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## Capital-intensive industries in newly industrializing countries: the case of the Brazilian automobile and steel industries

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Institut für Weltwirtschaft an der Universität Kiel

Herausgegeben von Herbert Giersch

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221

Bernhard Fischer · Peter Nunnenkamp et al.

## Capital-Intensive Industries in Newly Industrializing Countries

### The Case of the Brazilian Automobile and Steel Industries

Authors:

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Matthias Lücke, Peter Nunnenkamp



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### Abbreviations and Acronyms

ABIFA	Associação Brasileira da Indústria de Fundição e Aço
ABIPEÇAS	Associação Brasileira da Indústria de Autopeças
ABM	Associação Brasileira de Metais
ACESITA	Companhia Aços Especiais Itabira
AISI	American Iron and Steel Institute
ALADI	Asociacion Latinoamericana de Integracion
ANFAVEA	Associação Nacional dos Fabricantes de Veículos Automotores
ASP	Associação das Siderúrgicas Privadas
BEFIEIX	Benefícios Fiscais à Programas Especiais de Exportação
BNDE(S)	Banco Nacional de Desenvolvimento Econômico e Social
BOF	Basic Oxygen Furnace
CACEX	Carteira de Comércio Exterior do Banco do Brasil
CDI	Conselho de Desenvolvimento Industrial
CEPAL	United Nations Economic Commission for Latin America
CIEF	Centro de Informações Econômico-Fiscais do Ministério da Fazenda
cif	cost, insurance, and freight
CKD	completely knocked-down vehicles
CONSIDER	Conselho de Não-Ferrosos e de Siderurgia
COSIGUA	Companhia Siderúrgica de Guanabara
COSIPA	Companhia Siderúrgica Paulista
CSN	Companhia Siderúrgica Nacional
CST	Companhia Siderurgica de Tubarão
DRI	Directly Reduced Iron
DRT	Direct Reduction Technology
EAf	Electric Arc Furnace
EC	European Community
ECLA	Economic Commission for Latin America
EFTA	European Free Trade Association
EIU	Economist Intelligence Unit
EPR	Export Performance Ratio
EUROSTAT	Statistical Office of the European Communities
FIESP	Federação das Indústrias do Estado de São Paulo
FINEX	Fund for Export Financing
fob	free on board

FRG	Federal Republic of Germany
FUNCEX	Fundação Centro de Estudos do Comercio Exterior
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GNP	Gross National Product
GSP	Generalized System of Preferences
IBGE	Instituto Brasileiro de Geografia e Estatística
IBS	Instituto Brasileiro de Siderurgia
IISI	International Iron and Steel Institute
IPEA	Instituto de Planejamento Econômico e Social
ISIC	International Standard Industrial Classification
LDT	Linz-Donawitz (Basic Oxygen) Technology
MBB	Mercedes-Benz do Brasil
MIC	Ministerio da Indústria e do Comércio
MVMA	Motor Vehicles Manufacturers Association of the United States
NBM	Nomenclatura Brasileira de Mercadorias
NICs	Newly Industrializing Countries
NTBs	Non-Tariff Barriers
OECD	Organisation for Economic Cooperation and Development
OHT	Open-Hearth (Siemens-Martin) Technology
PPPs	Purchasing Power Parities
RCA	Revealed Comparative Advantage
ROC	Republic of China
SIDERBRAS	Siderurgia Brasileira S.A.
SINDIPEÇAS	Sindicato Nacional da Indústria de Componentes para Veículos Automotores
SITC	Standard International Trade Classification
TIE	Transnationals Information Exchange
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
USIBA	Usina Siderúrgica da Bahia
USITC	United States International Trade Commission
USIMINAS	Usinas Siderúrgicas de Minas Gerais
VDA	Verband der Automobilindustrie e.V., Frankfurt
VRA	Voluntary Restraint Agreement
VWB	Volkswagen do Brasil

