the Brazilian metal working industry: capital goods, or more precisely, non-electrical machinery & equipment (NEM)[2]. However, differently from the major emphasis in the steel and automotive sector studies, which were testing the hypothesis if Brazil enjoyed a locational advantage in producing standardized capital intensive goods, the story of Brazilian NEM starts from the premise that it is unlikely that Brazil or any other LDC is currently able to outperform the advanced countries on a broad front in a sector characterized by human capital intensity, but that it has been and will be possible to find niches in world markets which may be rapidly expanding given the current pace of technological change. The question is, if it can be done efficiently and if it is taking place in subsectors with standardized machinery and equipment, or if LDCs can also excel and export more complex machinery the production of which requires very different skills from what used to be common only a few years ago.

---

1 Fasano-Filho et al. [1987]. Although the rise in capital intensive exports could be justified with the help of the product-cycle hypothesis, the incentives were found to be excessive.

2 For an investigation of Brazil's steel and automotive sectors, see Fischer, Nunnenkamp et al. [1988].

3. In order to determine the efficiency issue, we will investigate the role of the policy framework and contrast that with a closer look at the factors of production and their management. The NEM sector is known to be skill intensive. How did Brazil marshal the human resource necessary to build and export machinery and equipment at a significant scale? How rapid has been the adaptation and further development of technological change? How did the sector raise the financial resources to invest so heavily in the past 20 years? All three questions are interrelated and have to be examined jointly.

4. Traditionally, we understand under capital goods the production of [1] non-electrical machinery and equipment (NEM), [2] electrical, electronic and telecommunication apparatus and equipment, and [3] transport equipment.[1] In the latter two cases consumer electronics and non-commercial vehicles are excluded. Within the first group we distinguish among the following major branches: pumps, motors, engines and turbines, machine parts, all kinds of industrial as well as agricultural equipment and machinery, and office machinery. It is the export record of this group of products which we want to discuss and evaluate in some detail.

5. While not a large subsector among the NEM group, machine tools occupy a special place. They represent the heart of capital goods, i.e. machines producing machines. For many LDCs that branch has symbolized industrialization and everything which it provides, from more rapid output and employment growth to mastering technology and foster human resource development. While world production and exports are dominated by the advanced countries because of the subsector's relatively high degree of sophistication and skill requirements, the electronics revolution has cata-

---

[1] These three groups are classified under the International Standard Industrial Classification (ISIC) 382, 383, and 384, respectively and the Standard International Trade Classification Rev. 1 (SITC) 71, 72 and 73. For different subgroup classification see Table A1.

pulted Japan from a modest midfield position in world output and exports to the top within less than twenty years. Japan, and now increasingly some other East Asian countries are radically changing the comparative advantage in this industry from firms which possessed a lot of skilled manual labor to firms which are mastering electronics. As a consequence, the development of the machine tool branch will be used to qualify to the general findings of Brazil's production and exports of machinery and equipment, by giving more detailed insights in a sector which is characterized by a high degree of diversification and rapid technological change.

6. Having stressed the difference between this and previous sector studies, it remains to be emphasized that the major question and issues tackled in the automobile and steel sectors are also examined in the machinery and equipment part, i.e.

- to analyze and demonstrate to what extent Brazil has been able to penetrate foreign markets in the case of capital goods in general, and which particular items in the machinery branch had either special success or faced serious obstacles;

- to examine the principal factors which have been responsible for the subsector's accomplishments and shortcomings, distinguishing particularly between endogeneous (factor costs) and exogeneous (policy) variables;

- to identify and discuss problems and bottlenecks that now hamper the rapid and efficient development of non-electrical machinery and equipment as well as propose alternatives which should foster future production and exports.

7. Following that line of reasoning the essay is divided into five major parts, covering

(a) the worldwide characteristics and structural change of the NEM sector in general and the machine tool sector in particular,

(b) the performance of Brazil's machinery production and exports, and an assessment of its position in world machinery markets,

(c) an examination of the major policy variables having influenced Brazil's NEM exports and imports,

(d) a review of factor productivity and a comparative cost analysis of some NEM products.

(e) prospects for this subsector in the years to come.

With the first part being more descriptive and the last part being somewhat speculative, the analysis will concentrate on parts (b), (c) and (d), and with the use of several statistical techniques attempt to gain insights into issues of relative factor productivity and comparative advantage of the Brazilian machinery sector in general and the machine tool industry in particular, and with it provide insights into the current weaknesses and strengths of that sector.

B. NON-ELECTRICAL MACHINERY - WORLDWIDE FEATURES AND STRUCTURAL CHANGE

1. The group of products falling under the category of non-electrical machinery comprise a vast amount of different machines, equipment and components, ranging from small tools, dies and jigs to large and complex machine centers. As a consequence, it is difficult to generalize and to find common characteristics. Economies of scale may or may not play an important role within the same subsector, and individual markets which are dominated by a few leadings firms may be more competitive than segments where the concentration ratios are smaller.

2. Since a good part of machinery is custom made, the production runs are small in such branches as machines for food processing, chemicals, wood-working and most other specific industries. Typically these machines are produced in medium or smaller enterprises. On the other hand, there are quite a number of products where economies of scale play an important part, including engines and turbines, agricultural and small office machines, as well as ball- and roller bearings. The latter products are produced in large factories, which may however also be engaged in multiple production runs for small-batch production, making it difficult to achieve economies of scale.

3. It is then no surprise that empirical studies relating labor productivity to size of production gave a positive correlation in the case of agricultural machinery, but a negative one in the case of machine tools and textile machinery (Pack, 1981). Similarly, an analysis of market structure and concentration ratios is at best of limited relevance in an industry which is characterized by a great degree of heterogeneity. Typically, the branch consists of some large firms and many small- and medium-sized enterprises, which tend to be highly specialized. The latter firms are especially active in the production of parts and components, and they are closely connected with larger firms through subcontracting or subsidiary-parent relationships[1].

---

[1] For a more thorough survey see UNIDO [1984].

4. Having pointed out the diversity and differences of non-electrical machinery should not prevent us from examining those features which have determined the location of production and their international trade pattern. For once, firms in that sector are not only labor but "skilled" labor intensive, a characteristic which was noted of playing a vital role in explaining international trade flows only twenty five years ago (Keesing, 1967).

Factor Intensity in NEM

5. Table 1 presents summary data of relative skill intensities of the NEM branch vis-à-vis the rest of the manufacturing industries. Following Lary (1968), we are using the industries' wage and salary payments per employee to reflect labor and especially skilled labor intensity, and the non-wage value added per employee to characterize capital intensity. In all three cases, i.e. advanced market economies, centrally planned economies and the newly industrialized countries, it is shown that the NEM branch is relatively human resource intensive and less intense in using capital than the rest of the manufacturing sector. The average ratios among the three groups are very similar, although there are wider differences if individual countries are considered (see Table A2).

Table 1 - Relative Factor Intensities in NEM, 1970, 1978 and 1984

Countries	Relative Wage & Salaries per Employee			Relative Non-wage Value Added per Employee		
	1970	1978	1984	1970	1978	1984
Advanced Market Economies	1.11	1.08	1.12	.89	.93	.97
Centrally Planned Economies	1.10	1.07	1.08	1.07	.99	1.03
Newly Industrializing Economies	1.12	1.19	1.23	.74	.83	.89

Source: Appendix, Table A2.

6. Evidence on the technology intensity of the NEM industries can be derived from the statistics of R&D expenditures and manpower used during the last 20 years in the OECD countries. The data summarized in Table 2 again reflect the relative intensity of skilled manpower in the NEM branch contrasted with the manufacturing sector as a whole. In both cases, i.e. research scientists and engineers to total employees as well as R&D expenditures as percent of gross output, the percentages of the NEM industries are clearly above the industry average, resulting in average ratios of about 1.3[1].

Table 2 - R & D Intensity in NEM of Major OECD Countries, 1975

Indicators of R & D Intensities	EEC	Japan	USA
(1) Research scientists & engineers/ total No. of employees			
Non-electrical machinery	0.81	1.58	2.65
Average manufacturing	0.61	1.20	2.02
NEM/average manufacturing	1.33	1.23	1.31
(2) R & D expenditures/gross output			
Non-electrical machinery	1.99	1.49	3.21
average manufacturing	1.50	1.22	2.26
NEM/average manufacturing	1.33	1.22	1.42

Source: OECD [1979].

7. The latter characteristics are not only a consequence of a long historical tradition in a branch which prides itself with quality workmanship, but also a result of intense worldwide competition and a need to increase productivity and reduce costs. The rapid development of world trade and the increasing labor costs in the advanced countries during the post-war period led to

[1] To what extent the more than proportional input of R&D in the NEM branch has led to a process and product innovation will be discussed below.

innovations in producing labor saving machinery. In the Anglo-saxon countries automated machinery increased its share in total NEM sales from 10% in the 1950s to over 30% in the 1970s (Coombs, 1981). That tendency accelerated in the mid-seventies with the introduction of electronics into the engineering sector, particularly in the machine tool production process.

8. Given these features, it is not surprising that the advanced countries have an overwhelming share of the production and world trade of NEM. However, there have been substantial changes in world output and trade since WW II and chances for the NICs to break into the rich club in various branches and subsectors. It is the task of the following part to point out where they have been opening up and to what extent Brazil has been able to participate in that endeavor.

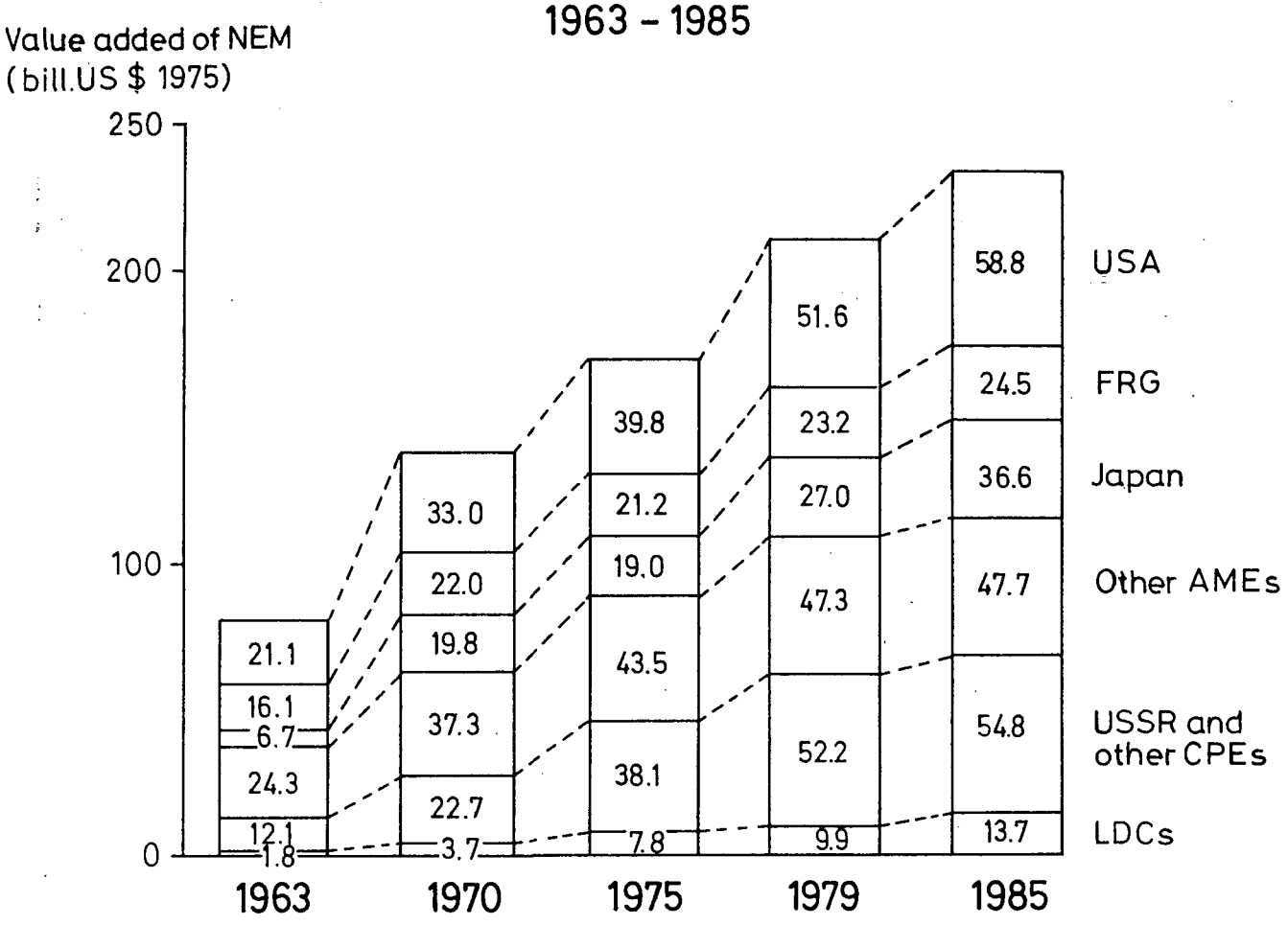
World Production and Trade

9. Graph 1 portraits the distribution of world machinery production between 1963 and 1985. World output trebled in real terms within two decades from about US$ 80 close to 240 bill. Although production in the developing countries increased by a factor of four, it only reached US-$ 12 bill. in 1980, just crossing 5% of total world output. But while the relative distribution among advanced market-, centrally planned-, and developing countries hardly changed in the 1960s (83%:15%:2%), the contribution of the latter two groups of countries rose to about 25% and 5% respectively during the decade of the 1970s, and managed to hold on to those shares in the first parts of the 1980s.

10. A similar picture emerges with respect to world trade. Table 3 shows the continuous dominance of the advanced countries in world exports with a share of about 85% since the early 1960s. True enough, the UK and the US have lost significant market shares, but they have been captured first by Japan and to lesser

Graph 1

Growth and Distribution of World NEM Production 1963 - 1985



AME = Advanced Marked Economies
CPE = Centrally Planned Economies

Source: UNIDO [1985].

Table 3 - World Exports of NEM and Shares of Major Participants, 1963-1985

Exporter	1963	1970	1975	1979	1985
Total value of NEM exports (US$ bill.)	16.8	38.2	102.7	184.3	226.5
Total shares (in %)	100.0	100.0	100.0	100.0	100.0
Advanced countries	85.0	87.7	87.0	86.8	82.3
United States	23.7	22.0	20.3	18.2	20.1
West Germany	19.6	20.0	19.7	19.1	17.7
United Kingdom	14.3	10.3	9.2	8.8	6.6
France	4.8	5.8	7.2	7.1	5.0
Italy	4.7	6.5	5.9	6.1	5.6
Switzerland	3.4	3.2	3.2	3.3	3.2
Japan	2.1	5.3	6.6	9.1	13.8
Others	12.4	14.6	14.9	15.1	10.3
Centrally planned Economies	14.4	11.3	11.3	11.1	11.6
Developing Countries	0.6	1.0	1.7	2.1	6.1

Source: United Nations [1978 and 1986].

extent by some EEC countries. While the centrally planned economies saw their participation decline from over 14% to 11%, a few developing countries have gained a foothold. Among seven newly industrializing countries, Brazil, Singapore, and Taiwan succeeded to increasingly export less sophisticated machinery into both, the markets of developed and developing countries[1].

11. The revealed comparative advantage (RCA) of the major competitors in this branch has been found to be positively related to per capita income[2]. However it is interesting to note that while this correlation is significant, the R^2 coefficient is only 20%, leaving plenty of other explanations for the determination of ex-

[1] The other countries include Argentina, India, South Korea and Yugoslavia.

[2] Dick [1981].

port competitiveness. More importantly than per capita income were the two other factors pointed out above: skills and technology. In the first case a regression analysis between the RCA of individual firms in the NEM branch with the relative share of employees working in research and development, design as well as the amount of skilled workers relative to total employment arrived at positive and significant coefficients.[1] In the case of technology, the degree of product and process innovation in this branch, which were substantially above the industry average in the major machine producing countries, turned out to be an important criterion for export competitiveness (see Table A3). Interestingly enough, there was no clearcut positive correlation between high R&D expenditures and manpower on the one hand and technological innovation on the other, which would seem to indicate that the success in achieving technological breakthroughs requires more than just high powered inputs.

12. One variable, which turned out not to be significantly related to the RCA of machinery is the size of the domestic market. That finding would again reflect the problem with economies of scale in determining efficiency and competitiveness in this field. In the case of West German firms, there was not only a negative relation between export competitiveness and size of firm but also between the RCA and unit output. According to Table 4, Germany has been specializing in the first group of products, most of which are produced in small batches and are also relatively more skill intensive. On the other hand, imports from LDCs have increased from the more standardized products of the second and third group.

13. Before tracking the development of the Brazilian NEM sector and examining its export performance over the last 30 years, we will discuss the machine tool industry to gain some insights into issues of technological change and rapid structural transformation of worldwide production and export patterns. While the above Table 4 indicates that this branch is characterized by small bat-

---

1 However it should be noted that the R&D employment alone did not bring the expected results.

Table 4 - Typical Production Size for Selected Categories of Machinery

Production Methods	Typical Batch Size	Possible Range of Units Produced by Firm
Single part and small scale and production	1-20	
Smelting equipment, rolling mills	1	1
Industrial furnaces	1	1
Mining equipment	2	1- 3
Heavy engines for special equipment	3	1-100
Food-processing machinery	6	1- 50
Apparatus engineering	8	1- 55
Machine-tools	12	1- 50
Rubber and plastics machinery	14	1- 20
Textile machinery	16	1- 20
Medium scale production	21-100	
Pumps and compressors	36	1-200
Printing and paper machinery	42	1-180
Woodworking machinery	55	1-125
Construction machinery	66	1-150
Large scale production	>100	
Aviation equipment	151	1- 3500
Precision tools	552	2- 1000
Office and information equipment	787	1-10000
Agricultural machinery	988	100- 2000
Instruments	7041	21- 5000
Sewing and clothing machines	14377	280-15000
Automobile engines and pistons	15747	1-20000

Source: Dick [1981].

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ches in the advanced countries, it will be shown that it is exactly here where conventional lathes are produced at larger numbers and that those machines have been exported successfully by Brazil and other newly industrializing nations to their more advanced counterparts, which have moved on to produce more specialized machine tools.

Machine Tools: Changes in Technology, World Production and Trade

14. Machine tools, the power driven machines used for cutting, shaping or processing metals and other materials into desired forms, date back to the Industrial Revolution in Great Britain, where John Wilkinson invented the horizontal boring mill about two hundred years ago. Ever since then an increasing amount of machine tools have been produced to serve in such industries as clock and instrument making, heavy capital goods for the textile and railway equipment producing firms, sewing machines and typewriter production and finally for the mass production of automobiles at the beginning of the 20th century.

15. From the beginning, arms production played an important part in developing new machine tools, but it was only in World War II that after the invention of the computer, the U.S. Air Force commissioned research into electronically controlled machine tools. The first numerically controlled milling machine used paper tape output from a computer, but faced difficulties to be accepted by other than the aerospace industry because of its high costs. That situation changed dramatically with the introduction of inexpensive microprocessor based controls by the Japanese in the early 1970s.