## Preface

This study is part of a research project on the present problems and future prospects of the Brazilian economy in the international division of labour. While earlier studies highlighted the fact that capital-intensive products become more and more important for Brazilian export growth, the present study deals with the question of whether this phenomenon was due to natural cost advantages or whether it was policy-induced i.e. the result of artificial advantages granted to specific industries or firms. It is the major aim of this study to evaluate these two competing hypotheses by empirical analysis at the sectoral level. The focus is on the automobile and the steel industries, two sectors that have contributed significantly to Brazil's export expansion in the 1967-1986 period. The actual and potential role of these two industries in the international division of labour is evaluated in relation to major competitors in both developed and developing countries.

The study finds that the favourable export performance of the automobile industry was helped by export incentives which significantly exceeded the average for the manufacturing sector. The overall human capital requirements of this industry proved to be very high given Brazil's factor endowment. However, specialization in the less human capital intensive stages of motor vehicle production was made difficult by import restrictions that prevented a fuller integration of the Brazilian subsidiaries into the worldwide sourcing of components by the automobile multinationals.

By contrast, steel production in Brazil is found to have been largely in line with the country's factor endowments. The technology used in the production of basic steel products is mostly standardized, i.e. embodied in physical capital equipment, and therefore does not require relatively large amounts of human capital. The competitive position of the Brazilian steel industry is further enhanced by the local availability of important raw materials. The product composition of exports reflected Brazil's locational advantage in basic steel products. Exports increased considerably although the anti-export bias of the incentive structure faced by the steel industry was found to be larger than for the manufacturing sector as a whole.

Both industries enjoyed significant labour cost advantages relative to their competitors in industrialized countries. However, the beneficial effects of low labour costs were eroded by excessively high financial costs. Domestic real interest rates were driven up by the government deficit, while large increases in international rates negatively affected those steel producers who had borrowed extensively in the international credit markets, often encouraged by government guarantees. Furthermore, the profitability of both industries (and hence their ability to finance investment from internal sources) was seriously impaired by domestic price controls.

The study concludes that Brazil's economic policy has to be revised in several important respects to enable the country to benefit fully from its growing natural advantage in the production of standardized goods. The rules governing foreign direct investment should encourage capital inflows because the future investment needs of both the automobile and the steel industries cannot be met without considerable foreign participation. A favourable investment climate also requires a reduction of the government deficit as a precondition for controlling inflation and avoiding the crowding-out of private investment from the domestic capital market. Furthermore, international specialization in line with Brazil's factor endowment cannot succeed without a liberal import regime and a realistic exchange rate. In this case, special export incentives that constitute a drain on the government budget and favour some sectors of the economy at the expense of others would become unnecessary.

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version of Part C on the steel industry, while Peter Nunnenkamp prepared Part B on the automobile industry.

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Kiel, October 1988

Herbert Giersch

## A. Introduction

In the early 1980s, capital-intensive products dominated Brazil's manufactured exports to the neighbouring Latin American economies. Recently, the country succeeded in entering advanced markets for capital-intensive products as well. The increasing importance of such items in Brazil's manufactured exports may be attributed to the product-cycle hypothesis. According to this concept, newly industrializing economies enjoy locational advantages in producing standardized goods, which are capital-intensive in terms of physical capital, but do not require considerable inputs of highly skilled labour (human capital). Alternatively, government interventions may be responsible for the rising share of capital-intensive exports of Brazil. Policy measures may have created a competitive edge for domestic industries although they had no comparative advantage.

Previous studies on the manufactured export performance of Brazil provided only limited evidence on the relevance of these competing hypotheses. Some findings suggested that the country did not make use of its locational advantage in supplying standardized product-cycle goods as significantly as might have been expected. Export subsidies were found to be positively related to Brazil's export performance in the United States and other developed economies. However, the bias of trade policies towards rather capital-intensive industries could not be proven to be statistically significant [Fasano-Filho et al., 1987]. This was partly due to inconsistencies in incentive policies towards exports and domestic sales which weakened the policy impact on exports. More importantly, the Brazilian government heavily discriminated between different industries and even between different branches and types of enterprises within industries. Export subsidy rates granted by the authorities increased with the size of the firms, for example.

Due to the extremely wide dispersion in the degree of import protection and export subsidization, the impact of economic policies on export performance was largely blurred when assessed at the overall level of total Brazilian manufacturing. For specific industries, the preferential treat-

ment, which the government justified by referring to infant-industry arguments, may have helped significantly to expand overseas sales. The earlier studies thus stress the need to proceed at a more disaggregated level in order to identify the major determinants of Brazil's current position in world markets and its future export prospects. This study tries to gain more detailed insights on the relative importance of the competing hypotheses on the manufactured export performance of Brazil by analysing two important industries specifically. It focuses on the automobile industry and the steel industry, i.e. two sectors that contributed significantly to non-traditional exports in the recent past. The study may thus provide a better understanding of the factors which were responsible for the rising share of capital-intensive products in Brazilian manufactured exports.

The automobile industry has frequently been considered a major element of the so-called "Brazilian Economic Miracle" of high economic growth and booming exports [Stevens, 1987, p. 4]. In the early 1980s, this industry represented the largest producer of fully built-up vehicles in the Third World and ranked worldwide among the top ten. Overseas sales of Brazilian automobiles increased considerably in the 1970s and early 1980s. This sharply contrasted with earlier presumptions according to which countries such as Brazil would hardly be able to compete successfully in international automobile markets. The significant support the government provided in establishing a local automobile industry and in helping its access to overseas export markets gives further reason for the selection of this industry to assess the current world-market position and future export prospects of Brazil at the sectoral level.

Similarly, Brazil became the most important exporter of steel within the Third World in 1985. The steel industry now ranks first in terms of export earnings within the manufacturing sector of Brazil, after it had been a major engine of import-substitution efforts since the mid-1930s. In contrast to the automobile industry, where foreign-based multinationals dominated, the majority of steel producers are domiciled in Brazil; state-owned companies concentrated on the production of basic flat steel, whereas private enterprises specialized in non-flat steel products.



Consequently, the competitive position of different industries and different types of enterprises is analysed in the following. Competing explanations for the export performance of the automobile and steel industries are subjected to empirical tests. The first hypothesis focuses on the relevance of economic incentives. If the selected industries competed in world markets successfully, this may be traced to policy-induced (i.e., artificially created) improvements in world-market performance, rather than cost advantages of Brazilian production vis-à-vis its overseas competitors measured at undistorted factor and product prices. If this proposition cannot be rejected empirically, such a result may have considerable implications for Brazil's future prospects in exporting manufactures. Export expansion is hardly sustainable in the longer run if mainly based on artificially created competitiveness. Apart from the economic costs borne in Brazil that arise from subsidizing industries whose production is in conflict with the country's locational advantages (1), the importing countries, most probably, will be less prepared to tolerate "dumping" at the expense of their own production and employment in the future.

However, it would be misleading to conclude from the mere existence of export incentives that the industry receiving them represents an example of mis-allocation of productive resources. These measures may rather compensate for discriminations in other policy areas, be it export-retarding effects of import restrictions or be it an anti-export bias arising from overvaluation of the domestic currency. Thus, the alternative hypothesis should not be disregarded, according to which Brazil enjoys locational advantages in automobile and steel production. This reasoning relates to a major extension of the factor-proportions theory of international trade. By introducing human capital as a separate production factor, so-called product-cycle goods can be identified. The production of such goods has reached the stage of maturity [Vernon, 1966]. Production technologies have become fairly standardized so that they can

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(1) High public budget deficits and inflationary pressures stand for the most visible costs. Even more importantly, the export performance of industries which enjoy comparative advantages may suffer, because it is mainly them who have to finance the subsidies granted to other industries.