16. As a consequence of the early inventions and the demand of machinery and equipment in the advanced countries of the world, production was centered in Europe and the United States for most of this and the previous century. As Table 5 indicates, even after the innovation of computer numerically controlled (CNC) machines in 1975, the U.S., West Germany, and the USSR dominated

Table 5 - World Production and Exports of Major Machine Tool Producing Countries, 1975 and 1980
(US$ mill. and per cent)

Countries	World production		World exports	
	1975	1986	1975	1986
World production and exports (US$ mill.)	13.007	28.155	5.495	13.213
	Shares in % of total			
5 leaders of advanced countries	66.2	70.8	55.8	58.5
USA	19.1	9.7	9.6	4.1
FRG	18.0	17.8	32.3	21.8
USSR	15.1	12.5	3.1	2.2
Japan	8.4	24.2	5.2	23.1
Italy	5.6	6.6	5.6	7.3
5 leaders of newly industrializing countries	3.05	5.75	0.71	2.74
Brazil	1.05	1.26	0.25	0.30
India	0.73	0.85	0.20	0.25
China	1.15	1.23	0.05	0.06
Taiwan	0.12	1.20	0.21	1.92
South Korea	<0.01	1.21	<0.01	0.21

Source: American Machinist [various issues].

the field with nearly 45% of world production. That situation did, however, change dramatically in the 1980s, as Japan took the lead by capturing 25% of world production in 1986.

17. Machine tools have always been a highly tradable good, with an export-output ratio reaching 30% in the 1950s and 1960s. It increased to about 45% in the mid-seventies and remained at that level in the 1980s. The pattern of world trade is similar to that of world production - a high degree of concentration in a few countries and a rapid growth of Japan's share in the late 1970s and early 1980s at the costs of the previous market leaders' shares.[1]

18. In contrast to the rapid changes on the top, production and exports of the five major LDCs advanced more gradually. Nevertheless, they have raised their share in world production from 3% to close to 6% and their export share from less than 1 to close to 3% within the last ten to fifteen years, and it would seem that some of them have not only taken over markets of traditional machine tools now abandoned by the advanced countries, but are also making determined efforts to produce and eventually export CNC machinery.

19. The current trend in the industrially advanced countries is towards flexible and integrated manufacturing (FMS and CIM), in which the tool and work piece design, scheduling, transport and dispatch are automated and closely coupled. Besides increasing the time that the CNC machines spend in actual machining, such systems aim to save manpower and space, cater to changing market demands by producing a large variety of products innovatively, and reduce inventory costs through "just in time" manufacturing.

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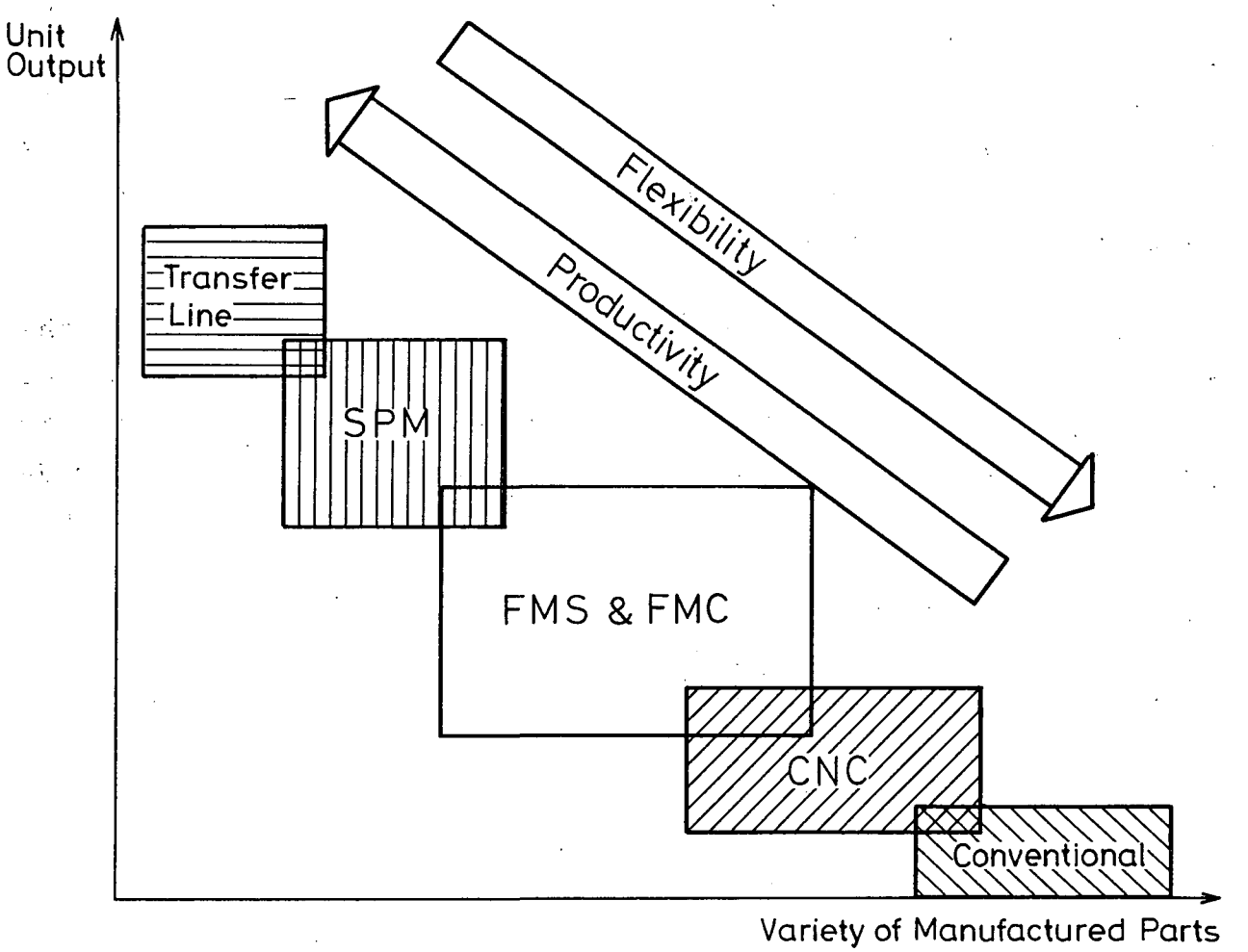
[1] It is interesting to note, however, that while the Japanese export-output ratio was nearly .5 in 1987, its import-consumption ratio did not even reach .1, way below the world average of .3, but characteristic for the difficulty to penetrate that market. The only other country which has a similarly low import consumption ratio is Brazil which was .12 in 1987. See Table A4.

20. While in a number of branches the participation of CNC machines has rapidly increased over the years, reaching over 50% in lathe, boring and milling machine production (see Table A5), conventional machine tools have kept a significant market share in less affluent subsectors and remain advantagous with respect to the variety of parts which can be produced with them, as the following graph indicates. General purpose machines (GPMs) are producing small batches and machine a large variety of parts, while special purpose machines (SPMs) and transfer lines are designed to produce a given component in large numbers. Here productivity is high, but the system lacks flexibility and variety. The flexible machine system and centers (FMS and FMC) are in the middle and seem to combine both of the characteristics and possibly advantages. However, while they optimize the machinery cycle on a component, idle periods can be high cost unless proper tools, workpieces and machining programs are rapidly made available. This would indicate that - for the time being - the machine tool group is heterogeneous enough to have newcomers and innovators capture market shares in specific niches of that industry.

22. As Table 5 has shown, world production of machine tools more than doubled between 1975 and 1986. If we adjust for inflation, real growth was 20%. Those two statistics hide the fact that, while growth was exuberant in the late 1970s, it became negative in the early 1980s. A good indicator of what happened in that industry are the U.S. data on productivity and investment. In the first case output per employee fell from an average of US-$ 75 thous. between 1978 and 1982 to close to US-$ 52 thous. in 1983/87. Similarly, investment in that industry dropped from US-$ 215 mill. to US-$ 125 mill. during the same time periods. While the U.S. suffered a much more severe decline of the machine tool industry in the 1980s than the other industrialized countries, world production, productivity and investment did fall between 1981 and 1985, but have since then recovered.

Graph 2

Trade-off Between Scale Economies and Flexibility of Production in Machine Tools



SPM = Special Purpose Machines
FMS = Flexible Machine Systems
FMC = Flexible Machine Centers
CNC = Computer Numerically Controlled Machines

C. STRUCTURAL CHANGE IN BRAZIL'S PRODUCTION AND TRADE OF NEM

Importance of Machinery Production in Historical Perspective

1. Capital goods production has been an important activity in the Brazilian economy for over 100 years. Although its share in total manufacturing value added did not cross the 10% mark until the 1950s, equipment for a booming agro-export and transport sector was already produced and repaired by a rapidly growing number of machine shops during the latter part of the 19th century. Led by the production of machines for coffee hulling and sugar refining, most of the producers were active in supplying equipment to the food processing industries and to a lesser extent to the transport sector.

2. Two characteristics stood out in those early days: the public's intense interest in technical aspects and innovation of machinery; and the relative openness of the sector towards imports. In the latter case, it has been pointed out that although capital good imports received low tariffs and preferential exchange rates, the ratio of domestic production over total domestic demand was high compared with other countries at a similar stage of development (see N. Leff, 1968). In the first case, technical expertise and interest - particularly in the São Paulo region, which has remained until today the home of over 75% of machine producers - came with the immigrants, who brought with them their skills and capital to start up production in the New World.

3. Growth in production of capital goods was determined by the growth of the other industrial activities until the 1930s, when the Great Depression cut world trade to a trickle and forced many a Latin American country to substitute for imports. For Brazil, machinery was one sector in which domestic producers were able to respond quickly to the challenge, and as a consequence that branch expanded by 12% p.a., which was twice the rate of industry as a whole. While the shortage of inputs during World War II decelerated that growth rate, both the manufactured sector as a whole and capital goods in particular managed to average 7.5% between 1940 and 1945.

4. The 1950s witnessed renewed strong growth and innovation in the machinery sector, particularly after President Kubitchek laid the foundation for the indigenization of the automobile industry. Policies which encouraged large scale import substitution activity and openly invited foreign investment led to growth rates above 10% p.a. for over a decade in the capital goods sector. While continued overvaluation of the currency stimulated imports in general, quantitative restrictions (until 1953) and the Law of Similars, which allowed imports only when a similar machine was not manufactured in Brazil, had the import-consumption ratio fall from 40% to 30% within a few years.

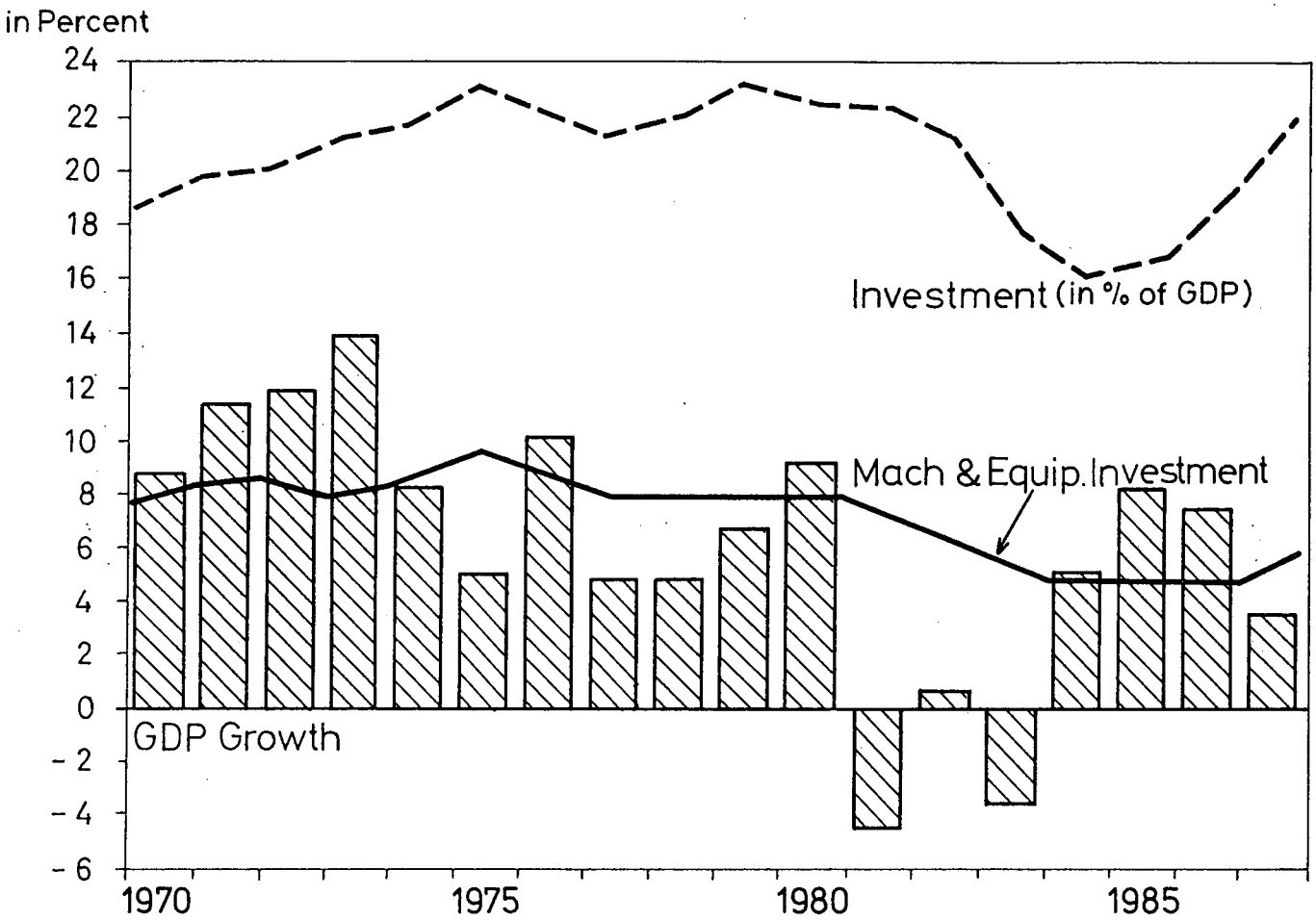
5. The exuberant period of strong expansion was followed by a rapid acceleration of inflation which turned into stagflation in the early 1960s. Although the foreign exchange constraint led to more stringent import controls, reducing the import-output ratio to 10%, significant cuts in public investment spending had rather immediate effects on the capital goods industries, which experienced a number of crisis years leading to significant excess capacity. Output advanced very slowly for a number of years, even after the economy was back on its way to a more stable recovery in the mid-1960s.

Development of Capital Goods Production and Trade, 1965-1985

6. The growth record of the NEM industries during the last 25 years is recorded in Table 6 and Graph 3. Induced by favorable policies, which brought relative stability of price changes, expectations and profits, domestic demand boomed, taking with it overall investment as well as specific demand for new machinery and equipment after excess capacity was used up. As demonstrated in the graph, with GDP expanding at an average rate of 10% during the early 70s, the investment-output ratio climbed to over 20%, and the ratio relating machinery purchases to GDP averaged over 8%.

Graph 3

GDP Growth and Investment Ratios 1970 -1987



Source: FGV [various years].

Table 6 - Output and Employment of Brazilian Capital Goods Industries 1965-87
(in 1977 Mill Cr. and Thousands of Employees)

Year	Non-electric Machinery		Electric Machinery		Transportation Equipment	
	Output	Employment	Output	Employment	Output	Employment
1965	15.9	74.0	12.4	83.0	12.8	134.0
1966	11.8	88.0	11.4	95.0	9.9	134.0
1967	13.4	91.0	12.6	105.0	12.4	131.0
1968	14.5	104.0	11.7	115.0	12.2	151.0
1969	17.6	109.0	19.3	113.0	32.4	149.0
1970	19.7	121.0	21.7	115.0	39.0	158.0
1971	27.0	133.0	21.9	124.0	43.7	184.0
1972	37.5	181.0	28.5	133.0	57.2	185.0
1973	69.1	289.0	44.2	175.0	114.0	214.0
1974	96.2	337.0	61.6	196.0	112.6	204.0
1975	120.1	391.5	73.8	176.5	126.8	221.6
1976	129.1	397.1	80.8	193.1	143.0	221.6
1977	136.1	431.1	89.1	210.9	147.8	224.5
1978	151.9	457.9	103.2	235.8	152.9	249.7
1979	172.1	486.8	107.5	229.5	166.5	264.5
1980	201.1	538.1	122.6	243.5	212.7	281.3
1981	156.7	468.9	101.5	221.0	143.7	222.4
1982	151.7	429.7	107.0	220.2	135.3	237.2
1983	124.7	416.5	90.4	190.7	144.2	224.6
1984	140.6	441.7	98.1	203.5	157.8	233.9
1985	155.1	n.a.	116.5	n.a.	175.1	n.a.
1986	190.3	n.a.	141.0	n.a.	198.9	n.a.
1987	219.3	n.a.	150.8	n.a.	205.4	n.a.

Source: FIBGE [b, 1979, 1980; c, various issues].

7. While not accelerating quite at the same pace as output, employment grew in large numbers from less than 200 to close to 300 thous. between 1972 and 1973, and it reached over 500 thous. at the end of the decade. When recession hit in the early 1980s, employment declines were much less than the output cutbacks, following the capital goods sector's tradition of keeping most skilled workers during the downswing of the business cycle and employing them in renovating the firms' proper capital infrastructure. For the period as a whole the employment-output elasticity was close to .7, substantially above the one in the other capital goods industries. By 1984, total employment in the NEM branch was slightly above the combined employment of the electrical machinery and transport equipment sectors.

8. Those were the years in which the subsectors belonging to non-electrical machinery made significant advances by raising their share in total industrial production to over 10%. Contrasting NEM's actual share with the normal share estimated by a cross-country comparison between 1970 and 1977, shows that Brazil jumped ahead and surpassed its normal share by a factor of 1.2 (see Table A6). Growth was particularly strong in engines and machine parts, but as is demonstrated below, branches such as the machine tool industry also grew in leaps and bounces.

9. Strong growth continued during the latter part of the 1970s. However, the source of that growth changed dramatically as shown in Table 7. While earlier growth was mainly induced by the expansion of the domestic economy and to a modest degree by export diversification, the new policies of import substitution especially designed for the capital goods sector after the first oil crunch, became a major factor in determining the growth of that sector and its principle branches.