be handled without demanding too much of the relatively poor human-capital endowment of developing countries, though physical-capital requirements may remain considerable [Hirsch, 1974]. The automobile and steel industries were frequently mentioned as typical suppliers of standardized product-cycle goods (1). Furthermore, Brazil is to be supposed to be among the first candidates to reap benefits from the expected relocation of worldwide automobile and steel production to the developing world [Johnston, 1982]. The latter presumption refers to the rich endowment of Brazil with important raw-material inputs, the great potential in demand for automobiles and steel both in the domestic market and the neighbouring Latin American markets, and the relatively easy access to international financial markets that Brazil enjoyed up to the early 1980s.

The neo-factor-proportions approach [Hufbauer, 1970; Johnson, 1970] derives its plausibility from the observation that physical capital does not represent the limiting factor in explaining trade patterns between industrialized and developing economies. Though relatively scarce in third-world countries when measured in terms of domestic savings, developing economies may successfully approach foreign capital markets, provided that they offer profitable investment opportunities. In contrast to the traditional Heckscher-Ohlin model, capital must be assumed to be internationally mobile, both in the form of foreign lending and direct investment [Wolter, 1976]. As concerns the automobile industry, Brazil clearly favoured the latter alternative of foreign financing. In order not to draw upon the domestically available investment funds, foreign-based automobile multinationals were encouraged to build up production facilities in Brazil (2). Thus, the automobile industry represents an inter-

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(1) For the automobile industry, see e.g. UNIDO [a, Part I, p. 65]; Dicke [1978, pp. 38 f.]; Jones [1981, p. 5]; Sinclair [1982, p. 4; 1983, p. 56]; for a more sceptical view, see Maxcy [1981, p. 199]: "However commonplace the motor car has become, it is, nevertheless, a complex, highly sophisticated product ... The ability to perform this critical function (to design, develop and plan for the production of a unique model) is still limited to firms in less than ten countries".

(2) In 1978, foreign-owned firms accounted for 99.7 per cent of total Brazilian road-motor-vehicle production, leaving a market share of only 0.3 per cent to nationally owned producers [UN Centre on

esting example of technological development based on foreign direct investment. This contrasts with the approach taken in other key sectors such as steel where debt finance figured prominently.

The differences in ownership structure and the principal type of external finance reinforce the need to proceed with an empirical investigation of the consequences for Brazil's position in world automobile and steel markets and the country's position within the international division of labour. The major objectives of this study may be summarized as follows:

- firstly, to show to what extent Brazil succeeded to penetrate world automobile and steel markets;
- secondly, to differentiate between major product categories within the selected industries and to discuss in which of these areas a favourable export performance was most likely to be achieved;
- thirdly, to identify the principal factors which were responsible for Brazil's relative position in world automobile and steel markets;
- fourthly, to discuss possible bottlenecks that may hinder the Brazilian automobile and steel industries to make use of their export potential in the future.

Before assessing the export prospects of Brazil, the industries' economic performance in the past has to be analysed. Parts B (automobile industry) and C (steel industry) are organized in a similar way. Chapters II outline Brazil's position in worldwide automobile and steel production; they provide a first test of the hypothesis that production has already been relocated to a significant extent from the traditional suppliers (i.e., the major industrialized countries) to developing countries in general, and Brazil in particular. Furthermore, Brazil's past performance in exporting automotive and steel items is discussed. In this context, it is crucially important to present a disaggregated analysis, with respect to both major products and principal export markets. The former differ-

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Transnational Corporations, 1983, p. 108]; the de-nationalization of Brazilian automobile assembly was analysed by Moore [1980, pp. 132 ff.].

entiation accounts for different production and export strategies pursued by major companies operating in Brazil. The emphasis placed on the direction of trade is required because of the markedly different export conditions between the ALADI-market (1) (preferential trading arrangements) other third-world markets (similarities in demand profiles) and developed-country markets [Nunnenkamp, Fasano-Filho, 1986, pp. 14 f.].

In the second step of our analysis, different measures are applied that help to quantitatively assess Brazil's revealed comparative advantages (RCA) in world markets (Sections III.1). Export-performance ratios and RCA-values compare the share of automotive and steel exports in total manufacturing exports devoted to selected export markets between Brazil on the one hand and the world on the other hand [Balassa, 1965]. Additionally, unit values are calculated for various automotive and steel items imported by EC-countries and the United States, in order to gain further insights into the price competitiveness of Brazil vis-à-vis other major supplying countries.

In Sections III.2, the competitive position of Brazil in world markets will be traced to major cost elements in motor-vehicle and steel production. This involves empirical tests of the hypotheses that:

- Brazil's advantages in labour costs vis-à-vis the traditional producers are sufficiently large to outmatch remaining disadvantages in labour productivity, so that unit-labour costs are relatively low in international perspective;
- Brazil's production is increasingly becoming scale efficient and cost-decreasing learning-by-doing effects have already been realized to a significant extent.

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(1) The Associação Latino-Americana de Integração (ALADI; formerly Latin American Free Trade Association, LAFTA) consists of Argentina, Brazil, Bolivia, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay, and Venezuela.

Furthermore, the cost situation of the automobile and steel companies in Brazil will be analysed by comparing price developments for major input items in Brazil and other producing countries.

The conflicting hypotheses on the determinants of Brazil's export performance represent the topic of Chapters IV. In order to test the proposition that the production of motor vehicles and steel products is increasingly becoming standardized and that these industries, therefore, are candidates for relocation to the Third World, relative human-capital and physical-capital intensities are calculated for selected countries by applying the so-called Lary-concept [Lary, 1968]. The same approach is used to gain more detailed insights into the patterns of factor absorption in different sub-branches of the Brazilian vehicle industry. Additionally, the role of technology diffusion and economies of scale are discussed for the steel industry in order to test the technology-adaption hypothesis.

Economic policies may matter in the following two respects. Exchange rate policies, by determining the *global* competitiveness of a country's manufacturing sector, are assumed to have influenced the world-market performance of Brazilian automotive and steel producers. The *relative* competitiveness of the selected industries (*vis-à-vis* other Brazilian industries) is likely to be affected by discriminatory economic policies. However, the net policy impact is highly uncertain, as indicated by both considerable nominal import protection and export subsidies for automotive products for example. Thus, effective incentive rates granted to domestic and overseas sales must be assessed.

The aforementioned analysis provides the basis for evaluating the future prospects of automobile and steel production in Brazil in Chapters V. The country's export potential is determined by future developments in world demand as well as technological changes and the strategic responses of major producers. As regards probable trends in demand in Brazil's principal export markets, the projections available in the literature will be summarized and their plausibility be checked in the light of additional and more recent information. Domestic-market trends in Brazil are relevant as well. A growing domestic demand may considerably help to reduce per-unit costs of production and thus give a fresh

impetus to the export performance of companies operating in Brazil. Technological changes, such as the assumed trend towards greater flexibility in car production (1), may negatively affect the degree of further relocation of production to developing countries. Possibly, the rather optimistic view prevailing up to the early 1980s (based on the standardization argument) must be revised, considering the competing "specialization" or "technological divergence scenario" [OECD, 1983, pp. 80 ff.; Black, 1982b].

Finally, Brazil's chances to make use of its export potential in the future have to be discussed. This relates to internally created bottlenecks that may pose a serious threat to the further development of Brazilian manufacturing industries. For example, difficulties may arise from domestic labour markets (e.g. squeezed unit-labour-cost advantages due to insufficient improvements in productivity), market interventions such as domestic price controls, an inefficient supply of inputs due to restrictive import regulations on the background of persistent foreign debt problems, increasing pressures from overseas competitors and the GATT to reduce export subsidies, and an overvalued exchange rate of the domestic currency.