Table 7 - Sources of Growth 1970-1985
(in % of Output Changes)

	1970-1974			1974-79			1978-1985		
	IS	EX	DD	IS	EX	DD	IS	EX	DD
Non-electrical machinery	-9.7	7.1	102.5	20.8	12.2	67.0	37.5	19.0	43.5
Engine & turbines	-41.9	27.9	114.0	13.0	47.4	39.6			
Machine parts	4.5	5.8	90.1	13.8	24.1	62.1			
Ind. equipment	-18.5	6.1	112.3	24.8	5.9	69.3			
Agr. equipment	4.2	3.6	92.9	10.6	6.1	83.4			
Office machines	-20.7	10.2	101.4	10.3	21.8	67.9			
Tractors	14.1	4.3	81.5	30.0	13.0	57.0			
Electrical equipment & apparatus	-8.1	9.1	98.9	12.8	4.6	82.7	74.2	3.7	22.1
Transport equipment	-1.4	10.9	90.4	7.1	12.5	80.4	79.5	10.9	9.6
Total Manufacturing Activities	-8.4	12.0	96.4	10.1	9.4	80.5			

IS = Import Substitution
EX = Export Diversification
DD = Domestic Demand

Source: World Bank [1983] and own calculations.

10. The second oil shock in 1979 hit Brazil harder. Import substitution was intensified, but policy makers ran out of steam to further stimulate capital goods sector production. With the fall in public investment, the demand for machinery and equipment dropped precipitously. The ratio of equipment sales-to-GDP fell from an average of 8.5% in the 1970s to 5% in the early 1980s, at a time when GDP growth itself hardly remained positive (see Graph 3 and Table A7). While the latter variable recovered somewhat in the second half of the 80s, demand for investment has remained shaky, leading to renewed excess capacity and attempts to find some outlets in international markets[1].

11. A branch which especially suffered from the decline in investment activity of capital goods was the machine tool industry, which sells over 40% of its products within the NEM sector. After experiencing rapid expansion during the boom years of the 1970s, output fell substantially between 1981 and 1984, before recovery began in 1985. As Table 8 indicates, exports did reasonably well, but imports were drastically curtailed, with the import-consumption ratio declining from an average of 45% to less than 15% between 1983 and 1987. This change in policy was part of a general strategy to control imports in order to save foreign exchange. In this case it was to a large extent a consequence of legal steps to reserve CNC machine tools for domestic producers, the causes and consequences of which will be discussed below in some detail.

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[1] According to Table 7 the role of export diversification increased in supporting GDP growth during the early 1980s, and it is remarkable that it was much more important in the NEM sector for output growth than in the other two subsectors. However, that contribution may be not representative for the mid-80s as a whole, since 1985 was an exceptional year for exports, whereas domestic output was still at depressed levels.

Table 8 - Brazilian Machine Tool Consumption, Production, and Trade, 1974-1987 (in US$ of 1980)

Year	Consumption	Production	Exports	Imports	Export/ Production (in %)	Import/ Consumption (in %)
1974	295.0	190.1	10.1	118.3	5.3	40.1
1975	316.4	210.4	21.5	127.5	10.2	40.3
1976	326.7	568.0	15.7	257.0	2.8	78.7
1977	391.3	611.2	15.5	235.4	2.5	60.2
1978	327.7	592.3	25.8	290.4	4.4	88.6
1979	441.3	559.5	32.0	150.3	5.7	34.1
1980	314.8	418.9	71.2	175.3	17.0	55.7
1981	279.6	325.1	67.7	113.3	20.8	40.5
1982	155.0	212.9	18.6	76.5	8.7	49.4
1983	87.0	104.9	21.4	39.2	20.4	45.1
1984	92.9	110.4	17.9	35.4	16.2	38.1
1985	235.1	245.2	24.8	34.9	10.1	14.8
1986	328.3	336.6	34.3	42.6	10.2	13.0
1987	363.8	354.9	34.6	43.5	9.8	12.0

Source: Computed from "American Machinist" [various issues].

Machinery Exports: Problems and Progress

12. After a slow start in the 1950s and 60s, Brazilian machinery exports succeeded to penetrate foreign markets more forcefully in the 1970s. Table 9 indicates that NEM exports which were only US-$ 17 mill. in 1965, surpassed the $ 100 mill. mark in the early 1970s and climbed to over US-$ 1.5 bill. in 1980, a level which it only reached again in the mid-1980s. The rapid increase in NEM exports vis-à-vis other Brazilian exports is reflected in the rising share, which doubled from 10 to 20% of total manufac-

Table 9 - Brazilian NEM Exports and their Direction to Major Markets, 1965-1985
(in mill. US$ and in per cent)

	1965	1973	1978	1980	1983	1985
NEM exports (mill. US$)	17.0	132.4	845.5	1549.0	1166.0	1661.6
as percent of:						
Manufactured exports	13.7	10.9	20.1	20.7	13.5	14.8
Total exports	1.1	2.1	6.7	7.7	5.3	6.5
To the following markets (% shares)						
United States	3.7	16.9	25.2	22.5	14.5	33.2
Other advanced countries	26.5	18.9	14.9	17.2	19.2	21.8
Latin America (ALADI)	60.1	58.3	49.2	35.7	46.5	21.9
Other countries	3.7	5.9	10.7	24.6	19.8	23.1
Export Performance Ratios[a]						
World	0.10	0.19	0.57	0.76	0.49	0.55
Industrialized countries	0.01	0.04	0.19	0.24	0.30	0.35
United States	0.02	0.27	0.69	0.69	0.96	0.88
Developing economies	5.04	2.83	11.78	31.53	44.32	22.12
Latin America	0.46	0.76	1.22	1.51	1.11	1.09

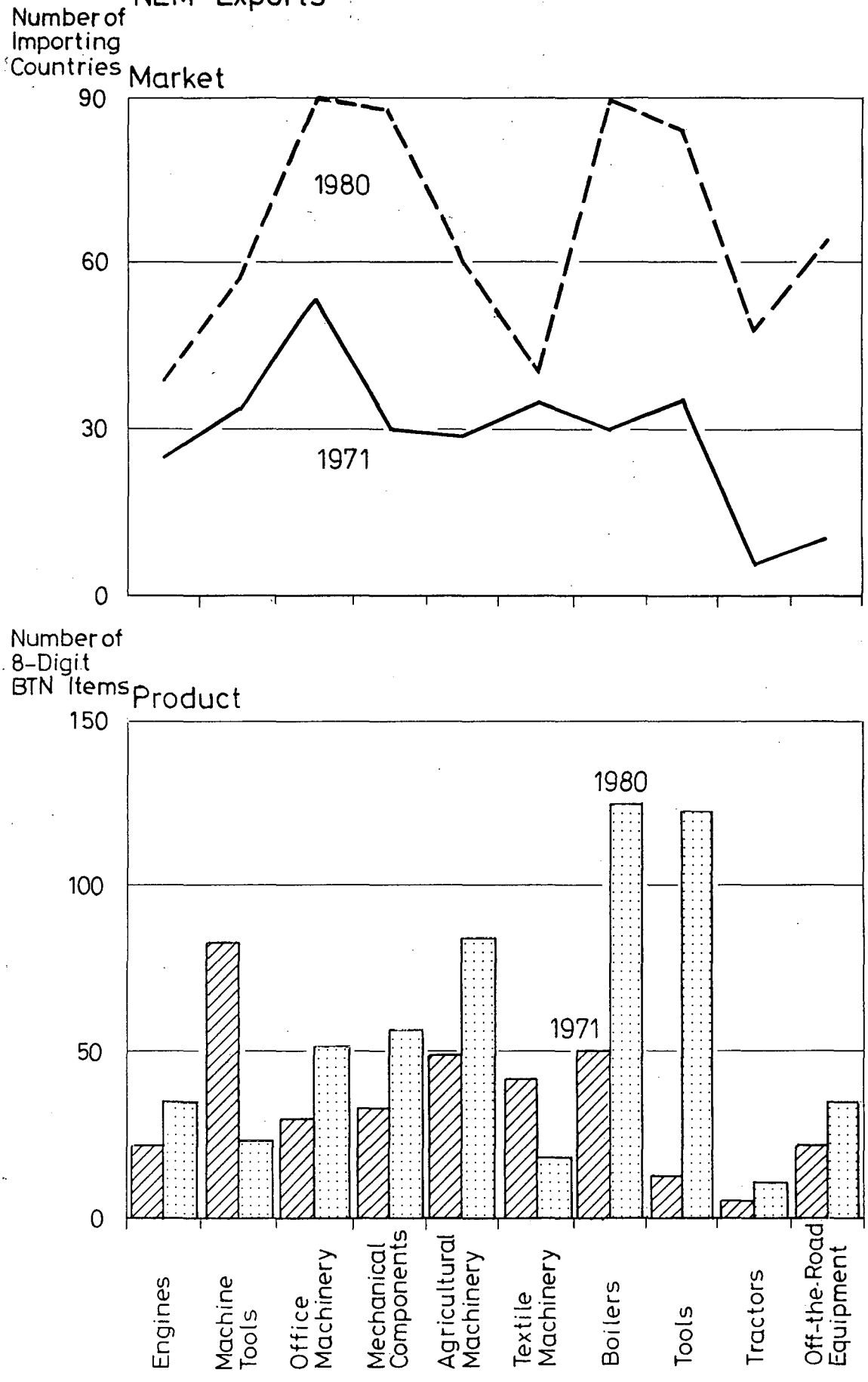
[a] $\frac{X\ NEM_B}{X_{TB}} \Big/ \frac{XNEM_W}{X_W}$

Where the numerator is the NEM share in Brazil's manufactured exports and the denominator the world or the region's NEM share in manufactured exports.

Source: United Nations [1978 and 1988] and own calculations.

Graph 4

Market and Product Diversification of Selected NEM Exports



Source: World Bank [1989].

tured exports within less than 10 years during the 1970s. However, it fell below 15% in the following years, mainly because of drastic declines of sales to Brazil's major markets in this branch: the members of the Latin American Free Trade Association (LAFTA), which had changed into the Association for Latin American Integration (ALADI).

13. Exports of machinery to other Latin American countries, with which Brazil had special trade agreements, were a natural first in the late 1960s and early 1970s. During the mid-1970s a gradual diversification took place with respect to both, products and markets. The diversification drive is depicted in Graph 4 for a number of machinery products which succeeded to significantly increase both, their products and markets. A further change occurred in the early 1980s, when Brazilian machinery exporters started to concentrate on the US market to compensate for the loss of the Latin American share. To what extent it will be possible to maintain that foothold in the US and at the same time expand sales again in Latin America after the debt crisis becomes less crippling for imports and investment there remains to be seen. The fact that it has been possible to maintain total exports and shift 20% from developing to advanced countries within five years speaks favorably for the flexibility of Brazilian machinery exporters.

14. A look at the export performance ratios of Table 9 confirms the above observations. While Brazil's comparative advantage vis-à-vis the rest of the world suffered a setback in the 1980s after it had gradually improved in the 1970s, its trade position with the United States reflects a position of relative strength, which could turn into comparative advantage in the years to come. The export performance ratios with developing countries in general and with the other Latin American countries in particular decreased, but they remained above 1, i.e. Brazil kept its relative advantage in those markets.

15. By examining subsector export growth, it becomes obvious that engines experienced the most rapid rate of expansion, selling over 660 mill. US$ in 1985 (see Tables A8 and A9). They were followed by office machines, which lost however some of their rapid advancement shown earlier in the late 1970s and 1980s. Both products were linked to multinationals which had determined that Brazil's location would give them a comparative advantage. It is characteristic that on place 3 and 4 two items of heterogeneous product groups were listed[1]: Heating and cooling equipment as well as pumps and centrifuges, each of which come closer to annual exports of US$ 100 mill. in the early 1980s. Among those which averaged about $ 50 mill., three very different types of machinery emerged, namely construction and mining machinery, sewing machines, and more recently paper mill machinery.

16. Ranking the different 4-digit SITC machinery exports according to their total export earnings in 1978 and 1985, and comparing them with earlier indicators of different skill and research intensities, led to a rank correlation of -.7. That would indicate that Brazil's NEM did concentrate within this branch on the "right" kind of products in which it was able to penetrate world markets. As Table 10 shows, an increasing part of the NEM products went to the USA and other advanced countries. It is, however, noteworthy that while Brazil kept second and third positions in most machinery exports from the NICs, its distance from the market leaders (most often the East Asian competitors Taiwan and South Korea) widened in several product groups, such as metal working, textile and leather machines, as well as machines for other special industries[2].

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1 That heterogeneity may also explain why US importers have not yet raised the issue of countervailing duties for NEM products, as they have done for steel and some metal products.

2 These are industries in which Brazil not only experienced decreasing export shares among competitors from other NICs, but in which also performance ratios were below the average of other subsectors (see Table 10, Row (5)).

Table 10 - Performance Indicators of Brazil's NEM Exports, 1965-1985 (in Thous. US$ and Percent)

SITC		1965	1973	1978	1983	1985
71 Non-electr. Machinery		8,832	83,809	279,182	710,403	1,011,252
711 Power Mach Non-electr.		3,398	31,954	130,177	445,825	667,307
	(1)	0.14	0.38	0.62	1.51	2.06
	(2)	19.07	20.16	17.57	21.48	24.49
	(3)	82.34	93.75	43.65	73.12	54.53
	(4)	17.89	42.98	81.62	90.82	96.85
7115 Piston Engines (non-air)	(5)	1.81	1.78	1.73	3.28	3.59
712 Agricultural Machinery		578	9,229	36,207	63,833	33,167
	(1)	0.03	0.23	0.40	0.68	0.38
	(2)	9.38	21.25	19.98	27.24	25.61
	(3)	51.70	42.27	36.79	75.10	83.44
	(4)	19.55	5.48	44.90	33.77	46.10
7121 Cultivating Machinery	(5)	0.68	1.59	0.59	0.79	0.79
714 Office Machines		216	8,679	24,595	47,564	92,713
	(1)	0.14	1.08	1.37	1.19	1.65
	(2)	3.15	11.79	14.21	15.07	14.56
	(3)	5.63	46.00	44.72	54.69	60.60
	(4)	71.79	56.69	44.44	55.02	64.22
7141 Type-,Codewriters	(5)	2.48	6.14	6.32	5.41	3.51
715 Metalworking Machines		1,306	5,117	21,328	37,133	37,043
	(1)	0.09	0.13	0.24	0.42	0.38
	(2)	19.08	11.89	10.21	9.85	9.07
	(3)	70.79	42.47	21.16	20.58	16.21
	(4)	15.62	62.50	53.77	82.58	89.45
7151 Machine Tools (for metals)	(5)	0.81	0.42	0.52	0.46	0.36
717 Textile, Leather Mach.		2,007	14,616	35,267	32,261	54,250
	(1)	0.13	0.27	0.45	0.40	0.61
	(2)	14.84	13.61	12.45	8.30	9.85
	(3)	44.73	36.79	32.35	14.92	21.10
	(4)	11.76	31.82	34.15	22.22	83.54
7173 Sewing Machines	(5)	4.82	3.85	3.10	2.29	2.65
718 Mach. for Special Ind.		1,327	14,214	31,608	83,787	126,772
	(1)	0.06	0.20	0.17	0.38	0.54
	(2)	7.97	12.12	7.05	10.04	14.48
	(3)	52.85	85.83	25.96	27.16	44.05
	(4)	14.77	28.73	43.94	59.66	80.09
7181 Paper Mill Mach.	(5)	0.37	1.33	0.40	1.63	1.47
7184 Construction & Mining Mach.	(5)	1.22	1.11	1.15	0.50	0.57
719 Mach. NES Non-electr.		2,931	33,810	153,276	282,422	264,976
	(1)	0.04	0.14	0.27	0.42	0.38
	(2)	7.60	9.20	13.06	11.08	8.79
	(3)	35.12	26.66	62.31	39.42	36.68
	(4)	15.73	20.42	24.84	36.49	69.67
7191 Heating & Cooling Equipment	(5)	1.37	0.61	0.66	1.11	0.48

(1) : Share of World Total (in percent); (2) : Share of LDC Total (in percent); (3) : Share of LDC Leader (in percent); (4) : Share Exports to Industrial Countries of Exports to World; (5) : Export Performance Ratios (RCA) for 4-digit SITC products.

Source: Table A8, own calculations.

17. Information from the machine tool industry highlights Brazil's effort to expand exports of machinery in a more erratic manner. While foreign sales remained at less than 30 mill dollars for most of the 1970s, averaging 6% of production, a sudden burst in 1980, caused by high demand of oil rich Mexico had exports more than doubled to over 70 mill. for two years (see Table 8). This was followed by a return to the level reached in 1978, which increased as a share of production because of the extraordinary low level of domestic output in the early 1980s. Only recently machine tool exports have risen to close to US$ 40 mill. reflecting the ability of Brazilian machine tool firms to get a foothold in markets selling traditional machine tools, production of which has been abandoned by most firms in advanced countries.

18. The extraordinary expansion of Brazilian NEM exports in the 1970s demonstrated the country's ability to capture new markets in a "skill intensive" sector. While the strongest branches were the ones producing standardized products, such as engines and pumps, it is noteworthy that export performance has also been remarkable in new and more sophisticated products, as the export growth of the paper mill machinery indicates. What has to be examined now is the question to what extent the mix of Brazilian trade policies has furthered or hindered the export strategies of the firms producing non-electrical machinery and equipment.

D. GOVERNMENT INCENTIVES AND THEIR IMPACT ON EXPORT COMPETITIVENESS

1. The analysis of the sources of growth has shown that Brazil went through two very distinct periods of capital goods development during the 1970s. While domestic demand dominated the first part of the decade, with export expansion just about equalling the decline in import substitution, the second five years showed the rising importance of renewed import substitution and a simultaneously healthy export expansion drive. But while imports were further curtailed in the eighties, export diversification kept up its drive, partly to compensate for cutbacks in domestic output. What has to be examined are the macro- and sector policies of the Brazilian government, reacting to two oil price shocks in the early and late 1970s, in order to separate the impact of international developments in the rise and fall of capital goods exports, and the effect of government incentives in the determined shift towards a "closed" capital goods sector.

Import Protection Policies and Effective Protection

2. During the strong expansion of the economy in the late 1960s and early 1970s, capital goods production prospered as did capital goods imports. Policies were pragmatic and non-tariff barriers were quasi non-existent. Even the Law of the Similars was handled in a most flexible manner, with the effect that the industrial sector was able to thoroughly modernize its capital stock at relatively competitive world prices. All that changed with the oil price shock of 1973/74, and the launching of the Second National Development Plan (1974-79), which initiated a conscious effort to reduce imports in general and promote the private domestic capital goods industry in particular.

3. The data of Table 11 speak for themselves. Legal tariffs were increased for all capital goods and remained at high levels throughout the 1980s. In spite of a recent tariff reform, total legal import protection stayed at about 50% for all three major

Table 11 - Tariff & Non-Tariff Barriers of Capital Goods, 1975-1988 (in Percent)

Type & year of import protection		NEM	Electrical equipment	Transport equipment	Manufacturing average
Legal and Realized Import Tariffs					
1975	L	53.3	99.8	108.3	86.4
	R	22.7	33.6	70.8	32.7
1984	L	62.1	100.4	115.9	90.0
	R	17.2	11.2	2.9	19.1
1988	BR	55.3	69.7	73.5	56.2
1988	AR	46.8	47.5	51.2	38.1
1988	TIP	84.4	84.1	89.3	73.8
NTB 1					
1975		0.3	2.0	0.4	3.7
1980		13.0	19.5	36.3	21.5
1985		33.7	90.5	60.6	55.6
NTB 2					
1975		0.7	2.1	0.5	18.3
1980		22.0	36.3	2.6	23.4
1985		20.0	58.0	26.8	17.9

L = Legal import tariff rates
R = Realized tariff revenues as % of imports
BR = Before tariff reform of July 1988
AR = After tariff reform
TIP = Total import protection, including import tariffs, taxes and transport costs
NTB1 = Proportion of tariff codes subject to non-tariff barriers
NTB2 = Proportion of imports subject to NT barriers

Source: Tyler [1981]; Braga et al. [1987]; Guimarães [1988], Kume [1988].

subgroups of the capital goods sector. With the domestic sales tax (IPI) and the transport costs being added, import protection amounted to 85% in 1988/89. At the same time, however, actual import tariffs paid or realized decreased for the NEM group from 22.7% in 1975 to 17.2% in 1984. In the case of individual NEM products, realized tariffs as percent of the official legal rates were even lower, reflecting the many exemptions and special arrangements the government has created for imports.

4. That problem is even more pronounced in the other two sectors, in which the difference between legal and realized tariffs has been widening conspicuously. In 1984, the actual rate of collected import tariffs was about 10% of the legal one in the case of electrical equipment and 2.5% in the case of transport equipment. While the fiscal erosion of the import tariff is linked to the attempt of the policy makers to strengthen the export incentives, the import protection function of the tariff has been taken over by non-tariff barriers, which increased from less than 1% to 20% of total imports of NEM products and from 1% to 33% of all tariff codes between 1975 and 1985. In the case of electrical and transport equipment, special regulations were controlling 58% and 27% of total imports of these two sectors in 1985.

5. The increased use of quantitative restrictions on the one hand and special exemptions on the other has made it ever more difficult to estimate the degree of import protection for the capital goods industries. However, empirical studies of international price comparisons have been made from time to time, indicating substantial tariff redundancy and an increasing degree of competitiveness, especially in the non-electrical machinery branch. A number of examples are given in Table 12. The price comparisons of various machine tools as well as agricultural and textile machinery were undertaken in 1978 and show that the price difference of these selected products of the NEM branch averaged 7%, i.e. Brazilian machinery seemed to be quite close to what the international competitors had to offer. What Table 12, however, also indicates is a rather wide dispersion around that average,

Table 12 - Price Comparisons Between Brazilian and Foreign Produced Machinery, 1977-1978

Industry & product	Price quotations of Brazilian product	Price of comparable foreign product	Country of origin for foreign product	Ratio of Brazilian to foreign price
Machine tools				
Bench lathe				
a.	850	820	Taiwan	1,03
b.	1,550	1,380	USA	1,12
Parallel lathe				
a.	16,811	11,806	Czechoslovakia	1,42
b.	9,422	9,925	Argentina	0,94
Bench perforator				
a.	386	363	Rhodesia	1,06
b.	862	1,363	USA	0,60
Textile machinery				
Spinning machine				
a.	40,968	40,000	Europe	1,02
b.	41,735	40,000	Europe	1,04
Looms				
a.	3,661	3,000	South Korea	1,22
b.	7,674	9,500	Europe	0,81
Agricultural machinery				
Automated harvestor				
a.	29,411	23,000	Europe	1,27
b.	32,866	23,000	Europe	1,42
c.	29,330	23,000	Europe	1,27
d.	24,203	23,000	Europe	1,05
Tractors/wheels				
a.	7,083	8,900	Europe	0,79
b.	9,608	10,404	USA	0,92
c.	9,383	7,658	Europe	1,22

Source: EMBRAMEC [1978].

even in the case of different models of the very same product. Given the problem that in a large number of cases no two machines are exactly equal and therefore comparable, it is important to look at the following sector estimates of nominal and effective protection with some caution.

6. Studies of nominal and effective protection have been undertaken for the Brazilian manufacturing sector from time to time, beginning with a joint study by Bergsman and Malan in 1966/67, continued by Tyler in the mid-seventies, the World Bank in 1980, and a team of researchers at two Brazilian research organizations for 1985.[1] From the summary data presented in Table 13 it becomes obvious that nominal or implicit protection, which averaged about 50% in the late 1960s was maintained at that level in the seventies, but has apparently been reduced in the eighties, in spite of the renewed and repeated protection efforts of the Brazilian government since 1974.

7. The development has been quite different in the other two branches of the capital goods industries. Nominal protection for electrical equipment and apparatus remained over 70% for most of the decade of the seventies and has only dropped in 1985 to around 50%. On the other hand, price comparisons with products in the transport equipment branch resulted in an average which is slightly below zero, i.e. Brazilian products in that sector were offered at lower prices than similar products in world markets. While the 1985 estimates show again a positive figure of 12%, the impression remains that this branch should have been most competitive in the recent past, a picture which is confirmed by the rapidly rising export figures presented earlier.

8. In order to consider the competitive situation of an industry, it becomes important not only to look at its output but also at its input prices. This is done through the concept of effective protection which compares the value added of a product in domestic prices with the value added of the same product in internati-

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1 Bergsman, Malan [1971]; World Bank [1983]; Braga et al. [1987].

Table 13 - Nominal and Effective Protection Estimates of Capital Goods Industries, Based on Price Comparisons in 1967, 1980, 1985

Year/protection		Non-electrical machinery	Electrical equipment	Transport equipment	Manufacturing sector average
1967:	nominal	47			48
	nominal (net)[a]	26			30
	effective	60			66
	effective (net)[a]	40			45
1980:	nominal	24.0	45.2	-16.7	11.9
	nominal (net)[b]	48.3	71.4	- 5.8	22.8
	effective	77.0	111.9	- 9.6	43.6
	effective (net)[b]	51.7	81.6	-22.9	23.1
1985:	nominal	11.8	47.0	12.4	18.0
	nominal[c]	13.9	41.4	7.9	10.0
	effective	5.6	54.7	-4.4	42.9

[a] Net protection takes into account overvaluation of Brazilian Currency estimated at that time to be at 14%.
[b] Net protection takes into account production subsidies which - in the case of capital goods - were estimated to average 20%.
[c] Estimates by FUNCEX with slightly different sample from IPEA estimates presented in the year above.

Sources: Bergsman, Malan [1971]; World Bank [1981], Braga et al. [1987].

onal prices. It is obvious that effective protection is higher, equal or less than nominal protection if domestic input prices are lower, equal or higher than international prices for the same product. In the case of machinery and equipment, steel and other metals are important inputs. Since their prices have been controlled at levels close to international prices during most of the 1970s and 1980s, effective protection in the case of NEM was above nominal protection in 1980. Five years later, however, inputs of the expensive electric and electronic branches had increased to such an extent that effective protection[1] fell below nominal protection. The same had already occurred earlier in the transport equipment sector, which uses heavily inputs of the two other capital goods branches.

General and Specific Incentives for NEM Producers and Exporters

9. In the discussion of import protection three further issues have to be mentioned, because they have influenced the relative competitiveness of foreign and domestically produced capital goods substantially during the last ten to fifteen years. They are: (1) exchange rate policies, (2) fiscal and monetary incentives, and (3) direct regulations, which have played an ever increasing role in determining investment and imports of capital goods in Brazil.

10. Exchange rate policies have been pursued for a number of often conflicting objectives in Brazil as well as in other industrializing countries. Since the need to stabilize the inflationary pressures of the economy was felt most urgent, overvaluation was common. That meant, however, that imports became automatically cheaper relative to domestically produced goods, and in the case of machinery a tendency to buy abroad and to go into more capital intensive industrialization than would have otherwise been desireable. Overvaluation also led to domestic producers clamouring for high tariffs to receive "just" protection.

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[1] For a more detailed discussion of the importance of electronic parts in machine tool production, see Table 18 and text.

11. After the 1964 price stabilization program, successive Brazilian governments wanted to maintain the real purchasing power of the currency, and indeed several studies of the 1970s showed that the cruzeiro underwent very little change between 1973 and 1979 in real terms (Pastore et al., 1978, von Doellinger, 1979). However, the previous overvaluation had not been eliminated, and as a consequence observers of the economy maintained that the shadow exchange rate remained about 30% above the actual one during that time. With accelerating inflation in the eighties it became even more difficult to keep up the real value of the Brazilian currency. Although earlier studies showed that overvaluation was diminished in the mid-1980s (Kume, 1988), the exchange rate adjustments lagged again behind inflation by mid-1989. It is, however, interesting to note that prices of NEM products increased less than other products in Brazil, a fact to be taken up again in some detail below.

12. Monetary and fiscal incentives were more direct and discretionary. In the first case, a special Agency for Industrial Finance (FINAME), which was established in 1964, developed a credit program for domestically produced capital goods, offering short term loans at below market interest rates. It was estimated that this measure led to a subsidy of up to 10% in the late 1970s (see Tyler, 1981). A larger subsidy could be derived by receiving investment finance from the National Development Bank (BNDES), providing long term credit not only at below the market interest rates, but also on a base of frozen monetary correction at 20%. Because of the accelerating inflation, estimates set the actual interest rate at -16.5% for a typical loan taken in the latter part of the 1970s (see Table A10).

13. The fiscal incentives are closely connected with the government's direct interventions and regulations and consisted of three major types. The first and most important bundle of incentives consisted of reductions or exemptions of the industrial production tax (IPI), tariffs, and the state level commodities circulation tax (ICM). The second and third benefits were given to purchasers of domestically produced capital goods and con-

sisted of accelerated depreciation, which was double the normal rate, and IPI tax credits. These benefits were given by a number of government agencies and were in most cases project and product specific. As a consequence, the range of protection of NEM products was extremely wide as shown in a number of examples in Graph 5.

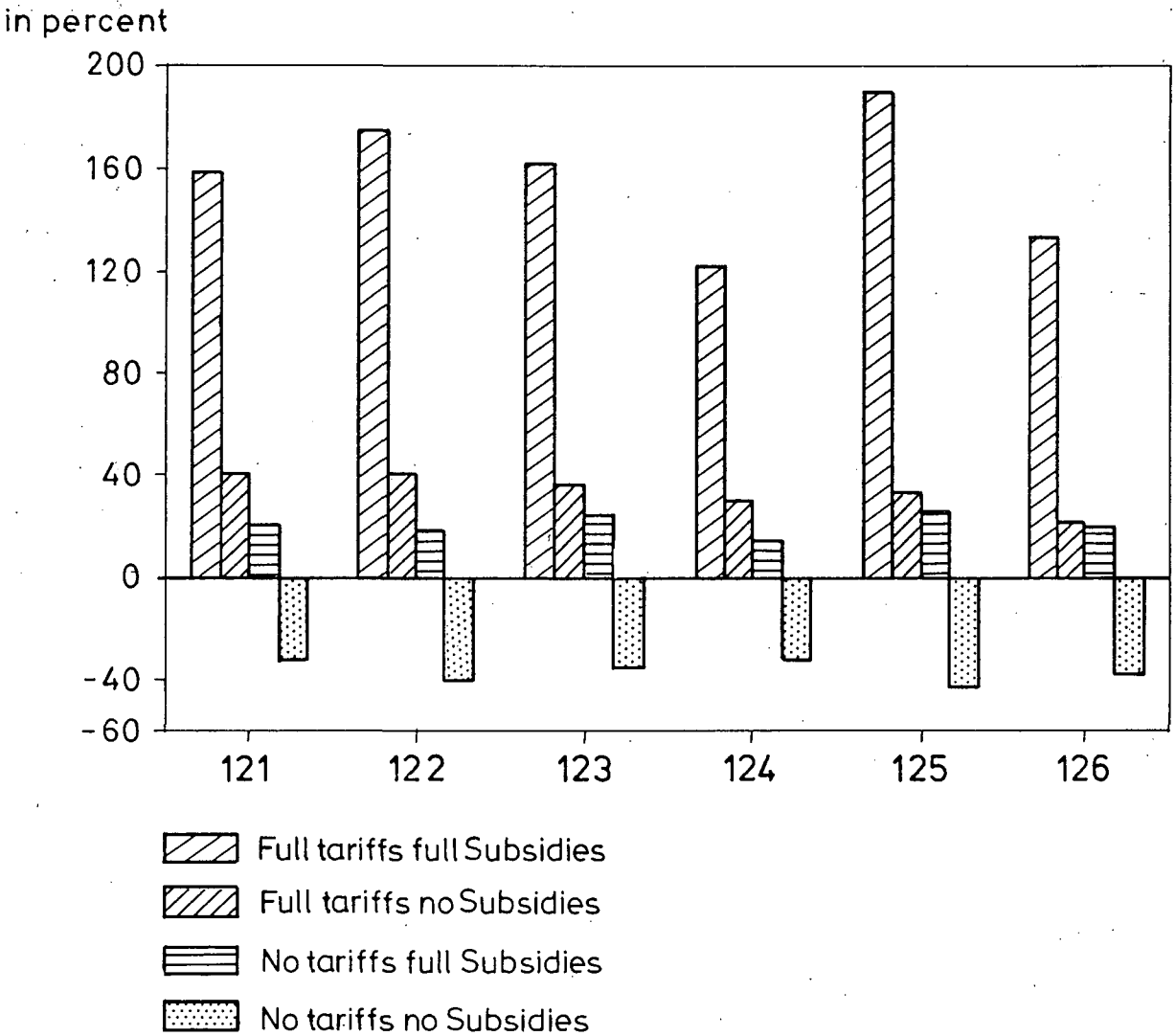
14. In the case of industrial equipment and machinery for example the domestic producer could get an import protection of over 150%, if his product received all the possible incentives, whereas the foreign competition had to overcome the full tariff. On the other hand, it was possible to face tough competition in case the purchaser of the imported good received tariff and tax reductions while the subsidies for the domestic producers were not granted fully. With so much at stake, it was a natural to pay more attention to government agencies and their decisions rather than to production and marketing issues.

15. How were these incentives to be obtained? First and most importantly, by submitting investment projects to the Industrial Development Council (CDI) which made concerted efforts to reduce their import content. In the 1980s, CDI's incentives were increasingly substituted by those granted by the Ministry of Finance under the BEFIEX program, which provided fiscal benefits for special export programs to large firms. These measures became the most powerful and uneven export incentives benefitting the large export houses.

16. The Trade Department of the Bank of Brazil (CACEX) had also an important role to play in evaluating capital goods imports. That agency seems to have applied the Law of the Similars on a stricter level during the last ten years than ever before. More importantly, CACEX officials are holding tripartite discussions with the investor and the domestic capital goods producer to examine the import content and the possibility of domestic substitution. In addition to those three national government agencies there exist a large number of regional development agencies and institutions and sectoral development agencies. The resulting

Graph 5

Net Protection for Brazilian NEM Producers under Alternative Policy Schemes



Source: Tyler [1981]

multitude of incentives "renders all coordination of industrial policies virtually impossible" (Tyler, 1981).

17. While it became apparent in the late 1970s that such a discretionary system had serious drawbacks, ranging from the above mentioned diversion of entrepreneurial talent to continued uncertainty of a system which was suffering from increasing fiscal deficits, two major reform efforts in 1979/80 and 1988/89 do not seem to have broken but merely changed the system of controls and regulations. The results are not difficult to find: a lack of flexibility and adjustment, which the external shocks of the last fifteen years required, and concentration of assets and power, which would seem less to be linked to efficiency and more to influence and tradition.

18. Inspite of the heavy emphasis on import substitution in the capital goods sector, export diversification played an increasingly important role in the case of non-electrical machinery. Brazil is a price taker in the world of NEM. As a consequence, one should assume that the firms in that branch would base their decision to either sell in the domestic or foreign market on relative profitability, which is determined by the net impact of the overall incentive system. After having discussed and quantified the protection for the domestic markets, it remains now to do the same for the export market and then evaluate the degree of pro- and anti-export bias.

Net Incentives and their Impact on NEM Exports

19. Realizing the need to diversify and expand exports more rapidly in the 1960s, Brazilian policy makers have developed a whole battery of export incentives, which attempted to compensate for both, the taxes and tariffs paid on inputs as well as for the overvaluation of the currency. But since the rate of devaluation was highly variable over most of the years, the impact of the

incentives became highly uneven, depending on the degree of inflation and the index used. Increasingly, policy-makers rewarded export performance of individual firms. In the case of machinery, these were mainly domestic producers, since most foreign establishments in that branch were medium sized and more oriented towards the Brazilian market.

20. Among the monetary incentives, prefinancing and financing of exports proper was very popular, reaching amounts of over US$ 1.6 by 1980. As in other credit incentives discussed earlier with respect to the BNDES, it was the prefixing of a low monetary correction which helped to provide the exporter with a subsidy. While the producer had to pay an interest rate of over 80% for his domestic transactions, he was able to get away with 24% for exports. That difference increased with the acceleration of inflation[1].

21. In the fiscal field, in addition to the drawback mechanism, the Brazilian government offered at one time or another exemptions of indirect taxes on exports and reduction of corporate taxes for exporters. The most powerful system became the BEFIEX scheme, which was established in 1972 to help individual enterprises which had long term export commitments with specific export-incentive packages. Expressed in percent of total export sales, these fiscal incentives amounted to 10% for the whole manufacturing sector, slightly less than the monetary incentives which reached 11.5% in the later 1970s.

22. For the machinery sector as a whole those incentives were a bit more powerful and reached close to 30% of total sector export sales by 1980. As Table 14 shows, however, the net export incentives, which were adjusted by the exchange rate overvaluation, reduced that amount to about half, i.e. 16.7%, a rate which was

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1 In December 1978 the difference reached 85%. See Moura [1981].

below the net nominal protection by just over 10%. Compared with the other branches of the capital goods sector and with manufacturing as a whole, significant differences emerged at the beginning of this decade. The net anti-export bias was over 30% for electrical equipment, it was minus 35% for transport equipment, and nearly neutral with respect to the average of all manufacturing activities.

23. If one compares now these indicators of relative profitability with some proxies for export performance, such as export growth, export-output ratio or the export share in total sales abroad, the poor performance of the electrical equipment sector and the strong growth of the transport equipment sector are consistent with the significant pro- and anti-export bias of the incentive systems in those two sectors. However, in the case of non-electrical machinery, the rather successful export expansion goes against the anti-export bias and has to be explained by other variables, unless earlier estimates of the relative incentive system come to very different results[1].

24. In the search for other variables to explain the greater export competitiveness of the NEM sector, neither excess capacity, which may help to sell abroad even at marginal costs, nor economies of scale were a typical characteristic of the NEM industry in the 1970s (see Table A11). However, rates of return of that industry were relatively modest, and its profitability relative to the manufacturing average was below 50% (Table A12). This phenomenon could have been a consequence of two causes, inefficiency or a high degree of competition, forcing competitors to lower prices in order to stay in business.

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[1] Rough estimates for 1974/75 confirm the 1980 calculations, see Tyler [1981]. Similarly Teitel and Thoumi [1986, p. 486] have mentioned that export incentives "seem to have had the role of at least partially compensating for overvaluation of the exchange rates, domestic taxation, and other forms of discrimination in favor of production to the domestic market".