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(1) See, for example, Altshuler et al. [1984, pp. 135 ff., 247 ff.]; in Section B.V.2, the literature is reviewed in more detail.

## B. The Competitive Edge of the Brazilian Automobile Industry

### I. Introduction

The automobile industry has frequently been considered a major element of the so-called "Brazilian Economic Miracle" of high economic growth and booming exports [Stevens, 1987, p. 4]. Total production of passenger cars and commercial vehicles roughly tripled in both decades 1960-1970 and 1970-1980 [ANFAVEA, a, c]. Starting from very low export values, overseas sales of automobiles increased considerably in the 1970s. The Brazilian automobile industry was held up as a unique model, since, among the many developing countries that have attempted to create a full-fledged automobile industry, it stood for the only one that had succeeded in the early 1980s [Prud'homme, 1983b; O'Brien, Lobo Aleu, 1984, p. 133; Sinclair, 1983, p. 45]. Other developing countries may follow in the near future, South Korea standing for the most likely candidate. This sharply contrasts with earlier presumptions: in the mid-1970s, nearly all experts interviewed by Dicke [1978, pp. 81 ff.] agreed that developing countries would hardly be able to compete successfully in international automobile markets in the foreseeable future.

Depending on the exact definition, the Brazilian road-motor-vehicle industry accounted for only 3-6 per cent of total manufacturing production in 1980. If merely the production of passenger cars, trucks and buses is considered, i.e., those branches where the major emphasis of the following analysis is placed (1), the lower-end figure indicates the industry's direct participation in total production of manufactured goods. In this rather narrow definition, the industry's share in total manufacturing employment did not exceed 0.5 per cent. Autoparts included (2), pro-

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(1) In addition, tractors will be considered where separate data were available. In some parts of the following analysis, we have to refer to transport equipment rather than the road-motor-vehicle industry since disaggregated information was not available.

(2) Apart from "fabricação de peças e acessórios para veículos automotores" as defined in the Brazilian Censo Industrial (i.e., excluding electrical parts, parts of rubber, plastic and glass), bodies for motor vehicles and parts thereof are subsumed under this heading.

duction and employment shares increase to 6 and 3.5 per cent in 1980 respectively.

Despite the rather modest direct role of the road-motor-vehicle industry in total manufacturing, it was considered to be of crucial importance for the industrial development of Brazil over the past 25 years. This is due to the industry's strong backward linkages, as exemplified by the share of the road-motor-vehicle industry (autoparts and tractors included) in total Brazilian consumption of the following selected input items (figures are for 1984 and from ABIFA, if not otherwise stated) (1):

- uncoated flat-rolled iron and steel products (2): 18 per cent;
- cast iron: 36 per cent;
- copper alloys: 8 per cent;
- zinc alloys: 43 per cent;
- aluminium alloys: 76 per cent.

It was mainly because of its widespread and far-reaching backward linkages that the automobile industry was assigned by the Brazilian government a key role in the country's industrialization strategy (3). The industry was singled out and granted a privileged status as early as the mid-1950s (4). It was then that the government decided to establish a local vehicle industry and nearly all automotive imports were completely banned. Special incentives were granted to attract foreign automobile multinationals to set up production facilities in Brazil. Strict local-content requirements were enforced, so that the nationalization of automotive inputs reached virtually 100 per cent in the early 1960s. When the Brazilian government re-orientated economic policies from strict

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- (1) For roughly comparable information on the backward linkages of the automotive industry in the United States, see Mayer [1983, p. 54].
  - (2) CONSIDER [1986]; the figure is for 1985 and refers to automobiles and autoparts only.
  - (3) Lall [1980, pp. 789 f.] generalizes that the automobile industry "is recognized by most of the larger developing economies as having a tremendous potential as a 'lead' sector" because "it is highly 'linkage-intensive' in all senses of the term".
  - (4) For a detailed presentation of the different stages in the development of the Brazilian automobile industry, see, for example, Almeida [1972]; Guimarães [1980]; Guimarães, Gadelha [1980]; Saes [1986].



import substitution to a more outward-oriented development approach in the late 1960s and early 1970s, the road-motor-vehicle industry figured prominently in this new emphasis to promote exports as well. Fiscal export incentives were heavily concentrated on a few industries, among which the transport equipment and, particularly, the automotive sector received the bulk of public assistance (for a detailed analysis, see Section B.IV.2).