Table 14 - Import Protection, Export Incentive and Export Performance of Capital Good Industries, 1979/80 and 1985/86 (in Percent)

Incentives/ Performance	Year	NE Machinery	Electrical Equipment	Transport Equipment	Manufacturing Average
INCENTIVES					
Net nominal protection	1980	27.1	46.9	-19.3	5.2
	1985	17.3	44.5	9.2	16.4
Net export incentives	1980	10.7	16.1	14.9	3.5
	1985	6.3	8.2	7.0	4.1
Net anti-export bias	1980	16.4	30.8	-34.2	1.7
	1985	11.0	36.3	2.2	12.3
PERFORMANCE					
Export-output ratios	1980	14.2	4.4	9.9	9.1
	1985	10.1	5.6	15.9	10.5
Share in total manu-factured exports	1980/81	11.0	3.0	10.2	-
	1984/85	14.8	4.2	12.3	-

Source: World Bank [1983], Kume [1988], Guimarães [1988], own calculations.

25. As will be shown below, the NEM sector has been found to be efficient in using resources, and there is evidence that competitiveness was keener in that branch than in most other sectors. Relative prices of machinery increased much less than the rest of industry. While the real exchange rate for the manufacturing sector as a whole, which had rapidly improved in the early 1970s, deteriorated somewhat in the latter part of the decade (by about 10%), it kept on even keel in the case of machinery and improved significantly in 1980 before it also declined in 1981 (see Table A13). Translated into the context of the relative profitability, the anti-export bias may have well been changed into a pro-export bias as some data for similar comparisons indeed indicate[1].

26. More recent information on net nominal protection, export incentives and anti-export bias come to very similar results and confirm the findings for 1980. Inspite of the NEM anti-export bias, the sector's export performance kept up, although growth rates of exports did not advance as rapidly as in the 1970s. On the other hand, protection in the electrical equipment sector remained high and exports kept on being relatively insignificant. It remains then to be shown which productive factors contributed to NEM's performance and if these factors can be relied on in the future to perform similarly.

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[1] The 1981 anti-export bias was estimated to be -1.6 by Tyler [1983].

E. THE ROLE OF INPUTS IN DETERMINING NEM'S INTERNATIONAL COMPETITIVENESS

1. The discussion of the role of government policies in helping or hindering the efficient development of the machinery sector has shown that on balance the net incentives were anti-export biased, which did not stop firms in that sector to do well both, in domestic and foreign markets, at least until the early 1980s. The explanation of the rather strong export growth was given to be based on price competitiveness, which helped to sell successfully abroad.

2. There is additional evidence that the NEM sector was able to expand in a more efficient manner than the two other capital good industries and also to perform better than the manufacturing sector as a whole. In an analysis of total factor productivity between 1970 and 1983, Braga and Rossi came to the results shown in Table 15 below. Whereas factor productivity growth was negligible in both, the electrical and transport equipment sector as well as for manufacturing as a whole, it grew by 3.5 per cent p.a. for the machinery sector.

Table 15 - Growth of Output and Factor Productivity of Capital Goods, 1970-1983 (in percent)

	Non-electr. Machinery	Electr. Machinery	Transport Equipment	Industry Average
Growth of Production	12.4	9.6	7.8	8.2
Growth of Factor Productivity	3.5	0.4	-1.2	-0.6
Relative Contribution of Factors to Growth	100.0	100.0	100.0	100.0
Labor	15.6	7.9	4.2	5.5
Capital	18.1	22.8	34.2	34.5
Electrical Energy	0.4	-0.1	-0.3	1.0
Factor Productivity	28.4	3.7	-15.2	-7.1
Intermediate Inputs	37.5	65.6	77.1	66.2
Relative Contribution of Factors to Costs	100.0	100.0	100.0	100.0
Labor	21.5	13.2	7.8	8.4
Capital	28.5	29.2	37.8	37.7
Electrical Energy	1.4	0.9	0.7	2.1
Intermediate Inputs	48.6	56.7	53.6	51.8

Source: Braga and Rossi [1988].

3. The relative contributions of the major factors to that growth are shown in the second part of Table 15. Apparently, the NEM sector used the raw materials and intermediate inputs and capital more sparingly than the firms in the electrical and transport equipment branch. The relative labor intensity left enough room for a healthy total productivity growth, which contributed with nearly 30% to the rapid expansion of the machinery sector during the 1970s and early 1980s.

4. The above findings are consistent with earlier studies one of which claimed that "during the post-war period and earlier Brazil has provided a setting when capital goods production was quite efficient"[1]. Using pooled time series and inter-firm cross sectoral data, for the 1970s, Tyler (1981) attempted to examine sectoral efficiencies with the help of the Cobb-Douglas production function. He came to the result (reported in Table A14) that the firms producing industrial equipment and motors as well as the ones engaged in the production of office machines were characterized by significant X-efficiency and technological advancement. In this case, however, the productivity difference between firms in the NEM branch and firms in the electrical equipment sector were not significant.

5. Tyler's study further confirmed the earlier findings that there was no significant relationship between efficiency and profitability. An attempt to relate efficiency to ownership, i.e. testing for the hypothesis that foreign firms produced more efficiently than domestic ones in some capital goods branches gave a positive but statistically not significant correlation.

Labor Productivity, Skills and Costs in the NEM Sector

6. The analysis of NEM development in post-war Brazil has pointed out that this sector experienced both, high growth rates of output and employment. A second look at Table 6 will also show that labor productivity advanced rapidly, especially in the early

[1] See Bergsman [1970, p. 186].

1970s, when the annual rate averaged 7% and more. Similarly, we have shown that part of the success in raising labor productivity must be linked to that sector's ability to attract and train manpower which became an important factor in a relatively short time[1]. What remains to be examined are the development of absolute and relative labor costs, as well as the demand for and the supply of required skills, and the infrastructure which is supporting the labor markets in Brazil.

7. Cost comparisons in the engineering industries between the newly industrializing and the advanced countries reveal that machine production by the NICs are characterized by substantially lower wage levels. While their overall labor productivity has remained below the one achieved in fully industrialized countries, that difference seems to be relatively small if one measures the operator efficiency per machine task. The issue at stake for LDCs to improve is much more the plant output per man-hour, which is determined by a number of factors which are linked (1) to the overall shortcomings of the economy, especially in infrastructure and (2) to the effects of poor management, ranging from inadequate plant layout and flow of work to poor inventory control, production scheduling and the planning of auxiliary activities.

8. The international comparison of labor costs in the automobile branch as depicted in Table 16 shows that the NICs keep their relative advantage in labor costs, even if one adjusts for the differences in productivity. In the case of Brazil, it would seem

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[1] See Table A2 in which Brazil's NEM shows level of "human capital intensity" which is above the average of most other countries. As mentioned earlier the actual statistics used, i.e. payments of wage and salaries would indicate that the acquired skills were paid relatively better than in most other countries of the world for most of the 1960s and 1980s. As shown below, however, intervention in the labor market changed that in the late 1970s and early 1980s.

Table 16 - International Comparison of Labor Costs in the Automotive Sector, 1984/85

Country	W/H (US$)	Q/L (US=1)	W/H (1:Q/L) / US W/H
USA	19.37	1.00	1.00
FRG	12.89	1.10	.61
Japan	7.24	1.40	.27
Mexico	3.53	.85	.22
Brazil	3.66	.80	.24
South Korea	1.95	.90	.11

W/H = wage per hour in US$
Q/L = relative labor productivity
The fourth column shows the relative wage, adjusted by differences in labor productivity.

Source: Korea Automotive Industry Corporation Association [1986].

that relative labor costs were about one fourth to one third of what they had been in the OECD countries in the early 1980s[1]. While we do not have a direct comparison for the NEM subsector, it can be maintained that similar difference should exist there[2].

9. Table 16 also indicates that Brazil's labor inputs relative to its competitors in South Korea and Mexico were more costly. Those differences would seem to be less a function of different wage levels, since real wages in Taiwan, South Korea, and Singapore are today at least at the level of most Latin American countries, but of the fringe benefits, social security and other costs related to labor. A summary of these extra costs is given in Table A16, showing that Brazil's and Mexico's non-wage labor costs amount to 107% and 78% of actual wages paid whereas the East Asian countries average is about 50%.

10. With respect to wage differentials between skilled and unskilled employees, the census and other data reveal that they had been increasing for a period of over 10 years from the mid-1960s to the second part of the 1970s, but that they have been reduced since then. That development contradicts the more rapid growth of relatively skill intensive industries, as depicted in Graph 6, which would indicate a more intense labor demand for the skilled group than for the unskilled one from 1965 on until the early 1980s, when it reached its peak.

11. Part of the explanation can be found in the wage policy of the Brazilian government which, in an attempt to prevent the purchasing power erosion of the lowest wage group, enacted legislation in 1979, which gave a higher adjustment for unskilled workers than for other employees. The negative effects of these

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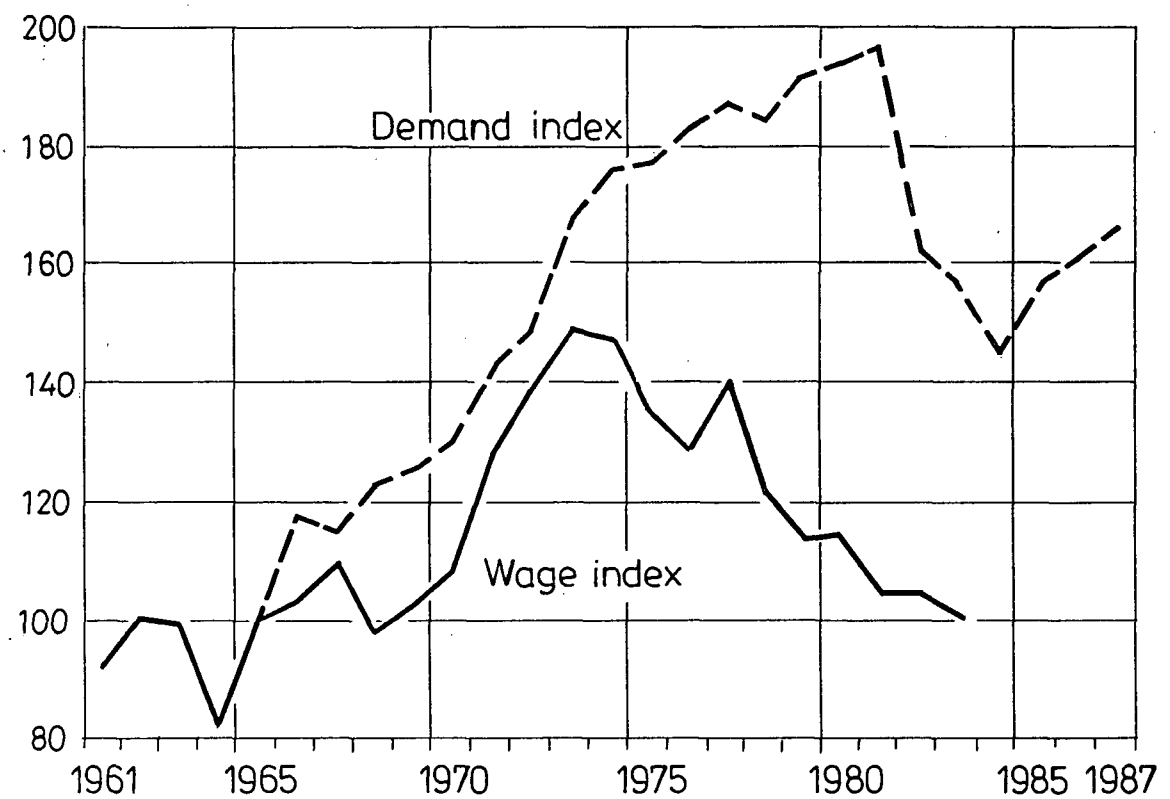
[1] For similar observations, see Fischer et al. [1988, p. 197].

[2] For a comparison of labor costs and average wages in transport equipment and NEM see Table A15.

Graph 6

Labor Demand for Different Skills and Wage Differentials



Source: Spinanger [1988]; own calculations.

policies on employment and international competitiveness were pointed out in a number of studies, and the government rescinded these measures in 1985[1].

12. Another explanation for the more rapid increase of skilled labor supply and with it the narrowing of the wage differential can be traced to the improvement of the technical and vocational infrastructure, which was reinforced in 1975/76 with the creation of the National Vocational Training System (SENAI) as an umbrella organization of all existing vocational training programs in Brazil and the financial incentives for firms to train their own labor[2]. The financial incentives, which are still in effect today, allow the firm to deduct 200% of expenditures made for training employees from pretax income. Although such deductions cannot exceed 10% of taxable profits and are subject to explicit approval from the Ministry of Labor, the fact that by 1985 over 330 firms were providing training for about two million employees indicates the importance and effectiveness of this incentive measure. To what extent that measure has contributed to lower the wage differential between skilled and unskilled workers is difficult to decide, but firm interviews in 1989 found rather unanimously that management had been able to successfully use most of their in-house trained people and there was no shortage of skilled labor including the area of electronic devices used in the new CNC machines.

13. Of greater concern to a number of policy makers today is Brazil's sliding back in providing secondary and higher education to an increasing number of students. Although Brazil's degree of industrialization is above the average of the NICs, and skill intensive sectors are playing a major role in the industrialization process, the share of youngsters that attended secondary schools and go on for higher education is substantially below not

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[1] For a discussion of the effects of these policies, see Spinanger 1988.

[2] For a discussion of the flexibility of the sector to train its manpower in the 1950s and 1960s see Leff, 1968, Ch. III.

only the averages of the East Asian competitors but also Mexico. A glance at the expenditures going to education is even more disheartening. After having been half of what it was in Korea, Taiwan and Mexico in 1965, they fell back to less than a quarter in 1984 (see Table A17). While in-house training seems to have provided a successful undertaking which has supported Brazilian industry's move into the production of more sophisticated products, it would not seem difficult to forecast that the basis for that kind of training will be become increasingly inadequate.

Modernization, Subsidies and Capital Intensity of NEM

14. The earlier discussion has shown the intensity of the Brazilian effort to invest in machinery and equipment and modernize (Section B). Evidence from the engineering sector itself shows that investment in those industries also proceeded faster than output during the 1970s and early 1980s. Those investments were largely financed by sources external to the firms, a substantial amount of which at subsidized interest rates.

15. The major financing agency was the National Development Bank, the loans of which reached an average of over US$ 200 mill. p.a. between 1974 and 1976, but then declined to an average of about US$ 60 mill. for the rest of the decade. As Table 17 shows that financial support concentrated on saving engineering firms from financial distress in the early 1980s. That action, together with renewed finance for investment and continued high protection should have given capital goods producers a chance to regroup and modernize. The evidence is not yet in, but it is more likely that by preventing exit, these policies hindered industry to adjust forcefully, permitting firms to further diversify rather than to specialize.

16. The subsidies in long- and short-term credit combined with the desire of many producers to buy the latest rather than the most effective equipment led to a less than satisfactory use of

the factor capital in many firms. In addition to price and availability, the efficient use of capital depends also on the organizational management which the expensive equipment and the complex production process of capital goods entails in general and the ability to spread indivisible investment capacities over larger volumes of output.

17. in the industrialized countries, the manufacture of parts and components and processes like casting, forging and heat treatment are mostly carried out by ancillary firms under subcontracting arrangements. This is not the case in the NICs, where plants are more vertically integrated. It is therefore not surprising to find in the case of Brazil, India and Korea that there has been a tendency towards large firms in the NEM branch, quite different from the typical medium size in ACs. However, while one would expect that large size should generate economies of scale, observers of the industry have reported a prevalence of inadequate scales in individual product lines, together with clearcut trends toward increased product diversification[1].

18. In Brazil, the evidence is mixed. As shown earlier, installed capacity has been fully utilized by the industry as a whole, but it seems that only a few firms are rigorously specializing. The largest machine tool producer, ROMI, has strenghtened his specialization in traditional lathe production. He has also invested large sums - financed by special credit from BNDES - into new CNC machinery and equipment at the same time when he is streamling the production of conventional lathes. On the other hand, Brazil's largest producer of special machinery, VILARES, has diversified into many other branches as have most other firms, whose diversification has occurred often as a consequence of high fluctuations in demand from domestic users of specialized capital goods and the inability of the firm to sell abroad.

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[1] Datta Mitra [1979].

Table 17 - The National Development Bank's Role in Financing Capital Goods Expansion and Distress Management, 1983-1987 (in mill. US$)

	Capital Goods Industries			Basic Industries		
Year	Total	Fixed capital	Financial distress	Total	Fixed capital	Financial distress
1983	20.26	3.14	17.12	171.52	124.44	47.08
%	100	16	84	100	73	27
1984	19.22	4.97	14.25	161.27	104.10	57.17
%	100	26	74	100	65	35
1985	18.99	9.27	9.72	119.73	60.64	59.09
%	100	49	51	100	51	49
1986	25.06	17.19	7.87	135.27	61.02	74.25
%	100	69	31	100	45	55
1987	45.62	33.95	11.67	112.37	91.81	20.56
%	100	74	26	100	82	18

Sectoral Distribution of Approvals for Distress Management, 1981-1988 (in percent)

Sector	Private	Public	Total
Non-metallic minerals	8	19	14
Metal and metal products	11	54	36
Non-electrical machinery	42	21	30
Electrical equipment	-	6	3
Paper and cellulose	23	-	10
Consumer durables	16	-	7
Total	100	100	100

Source: World Bank [1989].

Foreign Investment, Technological Change, and High Cost Production

19. In that context it may be interesting to postulate that foreign investment in Brazil's machinery sector should have been contributing with their traditional organizational strength to higher efficiency of capital used in that sector. While not so dominating as in the transport sector, foreign firms have played an important part in the development of the NEM sector since World War II. As Tables A18 to A20 show, foreign investment participated with 30% to 45% in three major branches of the NEM sector, i.e. industrial equipment for basic industries and electric energy, machinery for specific industries, and machine tools. In all cases, Brazilian firms are the largest producers, but it is especially in the machine tool branch where the foreign suppliers are of substantially smaller size than the two leading Brazilian firms. Most of them are not vertically integrated but have managed to build up a reliable net work of component producers, which has made it possible to not only sell in the domestic market but also abroad.

20. Besides the discussion of foreign investment's contribution to the balance of payments, which has kept economists occupied in Brazil for many years, the more recent investigations have concentrated on technology, its transfer, adaptation and further development[1]. While the BNDES study recognized the crucial role of foreign investments in transferring technology, a broad examination of that issue in the case of complex capital goods in Brazil and other newly industrializing countries came to the conclusion that the technological impact of foreign firms on the host country was more limited than the impact made by the more enterprising indigenous producers. In the latter case, it was stated that despite "relying on licensing agreements for some of the technology needed to make complex capital goods and the intrinsic limitations of the agreements, domestic firms surveyed have been able to initiate their entry into vital segments of this sector"[2].

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[1] BNDES [1988b].

[2] UNCTAD [1982].

21. At the same time it was also pointed out that the national firms still concentrated on adaptive work, i.e. detailed designs of parts and components. What was found missing was the basic design capacity, particularly in fields which are subject to more rapid technological change. In the case of electronic equipment which has become an important input in the machinery sector in general and machine tool industry in particular, the Brazilian government decided to take the initiative and reserve the production of these elements for national producers, banning not only all imports but also closing the door for joint ventures in that field.

22. While the rather heavy handed import substitution policies have been discussed widely, it has been difficult to quantify the costs involved[1]. In the case of machine tools, the industry got together in connection with the planned import tariff reform of 1988 to discuss comparative cost and prices and to analyze the major inputs and their relative importance in the production of a number of machines which are most common in this branch[2]. The results are summarized in Table 18, which compares three types of lathes.

23. Column 1 shows the relative price ratios for major inputs in Brazil and a number of industrialized countries. What immediately becomes apparent is the high ratio for electronic components and automation elements, which play a crucial role in the CNC machines. In 1987, five years after the Brazilian government had begun supporting domestic firms to build the electronic components, their price was still over three times the one offered by foreign competitors. The impact on the production costs of the CNC lathes can be seen from columns (5) and (7), which show the additional costs the Brazilian machine tool producer had to bear, based on his current production structure.

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[1] See for example, Schumacher and Wilkens [1989], Corsepius and Schipke [1989].

[2] ABIMAQ [1988].

Table 18 - Cost Comparisons of Brazilian and Foreign Machine Tool Production, 1987[a] (Ratios and %)

Major Cost Items	PB/PI[b] (1)	Conventional (2)	Lathe (3)	Simple CNC's (4)	Lathe (5)	Complex CNC (6)	Lathe (7)
A. Raw Materials							
Special Steels	1.7	4.8	3.1	4.1	2.7	4.1	2.6
Iron Castings	1.3	11.6	3.0	10.1	2.6	3.8	1.0
Non-ferrous Metals	0.7	0.7	-0.2	0.7	-0.2	0.2	-0.1
Electrical Motors	0.8	4.4	-1.1	3.4	-0.8	5.2	-1.2
Electrical Components	1.5	8.3	3.5	5.7	2.7	4.6	2.2
Electronic Components	3.8	5.0	14.2	20.3	57.3	28.0	79.4
Automation Elements	3.3	3.5	8.0	2.2	5.1	5.6	12.6
Ball Bearings	2.3	6.0	7.9	3.9	5.2	2.5	3.2
Forging Products	1.2	0.8	0.1	0.2	0.1	-	-
Other Mechanical Components	2.9	2.4	4.6	3.2	6.1	11.2	21.5
All others	1.9	0.6	0.6	2.5	2.4	2.8	2.7
Subtotal	-	47.6	44.0	56.3	83.0	68.0	123.9
B. Transformation Costs							
Labour and Management	0.5	36.9	-18.1	32.8	16.1	28.0	-13.8
Electrical Energy	0.8	1.5	-0.3	1.1	-0.2	0.6	-0.1
Oil and Lubrification	1.4	1.5	0.6	1.2	0.5	0.4	0.2
Auxiliary Machinery	2.0	12.5	12.5	8.7	8.7	3.0	3.1
Subtotal	-	52.4	-5.2	43.7	-7.1	32.0	-10.6
Total	--	100.0	38.8	100.0	108.0	100.0	113.3

[a] OECD countries

[b] PB/PI = Brazilian prices over international prices.
Columns (2), (4), (6): Cost structure of conventional lathe, simple and complex CNC lathes (in percent).
Columns (3), (5), (7): Cost structure adjusted for price differentials between Brazil and OECD countries (in percent increases or decreases).

Source: ABIMAQ/SINDIMAQ [1987] and own calculations.

24. In the case of the simple CNC lathe, the extra costs amounted to nearly 60% of total production costs and in the case of the more complex lathe it increase to about 80%. The case is very similar with other machine tools such as milling and grinding machines and the more complex machine center. In each case, production costs were raised far beyond the possibility to compete with imports, and even less to sell in export markets.

25. Table 18 gives also some clues about costs of other inputs, which were above world prices and made it difficult for the Brazilian producer to compete actively in foreign markets, even in the case of the traditional lathes. While at a much more reduced scale, the expensive electrical components also played an important role to raise costs. In addition, the more expensive ball bearings and the auxiliary machinery increased production costs of the traditional lathe by nearly 40% more than its foreign competitors.

26. While a one year comparison of a particular branch, which is currently undergoing rapid technological change, should not lead to a hasty generalization in an analysis of a sector which has been found to be efficient, both in terms of input use and the capturing of foreign markets, the cost data in the machine tool branch are an indicator of the current problems facing an important part of the machinery sector.

F. PROSPECTS FOR AND PROBLEMS OF MACHINERY PRODUCTION AND EXPORTS

1. On the basis of the above findings of past and present performance of the machinery sector, it is now possible to examine the future perspectives of this sector. More than any other industrial branch, NEM production is closely linked to all other industries and depends on overall growth of the manufacturing and infrastructure sector to nearly 100%, as is shown in the input-output relationships for earlier years (see Table A21). In addition, export expansion has become increasingly important as a source of growth, reaching close to 20% in the mid-1980s. Given the problems the intensified import substitution policies have brought in the recent past, export efforts can be considered not only contributing to improved competitiveness but also renewed growth of the industry.

2. While capital goods in general and machinery production in particular are purchased by industrial enterprises of the same or other branches, the demand analysis of past, current and future developments can be linked to the very same variables which determine the production of industrial output in general: per capita income and the investment-output ratio, to be taken as proxies for representing domestic demand. An index of world income can be used to represent external demand from the rest of the world.

3. The empirical analysis, regressing apparent demand for NEM products with per capita income and the overall investment ratio of the economy, provides a good fit and the coefficients are statistically significant. The same is true for the estimates of import demand[1]. Under different assumptions about the development of the major independent variables for the years to come, it is

[1] The export demand equation has a significantly lower correlation coefficient. Here it would seem to be more important to maintain the incentive on the supply side as expressed by a relatively high correlation between the real effective exchange rate and NEM exports.

Table 19 - Estimates of Past, Present and Future Demand for Brazil's NEM Sector

Dependent Variable	Regression Equation	Period	R^2	F	DW
I Domestic Demand	$\ln DD = -17.104 + 3.843 \ln Y/N + .8276 \ln I/Q$ (-13.873)* (33.431)* (4.219)*	1965-85	.983	580.985	1.591
II Export Demand	$\ln X = -15.938 + 3.2315 \ln Y_w$ (-5.264)* (3.433)*	1965-85	.985	37.5301	1.470
III Import Demand	$\ln M = -24.690 + 4.131 \ln Y/N - 0.845 D$ (-14.193)* (17.860)* (-5.927)*	1965-85	.969	313.865	1.390

Y/N = per capita income; I/Q = Investment coefficient of Brazilian economy; Y_w = world income; D = dummy variable from 1965 to 1974 = 0 and from 1975 to 1985 = 7 for protectionist policies; * significant at 5% level with t-values in brackets.

		Selected Indicators				
Exogenous Variables		1980	1985	1990	1995	2000
World Income (Index 1980=100)		100.0	110.6	132.2	158.7	190.4
Per Capita Income Brazil (in US$)	A	3356	3282	3350	3600	3800
	B			3502	4043	4540
Invest-Output Ratio	A	23.3	16.1	18.1	19.0	20.0
	B			20.0	22.5	23.0
Dummy Variable						
(1 = Continued Protection)	A	1	1	1	1	1
(0 = Liberalization)	B			0	0	0
NEM (mill. US$):						
Domestic Demand	A	14.300	11.200	13500	16300	19700
	B			17100	26100	39800
Exports		1.550	1.660	2500	3000	3600
Imports	A	2.400	2.380	2400	3100	3500
	B			2900	4300	6700
Output	A	13.450	10.420	13400	16400	19600
	b			17500	27400	42900

Source: Table A7, own calculations.

possible to forecast the demand for machinery for 1995 and the year 2000. Table 19 shows two scenarios, with the first making rather cautious and pessimistic assumption of Brazilian income and investment growth, given the economic and political uncertainties. The second one introduces slightly more optimistic parameters, based on the assumption that a number of steps discussed below are undertaken and that the new Brazilian government will be in the position to reduce the public sector deficit and with it decelerate the high rate of inflation.

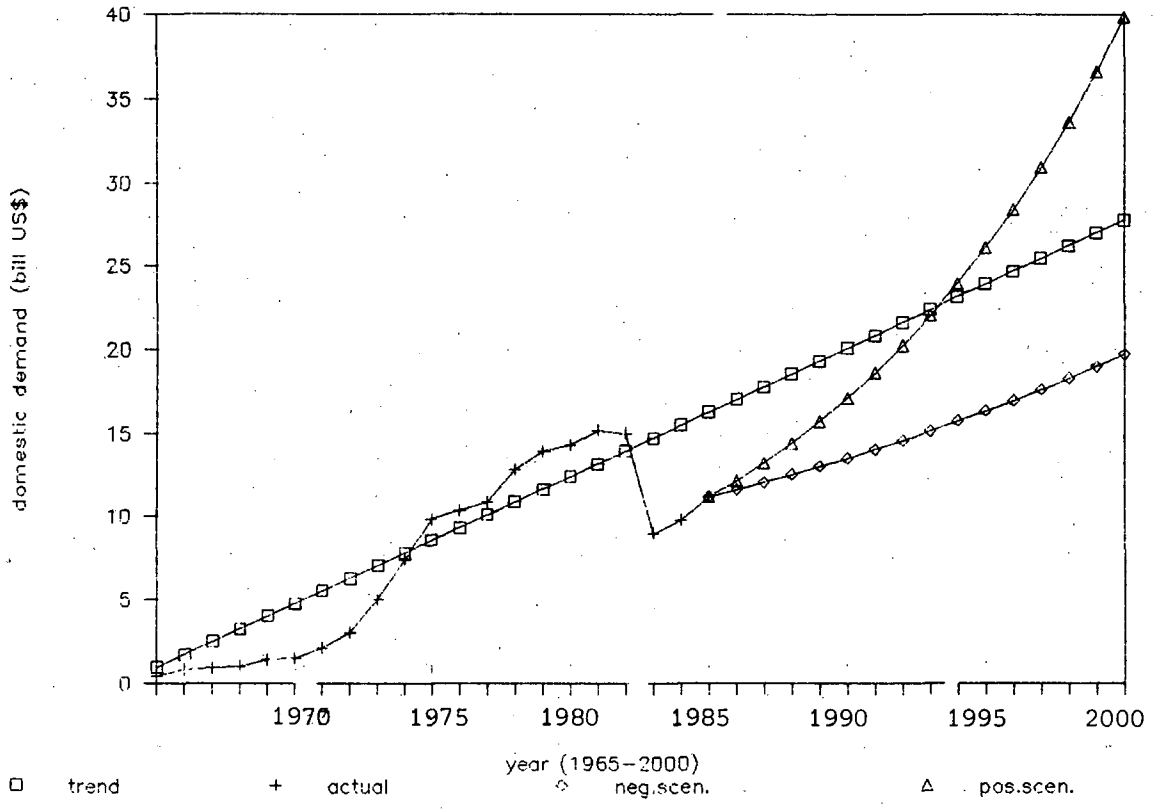
4. As Graph 7 indicates that even under the optimistic assumptions, Brazil's NEM sector will only be back "on the track" by 1995. More realistic is the second set of projections which shows that the domestic demand for non electrical machinery will reach the 1980 level of about 14 bill. US$ equivalent by 1994/95, to be just below US$ 20 bill. by the end of the century. In any case, total production and sales in the nineties will be significantly below the potential of this industry as was pointed out by the President of the Association of Machinery Producers (ABIMAQ). In a 1989 interview, opening a round table conference on the future of the machinery sector, he maintained that the gap between the actual and the potential output would be 1:3 by the end of the 1980s[1]. He forgot to mention that the NEM sector had gone through an unprecedented expansion and diversification period which was bound to face obstacles, once the economy would slow down.

5. As Table 20 shows, Brazil has increased its engineering product diversification more than any other country in the world. Between 1970 and 1984 the number of products jumped from 25 to 92, catapulting the country into the top ten of capital goods producers in terms of number of products. Interestingly enough that list is not led by the advanced market economies but by two countries of the socialist bloc. Even an organization which has wholeheartedly supported the NICs' move into capital goods production, has warned LDCs in 1986, that "very few industrialized countries manufacture the complete range of machinery and equip-

[1] ABIMAQ [1989].

Graph 7

Past and Projected Domestic Demand for NEM in Brazil, 1965-2000



Source: FIBGE, FGV [various years]; own calculations.

ment, and intra-industry trade is extensive in this industry. Developing countries will need to be selective in the range of machinery and equipment that they plan to produce" (UNIDO, 1986, pp. 86-87).

6. With respect to exports, prospects should be brighter. But while the trend towards international protectionism should be less stringent in this branch than in many others, competition will become tougher, mostly from continuous improvements of NICs competitors from South and East Asia. Given the problems of the Brazilian economy and with it the danger of overvaluation of the currency, one should not expect Brazil to relatively improve its position. If Brazilian firms can maintain the share in the more traditional NEM fields, which become increasingly standardized they will have accomplished quite a task. For breakthroughs in the more complex capital goods, rather drastic policy changes are required.

7. A major factor which will determine success in the more sophisticated NEM markets is the further progress made in technological change from traditional to CNC machinery. While the electronic revolution has entered the Brazilian NEM sector, current differences in production costs, which have shown only marginal declines in the last few years, will result in loss of potential market shares abroad and a lingering unwillingness to engage in the costly investments to be made in Brazil proper. While not all subsectors are fully involved in the electronic revolution, its importance and impact is bound to grow, requiring Brazilian producers to rigorously specialize and to reduce production costs.

8. Prospects for a more pragmatic technology development are good in terms of positions being held by government and firms at this point in time. Both parties have prepared sectoral plans for the years to come. Among others, the following policies are now being proposed to overcome the supply bottlenecks: (1) Increase the competitiveness of domestic electronics market by allowing exit of weak firms and with it reduce overcrowding of domestic supply to gain economies of scale and lower costs; (2) allow

joint ventures and a more flexible import policy of microelectronic components for the machinery sector; (3) co-ordinate between electronics and informatics with user industries (i.e. besides NEM and auto, Telecom & Radio/TV); and (4) make better use of R&D and manpower developed and trained at universities and technological centers[1].

9. Linked to both, new and/or improved technology and qualified labor, is the need for generating the resources to finance them. Whereas the public sector will hardly be able to collect the necessary funds to fully support research and development or training in this sector, private NEM sector firms have - in spite of the last disappointing decade - accumulated enough savings plus in-house technology to continue with investment in those areas. If indeed the slowdown in the 1980s was used by the firms to heavily modernize, they should be able to respond flexibly and forcefully to the challenge of international competitors[2].

10. This in turn requires a more stable monetary and fiscal policy as well as a more flexible trade policy environment, both of which are not given at present and are doubtful to develop rapidly in the next five years. The new and more pragmatic model of industrialization in Brazil is seen by some of its most critical observers as one which is not only able to incorporate the latest electronic innovations into the production process but which is open to a more stringent competitive pressure from abroad. In addition, it is suggested to decrease state participation in the economy, both for the financial problems cited above as well as for the need of improving resource allocation in sectors dominated by state monopolies[3].

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[1] Meyer-Staden [1989].

[2] Lanz [1986].

[3] Braga and Matesco [1989].

Table 20 - Diversification of Engineering Products 1970 and 1984[a]

Country/Years	1984	1970	% Increase
Hungary	104	118	13.5
Yugoslavia	99	115	16.2
FRG	112	114	1.8
Spain	84	111	32.1
Japan	105	109	3.8
USA	83	109	31.3
France	90	104	15.6
Finland	68	100	47.0
Brazil	25	92	268.0
Poland	68	89	30.9
UK	55	88	60.0
Denmark	62	88	41.9
Austria	79	85	7.6
Sweden	73	80	9.6
CSR	69	77	11.6
AVERAGE[b]	78 (82)	98 (99)	39.4 (23.1)

[a]Number of 6-digit ISIC engineering products produced in those two years.

[b]Average in brackets exclude Brazil.

Source: UNIDO [1988].

SUMMARY AND CONCLUSION

1. The major purpose of the study on Brazil's non-electrical machinery was to examine the international competitiveness of the sector. It was postulated that - contrary to earlier notions - Brazil should (1) have developed a comparative advantage in a number of NEM subsectors and that (2) the growth of exports and success in penetrating an increasing number of markets with an increasing number of products were not a consequence of over-generous incentives but first and foremost based on real progress in factor productivity.

2. The findings gave support to the two contentions made above. While export-output ratios of most firms remained modest, the analysis of the revealed comparative advantage indicated that close to ten subsectors of the NEM branch had at one time or another performed well, i.e. shown above average participation in Brazil's own exports vis-à-vis world exports. True enough, the winners were the relatively less human capital intensive branches which are normally produced at larger numbers, but there were also some significant gains in exporting more complex NEM products beyond the markets of the Latin American neighbors and some other LDCs.

3. Moreover, there was no evidence of excessive export subsidies, neither in the late 1970s when Brazil's NEM exports reached their peak nor in the mid 1980s, when they recovered from the crisis of the second oil shock. On the contrary, in both years, the analysis found a slight anti-export bias which could only be overcome through a more efficient use of productive factors than in most other sectors of manufacturing.

4. In explaining the significant factor productivity increases in the 1970s and early 1980s, a line of reasoning was pursued which had been expressed earlier by observers of the capital

goods industry in the 1950s and 60s, showing the efficiency of the Brazilian "learning by doing" and "in-house" training" programs. While the relevance of these programs was found to have remained important for fostering the rapid adjustment of the Brazilian labor force to the high standards of the industry, doubts were raised as to the viability of these measures in the future, given the fact that school education on the secondary and higher level had badly suffered over the last 20 years.

5. In the case of capital both, the inflow of foreign capital and the increasing support of the National Development Bank for the domestic firms were found to be plentiful and crucial to build up the NEM sector in the 1970s. Foreign investment was assumed to have an advantage over domestic investment in terms of administering and managing the complex production process of capital goods, but it was found that firms in the NEM branch which were foreign owned or controlled were not more efficient in using their capital than the domestic firms. While it was not possible to provide empirical evidence for the superior efficiency of foreign investors during the 1970s, the test for many national firms, which have been supported by the National Development Bank, is still to be taken, once the industrial strategy will shift away from import substitution to a more open environment.

6. Embodied in most capital goods is technology, the advance of which was particularly rapid in a number of NEM branches, such as machines and equipment for whole industrial complexes and machine tools. While new technologies had been introduced either through foreign investment or licensing in the early post-war period, increasing attempts were undertaken by local industrialists to adapt and develop technologies by themselves. While concerns by the students of the process of technology transfer and adaptation remain because most firms have still very limited resources for basic design and development, it is suggested that the benefits to be derived from mastering these complex skills may be still substantially below the costs involved.