According to the World Bank [1983, p. 116], "to a large extent the rapid development of the Brazilian auto industry over the past 20 years is a success story of infant-industry development. Through its backward linkages it played a key role in the development of Brazilian industry. In addition, it is the largest exporter of manufactured products in Brazil". However, the economic costs of infant-industry development via government support are frequently neglected. Accounting for both, benefits and costs, it was shown elsewhere that developing countries would be well-advised to be extremely cautious in protecting branches considered as infant industries [Bell et al., 1984]. Moreover, it remains an open question what the Brazilian "success" is based on, i.e. cost advantages of Brazilian production vis-à-vis overseas competitors measured at undistorted factor and product prices, or rather a policy-induced improvement in world-market performance.

The Brazilian automobile industry represents an interesting example of technological development based on foreign direct investment. This sharply contrasts with the approach taken by other newly industrializing countries (NICs) in establishing a domestic motor-vehicle industry. South Korea, for example, developed its national automobile industry without assigning a significant role to multinationals at the beginning, and only recently engaged in joint ventures with foreign companies [Prud'homme, 1983c]. The foreign-based multinationals operating in Brazil followed different production and export strategies. For example, the US-motor-vehicle industry has become a major importer of autoparts and components [Laing, Rahn, 1983; Cohen, 1982]. A significant part of outsourced items, such as engines and transmissions, is supplied by Brazil (and Mexico as well), which may indicate that it is primarily in production of autoparts where NICs enjoy locational advantages. Additional-

ly, it has been hypothesized that countries like Brazil would be well-advised to concentrate on commercial vehicles rather than passenger cars, i.e., on areas where technical change is relatively slow and scale efficiency can be achieved at relatively low production levels [UN Centre on Transnational Corporations, 1983, p. 39].

The consequences which the strategy of granting foreign companies access to the domestic market may have for the competitive position of Brazil's automobile production in world markets are still a matter of controversy. On the one hand, it was hypothesized that multinationals will be the spearheads of export expansion, since they strive for serving the whole ALADI region from their plants in Brazil and engage in intra-firm trade with parent companies in developed countries as well [Nunnenkamp, Fasano-Filho, 1986, p. 15]. On the other hand, scepticism prevails about the role of foreign-based companies in improving the export performance in automobiles. It was argued that "when employed in sectors dominated by subsidiaries of transnational corporations, an export promotion strategy may run afoul of difficulties" [Bennett, Sharpe, 1979, p. 200] (1). Multinational autofirms were assumed to pay not much attention to their third-world operations [Fujimoto, 1983, pp. 9 ff.]. Rather than developing optimal product concepts for different markets, they were supposed to introduce, more or less ad hoc, a set of relatively outdated models out of the existing pool of product concepts. The export potential of the Brazilian motor-vehicle industry, for example, might have been seriously inhibited because the automobiles produced in this country were years behind the more sophisticated demand for cars in Europe and Northern America [Bhaskar, 1980, p. 290]. Arguably, the parent companies are not at all interested in overseas subsidiaries usurping their traditional European and US-markets. Consequently, the Brazilian automobile companies may have only limited influence to raise exports even if they want to (2).

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(1) For the case of German direct investments in the Brazilian automobile industry, see Röhricht [1982].

(2) Dicke [1978, p. 36]; Bennett, Sharpe [1979]; UN Centre on Transnational Corporations [1983, pp. 111 f.].