7. Throughout the essay, the development of the machine tool sector was traced to highlight a number of specific issues of NEMs. Among them were the possibilities to expand exports of complex goods to industrialized markets, which was answered with a conditional yes. In the case of technological advancements, the current adaptation and development of microprocessor controlled machine tools was briefly outlined, since the substantial literature on the subject of the market reserve for a number of electronic products going to the NEM sector has been examined elsewhere. In analyzing the cost structure of a number of lathes with different technological sophistication (as well as some other machine tools), it was found that the market reservation policy for electronic devices for machine tools had rendered those machines uncompetitive in world markets for the last 5-7 years and doubts were raised if prices could be significantly reduced until 1992 when Brazil is planning to open up this sector to foreign competition.

8. As a consequence, current proposals to provide for a more flexible framework of the electronics policy were reiterated and complemented with additional evidence from recent studies on that subject. In addition, it was pointed out that unless the macro-conditions were improving, it would be unlikely for the branch to resume its export drive, particularly if lagging exchange rates continue for a while. In that context, it was found useful to build on some of the recommendations provided earlier by some Brazilian critiques and policy makers, who have maintained that the time has come to (1) open up the industrial sector in general and the electronic subsector in particular and (2) to reduce the public sector's share in industry and infrastructure.

Table A1 - Major Differences in Classifying NEM Between SITC and ISIC

SITC 71 ISIC 382	Product Groups	Contained in ISIC/SITC
SITC 71	Machinery Other Than Electrical	ISIC
71110-0	Boilers, steam generating	3813-04
71141-0	Engines, internal combustion for aircraft	3845-01
71142-0	Turbines, jet and gas for aircraft	3845-04
71150-4A 71150-4B	Engines, diesel for motor vehicles	3843-04A 3843-04B
71150-5A 71150-5B	Engines, internal combustion for motor vehicles	3851-04A 3851-04B
71963-1	Scales, industrial	3851-01
71963-2	Scales, other than industrial	3851-04
ISIC 382	Manufactures of Machinery, Except Electrical	SITC
3829-01	Ovens, household	69710-1+
3829-04	Stoves, ranges, cookers	69710-2+
3829-64	Washing machines for household use	72502-0

Source: Dick [1981].

Table A2 - Relative Factor Intensities of NEM, 1970, 1978 and 1984

Country	Wages per Employee			Non-wage Component of Value Added		
	1970	1978	1984[a]	1970	1978	1984[a]
Developed Market Economies						
FRG	1.08	1.07	1.15	0.66	0.68	0.83
Italy	1.11	1.05	1.06	0.97	1.12	1.01
Japan	1.24	1.19	1.18	1.10	0.96	0.99
Sweden	1.12	1.11	1.07	0.91	0.97	0.98
UK	1.05	1.02	1.10	0.75	0.87	1.00
USA	1.07	1.05	1.18	0.93	0.96	0.98
Average	1.11	1.08	1.12	0.89	0.93	0.97
Centrally Planned Economies						
Czechoslovakia	1.09	1.09	1.12	1.07	0.96	1.05
Hungary	1.11	1.04	1.03	1.06	1.02	1.00
Average	1.10	1.07	1.08	1.07	0.99	1.03
Developing Economies						
Brazil	1.48	1.36	1.58	0.90	0.81	0.83
Chile	0.99	1.18	1.37	0.37	0.52	0.38
Colombia	1.09	0.96	0.89	0.77	0.60	0.95
India	1.14	1.34	1.25	1.04	1.48	1.07
Korea	0.92	1.22	1.11	0.46	0.84	0.95
Singapore	1.01	1.14	1.22	0.72	0.91	1.11
Turkey	1.23	1.12	1.18	0.91	0.65	0.92
Average	1.12	1.19	1.23	0.74	0.83	0.89

[a]1982-1984 average.

Source: UNIDO [1984 and 1988].

Table A3 - Importance of New Products for NEM Firms and Average Manufacturing Firms in the US, 1952-1983[a]

Years[b]	NEM (1)	Average Manufacturing (2)	(1)/(2) (3)
1952-62	3.80	2.50	1.52
1960-64	5.75	3.50	1.64
1964-68	4.50	3.25	1.23
1970-74	6.00	4.00	1.50
1974-78	6.75	3.50	1.93
1978-82	4.00	3.25	1.23
1982-83	5.30	3.38	1.57

[a]Share of new products in annual sales, not produced in base year. [b]Base and final year.

Source: Mac Graw-Hill Survey [various years] cited in Dick [1981].

Table A4 - World Machine Tool Consumption, Production, and Trade (1987)

Country	Consumption (US$ mill.)	Production (US$ mill.)	Export (US$ mill.)	Import (US$ mill.)	Export/ Production (in %)	Import/ Consumption (in %)
1. USSR	5,303.2	3,976.3	312.3	1,639.2	7.9	30.9
2. FRG	4,270.2	6,402.0	3,306.2	1,174.4	51.6	27.5
3. United States	3,967.2	2,585.0	586.7	1,968.9	22.7	49.6
4. Japan	3,655.5	6,426.0	3,034.8	264.3	47.2	7.2
5. Italy	1,753.2	2,235.2	1,048.5	566.5	46.9	32.3
6. France	1,151.1	697.3	284.3	738.1	40.8	64.1
7. South Korea	979.5	530.9	37.5	486.1	7.1	49.6
8. United Kingdom	617.5	601.6	501.0	516.9	83.3	83.7
9. Canada	538.7	197.7	61.0	402.0	30.9	74.6
10. Spain	489.7	510.0	238.8	218.6	46.8	44.6
11. China	449.0	342.0	8.0	115.0	2.3	25.6
12. Taiwan	412.7	577.8	379.9	214.8	65.7	52.0
13. Brazil	410.0	400.0	39.0	49.0	9.8	12.0
14. Yugoslavia	405.3	573.8	325.3	156.7	56.7	38.7
15. Switzerland	400.0	1,475.7	1,435.8	360.1	97.3	90.0
16. Sweden	377.3	257.8	192.8	312.3	74.8	82.8
17. GDR	306.2	1,302.5	1,193.7	197.5	91.6	64.5
18. India	290.2	189.3	45.7	146.6	24.1	50.5
19. Mexico	267.4	21.4	2.7	248.7	12.6	93.0
20. Belgium	206.1	179.3	294.3	321.1	164.1	155.8
21. Bulgaria	205.0	140.0	85.0	150.0	60.7	73.2
22. Poland	190.0	173.0	78.0	95.0	45.1	50.0
23. Australia	177.5	45.0	4.9	137.4	10.9	77.4
24. Czechoslovakia	160.0	405.0	330.0	85.0	81.5	53.1
25. Netherlands	158.1	40.7	118.3	235.7	290.7	149.1
26. Hungary	156.4	216.8	184.6	124.2	85.1	79.4
27. Denmark	154.8	89.0	62.8	128.6	70.6	83.1

Source: NMTBA [1988].

Table A5 - Participation of CNC Machines in Total Machine Tools Production in Major Advanced Countries[a], 1976 and 1982

Type of machine		1976	1982
		as % of total machines	
Milling machines	CNC	23	53
	conventional	77	47
Lathes	CNC	30	61
	conventional	70	39
Drilling machines	CNC	13	34
	conventional	87	66
Boring machines	CNC	35	57
	conventional	65	43
Grinding machines and cutter sharpeners	CNC	1	8
	conventional	99	92

[a]Japan, USA, FRG, UK, Italy.

Source: Edquist and Jacobsen [1988].

Table A6 - Normal and Actual Shares in Total Manufacturing Value Added of NEM Production, 1970/71, 1979/80, and 1982/84

Country	Normal 1970/1971	Normal 1978/1979	Normal 1982/1984	Actual 1970/1971	Actual 1978/1979	Actual 1982/1984	Actual/Normal 1970/1971	Actual/Normal 1978/1979	Actual/Normal 1982/1984
NIC's									
BRAZIL	5.9	7.4	9.3	4.8	9.3	11.2	0.81	1.26	1.21
Argentina	6.5	6.8	7.2	5.6	5.7	n.a.	0.86	0.84	-
Colombia	2.8	3.7	4.1	3.1	2.8	2.3	1.12	0.76	0.81
Egypt	2.3	3.3	5.0	1.9	2.8	4.4	0.83	0.85	0.88
Hong Kong	3.5	4.4	5.1	1.6	2.6	n.a.	0.46	0.59	-
India	3.8	4.3	4.9	6.2	7.7	8.9	1.63	1.80	1.87
Mexico	6.1	6.8	6.6	3.5	4.8	5.4	0.57	0.71	0.82
Philippines	3.8	4.2	3.7	1.7	3.7	2.2	0.44	0.86	0.89
Rep.of Korea	3.0	4.7	5.2	1.7	2.9	4.0	0.57	0.61	0.78
Singapore	3.1	4.7	5.8	3.6	7.2	26.3	1.16	1.52	1.60
Thailand	2.2	2.9	3.3	1.1	1.0	n.a.	0.49	0.35	-
Turkey	4.5	5.5	6.4	2.2	4.4	6.6	0.48	0.81	1.03
AC's									
FRG	10.4	10.9	12.2	14.3	11.6	14.7	1.38	1.15	1.20
Japan	9.8	10.7	11.3	13.2	14.0	12.6	1.35	1.13	1.12
UK	9.0	9.5	9.8	14.6	12.5	13.4	1.62	1.48	1.37
USA	12.0	12.5	15.3	11.0	12.1	14.2	0.91	0.93	0.95
CPE's									
CSR	5.9	6.8	8.2	18.0	20.3	22.9	2.03	2.98	2.80
GDR	6.9	7.9	8.5	14.0	13.5	n.a.	2.03	1.71	-

Source: UNIDO [1984] and own calculations.

Table A7 - Brazil: Basic Statistics on Population, Income, Production and Trade of the NEM Sector, 1965-1988

Year	Population (in thous.)	Per Capita Income (in US$)	NEM Production (in 1980 mill.US$)	Domestic Demand (in 1980 mill.US$)	NEM Employment (in thous.)
1965	84292	1391	309.6	418.9	74.0
1966	86486	1420	495.5	780.0	88.0
1967	88737	1453	552.5	890.0	91.0
1968	91046	1571	687.1	981.7	104.0
1969	93416	1685	869.1	1,380.0	109.0
1970	95847	1782	1,001.3	1,454.0	121.0
1971	98169	1951	1,323.8	2,080.2	133.0
1972	100547	2111	1,887.4	3,002.7	181.0
1973	102982	2338	3,755.1	4,986.7	289.0
1974	105477	2504	5,714.3	7,408.2	337.0
1975	108032	2589	7,653.5	9,819.1	391.5
1976	110592	2805	8,535.6	10,376.2	397.1
1977	113197	2924	9,622.5	10,854.5	431.1
1978	115848	3030	11,477.6	12,826.3	457.9
1979	118545	3190	12,536.6	13,951.2	486.8
1980	121286	3356	13,823.7	14,300.0	538.1
1981	124015	3252	14,694.5	15,200.0	468.9
1982	126806	3191	14,495.4	15,000.0	429.7
1983	129662	3075	8,733.4	9,000.0	416.5
1984	132580	3105	9,422.4	9,800.0	441.7
1985	135564	3282		11,200.0	

Source: UNCTAD [Handbook of International Trade and Development Statistics, various issues]; own calculations.

Table A8 - Non-electrical Machinery Exports from Brazil to World, 1965-1985 (in Thous. US$)

SITC		1965		1973		1978		1983		1985	
711	Power Mach Non-Electr.	3,398	(2)[a]	31,954	(2)	130,177	(2)	445,825	(2)	667,307	(2)
7111	Steam Boilers	211	(2)	1,012	(2)	4,331	(2)	12,542	(2)	3,847	(2)
7112	Boiler House Plant NES	11	(5)	17	(5)	4	(5)	40	(5)	354	(5)
7113	Steam Eng., Turbines	0	(0)	8	(7)	176	(6)	508	(6)	555	(6)
7114	Aircraft Eng.incl.Jet	87	(6)	1,060	(6)	1,082	(10)	7,157	(7)	12,134	(6)
7115	Piston Eng., Non-Air	3,374	(2)	31,291	(2)	113,341	(2)	435,671	(2)	644,576	(2)
7117	Nuclear Reactors	0	(0)	1	(3)	66	(3)	115	(3)	40	(3)
7118	Engines, NES	52	(4)	216	(4)	849	(5)	3,543	(4)	2,696	(4)
712	Agricultural Machines	578	(2)	9,229	(2)	36,207	(2)	63,833	(2)	33,167	(2)
7121	Cultivating Machines	156	(2)	2,187	(2)	2,976	(2)	6,722	(2)	7,485	(2)
7122	Harvesting Machines	330	(1)	5,041	(1)	10,034	(1)	10,323	(1)	11,987	(1)
7123	Dairy-Farm Equipment	0	(0)	1	(10)	4	(13)	4	(9)	32	(7)
7125	Tractors Non-Road	375	(2)	5,503	(2)	30,229	(2)	59,139	(2)	12,445	(2)
7129	Agr. Machines, NES	39	(3)	221	(3)	396	(6)	1,659	(3)	1,448	(3)
714	Office Machines	216	(3)	8,679	(3)	24,595	(3)	47,564	(3)	92,713	(3)
7141	Type-/Che Cheque Wr.	614	(1)	12,390	(1)	34,664	(1)	66,233	(1)	53,112	(1)
7142	Account.Mach., Comp.	23	(6)	11,398	(6)	10,199	(6)	5,828	(6)	4,859	(6)
7143	Statistical Machines	7	(4)	948	(4)	2,201	(5)	1,163	(4)	1,667	(4)
7149	Office Machines, NES	1	(8)	758	(7)	5,293	(7)	5,916	(8)	34,915	(8)
715	Metalworking Machines	1,306	(3)	5,117	(3)	21,328	(3)	37,133	(3)	37,043	(3)
7151	Mach.Tools for Metal	1,216	(3)	4,884	(3)	20,358	(3)	28,276	(3)	30,068	(3)
7152	Metalworking Mach., NES	120	(2)	1,743	(2)	1,793	(2)	17,787	(2)	6,977	(2)
717	Textile, Leather Mach.	2,007	(3)	14,616	(3)	35,267	(3)	32,261	(3)	54,250	(3)
7171	Textile Machines	0	(0)	29	(23)	21	(30)	122	(20)	6,583	(9)
7172	Skin-/Leather-Wor.Mach.	2	(5)	46	(5)	265	(7)	441	(5)	591	(5)
7173	Sewing Machines	1,905	(2)	11,910	(2)	26,128	(2)	32,602	(2)	48,427	(2)
718	Mach.for Special Ind.	1,327	(3)	14,214	(3)	31,608	(3)	83,787	(3)	126,772	(3)
7181	Paper Mill Machines	162	(2)	3,990	(2)	3,994	(2)	27,476	(2)	37,591	(2)
7182	Printing, Binding Mach.	106	(5)	373	(5)	1,361	(5)	2,075	(5)	2,258	(5)
7183	Food Mach. Non-Domestic	126	(4)	1,631	(4)	4,884	(5)	5,393	(4)	4,650	(4)
7184	Const.&Mining Mach. NES	1,641	(2)	13,534	(2)	62,074	(2)	51,169	(2)	72,135	(2)
7185	Crushing, Glass Mach.	408	(3)	1,920	(3)	4,670	(3)	5,792	(3)	10,156	(3)
719	Mach. NES Non-Electr.	2,931	(3)	33,810	(3)	153,276	(3)	282,422	(3)	264,976	(3)
7191	Heating&Cooling,Equipm.	1,918	(1)	7,197	(1)	31,706	(1)	95,024	(1)	45,190	(1)
7192	Pumps, Centrifuges	1,130	(3)	7,356	(3)	25,997	(3)	61,836	(3)	95,756	(3)
7193	Mechanical Handling EQU	251	(5)	2,509	(5)	6,531	(6)	23,523	(5)	28,480	(5)
7194	Domestic Appl. Non-elec.	0	(11)	129	(10)	634	(7)	540	(7)	169	(8)
7195	Powered Tools NES	184	(3)	1,503	(3)	11,872	(3)	22,910	(3)	9,884	(3)
7196	Non-electr. Mach. NES	493	(3)	2,939	(3)	15,210	(3)	17,879	(3)	19,391	(3)
7197	Ball and Roller Bearings	8	(5)	362	(5)	1,507	(6)	7,892	(5)	8,620	(5)
7198	Other Mach. Non-elec.	43	(10)	2,677	(8)	9,340	(6)	15,439	(7)	19,245	(7)
7199	Mach. Parts, Accesr. NES	55	(16)	1,447	(13)	8,739	(10)	17,037	(8)	38,758	(7)

[a]Number in brackets signify ranking among LDC exporters.

Source: UNCTAD, special tabulations.

Table A9 - Ranking of RCA's of NEM Exports from Brazil to World, 1965-1985[a]

SITC		1965	1973	1978	1983	1985	1965/85 average	Rank
7141	Type-, Cheque-writers	2.4816	6.1357	5.3221	5.4086	3.5057	4.5707	1
7173	Sewing machines	4.8198	3.8500	3.1002	2.2853	2.6545	3.3420	2
7115	Piston engines non-air	1.8134	1.7757	1.7251	3.2768	3.5856	2.4353	3
7181	Paper etc mill machinery	0.3650	1.3349	0.4009	1.6275	1.4663	1.0389	4
7184	Const, mining machinery nes	1.2162	1.1080	1.1483	0.4959	0.5720	0.9081	5
7121	Cultivating machinery	0.6755	1.5895	0.5914	0.7949	0.7928	0.8888	6
7191	Heating,cooling,equipment	1.3712	0.6050	0.6586	1.1095	0.4766	0.8442	7
7125	Tractors non-road	0.2954	0.7623	1.1138	1.5280	0.3026	0.8004	8
7111	Steam boilers	0.9977	0.8267	0.5671	1.1019	0.3890	0.7765	9
7142	Acting machs, computers	0.0323	1.6407	0.9889	0.4448	0.2696	0.6753	10
7122	Harvesting etc machines	0.4810	1.1906	0.7639	0.4783	0.4409	0.6710	11
7192	Pumps, centrifuges	0.6948	0.5071	0.4375	0.5632	0.7131	0.5832	12
7152	Metalworking machinery nes	0.2973	0.5732	0.1927	1.3376	0.4369	0.5675	13
7151	Machine tools for metal	0.8079	0.4212	0.5200	0.4619	0.3601	0.5142	14
7196	Non-elect machines nes	0.6902	0.4202	0.6242	0.3691	0.3112	0.4830	15
7185	Crushing etc, glass mach	0.8056	0.4746	0.3123	0.2940	0.4502	0.4673	16
7183	Food machry non-domestic	0.3719	0.6731	0.5270	0.3283	0.2316	0.4264	17
7118	Engines nes	0.5185	0.2089	0.2724	0.5039	0.3398	0.3687	18
7195	Powered-tools nes	0.2467	0.2101	0.5131	0.5797	0.1814	0.3462	19
7143	Statistical machines	0.0237	0.1409	0.0571	0.7693	0.6297	0.3241	20
7129	Agriculture machines nes	0.4895	0.2892	0.1408	0.3338	0.2669	0.3040	21
7193	Mechanical handling equ	0.1687	0.1833	0.1332	0.3194	0.3053	0.2220	22
7194	Domestic appli nonelectr	0.0000	0.2153	0.4593	0.2218	0.0571	0.1907	23
7197	Ball,roller,etc bearings	0.0171	0.0893	0.1180	0.3434	0.2627	0.1661	24
7199	Machine parts, accesr nes	0.0400	0.1006	0.1703	0.1771	0.3192	0.1614	25
7198	Other machines nonelectric	0.0330	0.2029	0.1958	0.1877	0.1568	0.1552	26
7114	Aircraft engines inc jet	0.1080	0.1480	0.0617	0.1663	0.1888	0.1346	27
7172	Skin,leather working mach	0.0283	0.0846	0.1736	0.1441	0.1499	0.1161	28
7182	Printing, binding machinery	0.1931	0.0806	0.0977	0.0761	0.0572	0.1009	29
7149	Office machines nes	0.0017	0.0660	0.1806	0.0508	0.1686	0.0935	30
7112	Boiler house plant nes	0.0120	0.0323	0.0024	0.0122	0.1213	0.0360	31
7113	Steam engines, tubines	0.0000	0.0044	0.0253	0.0456	0.0427	0.0236	32
7171	Textile machinery	0.0000	0.0018	0.0006	0.0023	0.0937	0.0197	33
7117	Nuclear reactors	0.0000	0.0024	0.0170	0.0171	0.0031	0.0079	34
7123	Dairy-farm equipment	0.0000	0.0025	0.0028	0.0013	0.0105	0.0034	35

[a]RCA's are defined as in Table 9 of text.

Source: UNCTAD, special tabulations; own calculations.

Table A10 -Estimate of Interest Rate Subsidy Granted to Capital Goods Producer by the National Development Bank (BNDES) in the 1970s

Nominal Rate Payments		1977	1978	1979	1980	1981	1982	1983	1894	1985	1986
Price Index (1977=100)		100	139	217	415	840	164	4081	12675	42432	102855
Rate of Inflation (in %)		46	39	56	92	103	93	152	214	235	142
Principal Outstanding	A	100	151	218	390	688	573	458	344	229	
	B	100	125	156	195	244	203	163	122	81	41
Amortization	A	0	0	0	0	115	115	115	115	115	115
	B	0	0	0	0	41	41	41	41	41	41
Interest Payments	A	0	0	0	0	854	676	834	856	664	284
	B	0	0	0	0	61	51	41	31	20	10
Total Payments	A	0	0	0	0	854	676	834	856	664	284
	B	0	0	0	0	102	92	81	71	61	51
Total Payments (1977 Prices)	A	0	0	0	0	102	42	20	7	2	0
	B	0	0	0	0	12	6	2	1	0	0

Assumptions:

Loan approved in 1976 and disbursed in 1977
Total loan amount : 100
Interest rate : 5%
Amortization : 6 years
Grace period : 4 years

Total Payments 1977-86 (1977 Prices)

At full monetary correction (A) : 172
At 20% monetary correction (B) : 21
(B)/(A) : 12%
Interest rate equivalent of subsidy: -16.5%
(Interest rate that would result in total payments of 21 assuming an inflation rate of 20%)

Source: World Bank [1989].

Table A11 - Capacity Utilization of NEM, 1968-1988

Year	NEM (2)	Industry Average (5)	in Percent (2/5)
1968	77.0	83.0	
1969	78.8	85.0	
1970	84.0	85.8	.98
1971	87.5	86.8	
1972	86.8	92.0	
1973	92.3	90.5	
1974	86.5	88.0	
1975	86.0	87.0	.99
1976	85.0	88.5	
1977	78.3	83.3	
1978	77.8	83.7	
1979	77.8	83.6	
1980	80.0	83.8	.95
1981	76.0	78.0	
1982	69.3	76.3	
1983	61.3	73.1	.84
1984	64.3	74.0	
1985	69.2	78.0	.89
1986	75.4	82.5	
1987	77.8	80.8	
1988	77.2	79.5	.97

Source: FGV [various issues]; own calculations.

Table A12 - Absolute and Relative Profit Rates of Capital Goods, 1979

	Non-Electrical Machinery	Electrical Equip. & Apparatus	Transport Equipment	Industry Average
Profits/Equity				
Absolute	8.0	23.2	11.0	16.6
Relative	.48	1.40	.66	1.00
Profits/Assets				
Absolute	3.3	10.4	4.3	1.2
Relative	.46	1.45	.60	1.00
Profits/Sales				
Absolute	3.6	9.3	4.0	7.6
Relative	.47	1.23	.53	1.00

Source: World Bank [1981]; own calculations.

Table A13 - Real Exchange Rates for Manufactured Goods and NEM Products (1962-1984)

Year	Export prices Px	Exchange rate ER	Wholesale prices for manufact. sector WPm	Wholesale prices for NEM products WPnem	Rate of subsidy (1+s)	Real Exchange rate, manufact. sector RERm	Real Exchange rate NEM sector RERnem
1962	31.6	4.2	2.3		1,000	57.70	
1963	35.6	6.4	4.1		1,000	55.57	
1964	39.2	13.7	7.8		1,004	68.50	
1965	35.2	23.3	11.7		1,050	70.10	
1966	36.7	27.3	16.0		1,050	62.62	
1967	35.9	32.8	20.1		1,216	58.58	
1968	37.1	41.6	24.9		1,265	61.98	
1969	38.8	50.1	29.9	38.5	1,316	65.01	50.54
1970	41.0	56.5	36.6	44.2	1,389	63.29	52.37
1971	45.5	65.1	43.9	50.0	1,413	67.47	59.24
1972	50.8	73.0	52.1	57.7	1,421	71.18	64.28
1973	71.7	75.4	60.9	63.5	1,434	88.77	85.19
1974	100.8	83.5	78.6	76.9	1,470	107.08	109.42
1975	100.0	100.0	100.0	100.0	1,491	100.00	100.00
1976	95.5	131.3	143.4	136.5	1,506	87.44	91.84
1977	107.0	174.0	204.2	192.3	1,500	91.18	96.81
1978	107.0	222.3	280.9	263.5	1,513	84.68	90.28
1979	119.8	319.8	437.1	376.9	1,460	87.65	101.64
1980	130.7	648.4	903.1	696.2	1,387	93.84	121.73
1981	128.6	1,145.5	1,880.2	1,678.8	1,459	78.35	87.75
1982	116.8	2,208.3	3,610.4	3,298.1	1,535	71.44	78.21
1983	108.5	7,098.5	9,685.3	7,784.6	1,615	79.52	98.94
1984	113.2	22,734.0	32,557.8	23,819.3	1,699	79.04	108.04

Source: Fasano-Filho [1987]; own calculations

Table A14 - Measuring Efficiency: Cobb-Douglas Productive Function - Estimates for Some Capital Goods, 1965-80

Industry	Intercept lnA	α	β	γ	$\bar{R}^2$	C
Industrial Equipment and Motors	5.291	.158 (4.35)	.479 (13.50)	1.78 (11.07)	.76	.36
Office Machinery	4.183	.310 (2.17)	.408 (3.97)	.236 (5.60)	.90	.28
Electrical Equipment	6.658	.028 (3.29)	.440 (4.49)	.178 (6.98)	.86	???
Domestic Application & Technical Equipment	5.489	.174 (2.33)	.421 (5.05)	.177 (7.718)	.94	.41

α = output elasticity of capital
β = output elasticity of labor
γ = Hicks neutral technological program
c = output elasticity with respect to management based on assumption of constant return to sale.

Source: Tyler [1981].

Table A15 - The Structure of Employment and Wages in Non-electrical Machinery and Automotive Industries of Brazil, 1975 and 1980

	1975							1980						
	total employees	managers	blue collar upper level	blue collar medium level	blue collar workers	white collar upper level	white collar other	total employees	managers	blue collar upper level	blue collar medium level	blue collar workers	white collar upper level	white collar other
Non-electrical Machinery														
Employment														
1000	387.5	8.7	4.0	32.8	304.3	1.9	35.8	523.5	24.3	5.4	19.6	427.3	3.2	43.7
percent	100	2.2	1.0	8.5	78.5	0.5	9.2	100.0	4.6	1.0	3.7	81.6	0.6	8.3
Salaries														
Cr $ million	9,470	627	387	1,517	5,847	177	915	126,064	17,742	3,607	9,019	84,186	1,751	9,759
percent	100	6.6	4.1	16.0	61.7	1.9	9.7	100	14.1	2.9	7.2	66.8	1.4	7.7
Average wages														
Cr $ thousands	24.44	72.07	96.75	46.25	19.21	93.16	25.56	240.81	730.12	667.96	460.15	197.02	547.19	223.32
total employees=100	100	294.9	395.9	189.2	78.6	381.2	104.6	100	303.2	277.4	191.1	81.8	227.2	92.7
Transport Equipment														
Employment														
1000	218.1	4.6	1.5	11.3	180.4	0.8	19.5	273.8	9.3	1.5	8.8	232.1	1.1	20.9
percent	100.0	2.1	0.7	5.2	82.7	0.4	8.9	100.0	3.4	0.5	3.2	84.8	0.4	7.6
Salaries														
Cr $ million	4856	280	165	577	3259	68	507	58118	7034	1081	3947	41380	646	4031
percent	100	5.8	3.4	11.9	67.1	1.4	10.4	100	12.1	1.9	6.8	71.2	1.1	6.9
Average wages														
Cr $ thousands	22.27	60.87	110.00	51.06	18.07	85.00	26.00	212.30	756.30	720.70	448.50	178.30	587.30	192.90
total employees=100	100	273.3	493.9	229.3	81.1	381.7	116.7	100	356.2	339.5	211.3	84.0	276.6	90.9
Av.Wag. NEM/Transp.	1.10	1.18	0.88	0.91	1.06	1.10	0.98	1.13	0.97	0.93	1.03	1.10	0.93	1.16

Source: FIBGE [b, 1975, 1980]; own calculations.

Table A16 - Labour Market Regulations and their Impact on Plant Operations
Brazil, Mexico, South Korea and Taiwan, 1970-1985

	Brazil	Mexico	South Korea	Taiwan
Minimum Wages	monthly rates; adjusted often	daily rates; adjusted periodically	none	daily rates; adjusted seldom
Working Overtime	40-48 Hours; over 5-6 days; OT:+20%; S+H:+100%	40-48 Hours; --- OT:+100%; S+H:+125-200%	48 Hours; over 6 days; OT:+50%; ---	44-48 Hours; over 35-60 days; OT:+14%; H:+34
Vacation Bonus	30 days after 1 year 1 M. Bonus	6 days after 1 year +2 days p.a.thereafter bonus:min 3w.	12 days or 1d. per m. worked after 1yr.+1d. p.a.+16 holid.	7/10/14 days for 1-3/3-5/ 5-10 yrs.
Job Termination Severance	8 or 30 day notice and pay out of 8% payroll tax collected + interest	30 day notice 3m. wages +20 days p.a.	30 day notice	1m.p.a. up to 3 yrs. after 3yrs.3m. +10 dys.p.a.
Dismissal	notice necessary +10% of payroll tax if no cause	ok, but severance if no cause	---	---
Non-Wage Labour Costs				
Social security	25	10	4	7-10
Total	107	78	55	45
Normal Days Work per Year	273	290	286	345
Factory Operating Days per Year	284	315	308	355

Source: Spinanger [1988].

Table A17 - Importance of NEM Sector Human Capital Investment in Brazil and other NICs, 1965-1985

Country	Industry % of GDP	Machinery % of Manuf. Output	Education Expenditures (% of public spending)	School Enrollment (%) of Age Group		
				Primary	Secondary	Higher
	(1)	(2)	(3)	(4)	(5)	(6)
Brazil						
A	20	25.2	8.3	108	16	2
B	27	26.3	3.2	103	35	11
Mexico						
A	22	21	16.4	92	17	4
B	29	22	12.4	116	55	15
South Korea						
A	15	17.4	15.9	101	35	6
B	27	23.5	18.4	99	91	26
Taiwan						
A	22	21.7	17.3	97	57	72
B	42	22.3	19.8	100	99	87
Middle Income Countries						
A	17	-	14	85	22	6
B	23	-	11.5	104	47	13

(1). A=1965 ; (2). A=1972 ; (3). A=1965 ; (4). A=1970-80.
(1). B=1980 ; (2). B=1985 ; (3). B=1984 ; (4). B=1980-85.

Source: Spinanger [1988].

Table A18 - Capital Goods on Order: Major Firms Producing Equipment for Basic Industries and Electric Power, 1986

Firms	Ownership Control		Sales 1986 (mill US$)	Cumulated Percentage
1.Confab	Brazil	(1)	176,683	20.21
2.Cobrasma	Brazil		129,493	35.02
3.Armco (former Equipetrol)	USA		118,120	48.53
4.Usimec	Brazil	(2)	84,092	58.15
5.Dedini	Brazil		83,702	67.72
6.CBC	Japan		44,231	72.78
7.Conforja	Brazil		41,968	77.58
8.Brasimet	S.Africa		33,605	81.42
9.Nordon	France	(3)	32,696	85.16
10.Jaracuá	Brazil		29,451	88.53
11.FMC-Filsan	USA		23,147	91.18
12.Badoni-ATB	Italy		15,357	92.94
13.Fichet	France		13,311	94.46
14.BSI	Brazil		12,980	95.94
15.Mausa	Brazil		11,644	97.27
16.Codistil	Brazil		7,313	98.11
17.Usimeca	Brazil		6,160	98.81
18.CBSE	Brazil		5,709	99.46
19.Turin	Brazil		4,616	100.00
Total	------		874,278	-----

(1) 18% Participation of Sumito Group (Japan)
(2) 17.5% Participation of Kawasaki Ind.(Japan) and 7.5% Participation of Itoh&Co. (Japan)
(3) 5.6% Participation of DEG (FRG)

Source: BNDES [1988].

Table A19 - Major Firms Producing Non-electrical Machinery and Equipment, 1986

Firms	Ownership Control		Sales 1986 (mill US$)	Cumulated Percentage
1.Eq.Villares	Brazil		110,848	14.11
2.Atlas	Switzerland		98,321	26.63
3.Voith	FRG		88,523	37.90
4.Faco	Switzerland		68,763	46.65
5.Zanini	Brazil		64,362	54.84
6.Mecânica Pesada	France		50,601	61.28
7.CBV	Brazil	(1)	42,345	66.67
8.Bardella	Brazil		41,212	71.92
9.Schuler	Brazil	(2)	40,586	77.09
10.Máq.Piratininga	Brazil	(3)	22,048	79.90
11.PHB	Brazil	(4)	21,801	82.68
12.CEC	Brazil	(5)	17,098	84.86
13.Sulzer Weise	Switzerland		16,281	86.93
14.Cosinor	Brazil	(6)	15,670	88.92
15.Torque	Brazil		11,441	90.38
16.Omel	Brazil		11,233	91.81
17.Ata	Japan		9,230	93.01
18.Conamsa	Brazil		7,963	94.02
19.Delp	Brazil		7,408	94.96
20.Bühler Miag	Switzerland		6,595	95.80
21.AKZ	Brazil	(7)	6,086	96.57
22.Isomonte	Brazil		5,760	97.30
23.Renk Zanini	Brazil	(8)	5,507	98.00
24.Treu	Brazil		5,338	98.68
25.Spama	FRG		4,161	99.21
26.Innobra	Italy		3,721	99.68
27.Pilao	Brazil		2,626	100.00
Total	———		785,528	———

(1) 3.6% Participation of FMC Chicago (USA) and 1.18% Participation of Smith Int. (USA)
(2) 40.9% Participation of Schuler (FRG)
(3) 28.0% Participation of Davy McKee Part. (USA)
(4) 47.7% Participation of PHB Weserhülte (FRG)
(5) 10.0% Participation of Chisso Eng. (Japan)
(6) Participation of British capital
(7) 30.0% Participation of AEG-Kanis Turbinen (FRG)
(8) Participation of German Capital

Source: BNDES [1988].

Table A20 - Major Machine Tool Producers and their Market Shares, 1985

No.	Firm	Ownership/ Control	Sales	Percent	Cumulated Percentage	Equity	Number of Employees	Number of CNC Machines
1.	Romi	Brazil	68.78	26.96	26.96	440,860.0	3,295	120
2.	Schuler	Brazil	48.02	18.82	45.78	-	-	-
3.	Nardini	Brazil	28.10	11.02	56.80	184,170.0	1,221	-
4.	Wotan	FRG	17.45	6.84	63.64	30,603.0	310	40
5.	Index	FRG	11.40	4.47	68.11			66
6.	Grob do Brasil	FRG	8.39	3.29	71.40	175,200.0	415	15
7.	Micheletto		7.94	3.11	74.51	-	-	
8.	Sanches Blanes	FRG	7.23	2.83	77.34	49,653.0	525	
9.	Thyssen-Hüller	FRG	6.50	2.55	79.89			17
10.	Fermasa	Brazil	5.97	2.34	82.23	56,852.0	520	
11.	Mahnke Industrial		4.90	1.92	84.15			
12.	Newton		4.44	1.74	85.89			
13.	Engrenasa	FRG	4.41	1.73	87.62	8,761.0	127	10
14.	Inds. Emanoel Rocco		4.36	1.71	89.33			
15.	Maquinasa	FRG	3.57	1.40	90.73	29,783.0		
16.	Heller	FRG	3.50	1.37	92.10			16
17.	Prensa Jundial		3.34	1.31	93.41			
18.	Innobra		3.17	1.24	94.65			
19.	Rabello		3.09	1.21	95.86			
20.	UMJ Joinville		2.12	0.83	96.69			
21.	Harlo do Brasil		2.04	0.80	97.49			
22.	Franto		1.73	0.68	98.17			
23.	Mello		1.15	0.45	98.62			
24.	Centomac		0.96	0.37	98.99			
25.	Borg Mar		0.92	0.36	99.35			
26.	Jowa		0.85	0.34	99.69			
27.	Fobesa		0.78	0.31	100.00			
28.	Traubomatic	RFA	NA	NA	-			54
29.	Montra	RFA	NA	NA	-			
30.	Zema	Brazil	NA	NA	-			25
31.	Rittler	RFA	NA	NA	-			15
32.	IBH	Brazil	NA	NA	-			13
33.	Brevet & Burkardi	Switzerland	NA	NA	-			8
34.	Bonelli	Brazil	NA	NA	-			1
	Total	———	255.13	100.00	———	———	———	———

Source: BALANCO ANUAL, Gazeta Mercantil.

Table A21 - Input-Output Coefficients of NEM with Most Important Sectors, 1980 (in %)

Sector	Input Coefficents of NEM	Output Coefficients of NEM
Steel	8.26	0.10
N.F. Metals	2.35	0.37
Forged Steel	6.19	1.02
Other Metals	6.98	1.32
NE Machinery & Services	4.00	10.56
Machine Parts	8.14	6.40
Electrical Material	2.43	2.84
Electronic Material	0.22	0.80
Electric Apparatus & Goods	-	3.71
Automobile & Parts	0.64	3.37
Railway and other Transport Equipment	0.06	4.09
Total Inputs & Outputs of 12 most important Sectors	39.27	44.47

Source: FIBGE, unpublished Input-Output Table.

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