## II. Economic Performance of the Brazilian Automobile Industry

The "Brazilian Economic Miracle" of the 1960s and 1970s is usually closely connected with the economic development of the automobile industry [see e.g. Stevens, 1987, p. 4]. In particular, this industry is considered to have significantly contributed to the growth in manufactured exports of Brazil. Actually, automotive exports increased most remarkably in 1973-1978, when growth in total transport-equipment exports figured more than 3.5 times as high as in overall manufacturing (Table 1). The highest growth rates were achieved in overseas sales of buses (78 per cent), electrical autoparts (71 per cent), and engines (91 per cent).

However, such impressive figures may precipitate an ill-considered judgement. Let alone that the causes of booming automotive exports are open to question (Chapter IV), the above-mentioned figures are of only limited relevance. This is due to the rather low export levels from which the favourable development started. It is thus not surprising that export-growth rates levelled off considerably in the late 1970s and early 1980s, notwithstanding that the slackening demand for Brazilian exports, especially in neighbouring Latin American countries, contributed to this reduction as well. Moreover, Brazil's position in worldwide automobile production and trade has to be assessed in relative terms, i.e., compared to other producing countries. Finally, due consideration must be given to the completely different export conditions prevailing in various overseas markets and for the various automotive products as well. It is in these lines, that the hypothesis according to which Brazil belonged to the first candidates to significantly benefit from the relocation of worldwide automobile production to the Third World is confronted with the empirical evidence in the following paragraphs.

If Brazil was considered a promising and internationally competitive location within the "strategic positioning" [Cohen, 1982] of the major automobile companies operating at a worldwide scale, the consequences would go beyond higher shares in world *production* of automobiles, at the expense of the traditional suppliers (Section B.II.1). Brazil (and other developing countries as well) would also become increasingly integrated into world *trade* of automotive items [Jones, Womack, 1985,

Table 1 - Growth of Brazilian Manufactured Exports and Automotive Exports to the World, Developed and Developing Countries, 1973-1983 (per cent) (a)

	World		Developed countries		Developing countries	
	1973 -1978	1978 -1983	1973 -1978	1978 -1983	1973 -1978	1978 -1983
Total manufacturing (ISIC 3)	17.8	12.0	15.1	11.7	25.5	12.2
Machinery and transport equipment (ISIC 382, 383, 384)	44.5	9.7	45.2	13.5	43.9	6.4
Transport equipment (ISIC 384)	64.4	12.1	75.5	15.6	57.7	8.8
Passenger cars (SITC 7321)	58.5	18.6	29.8	93.8	60.2	10.1
Buses (SITC 7322)	77.7	-32.7	(42.7)	(-35.4)	77.9	-32.7
Lorries, trucks (SITC 7323)	52.2	10.0	137.5	30.4	46.1	1.2
Tractors (SITC 7325)	-	(249.6)	-	-	-	(244.7)
Motor-vehicle parts (SITC 7328)	44.5	11.4	46.6	10.9	42.4	11.9
Automotive electrical equipment (SITC 7294)	70.8	-3.5	91.0	-7.9	28.5	16.2
Internal combustion engines (SITC 7115)	91.1	14.7	96.9	16.3	70.4	2.9

(a) Nominal annual averages; in parentheses if export-base values are extremely low (below 100000 US \$).

Source: UNCTAD, unpubl. foreign trade data; UN [a, various issues]; own calculations.

p. 395]. The emphasis on standardization and scale economies within the so-called world-car strategy [OECD, 1983, p. 82] causes production to take place where cost-minimizing operations are guaranteed. This would result in a pattern of cross supply between plants of scale-efficient size. Thus, the engagement of multinationals in Brazil is to be expected to serve as an export platform, apart from producing automobiles for the domestic market [Wermuth, 1979; Kronish, 1984, p. 75]. At least initially, neighbouring markets are likely to absorb the bulk of *built-up and completely knocked-down (CKD) vehicles*. However, trade back to the industrialized countries and especially intra-firm trade is expected to

gain momentum when learning effects materialize. Probably, the product structure of exports then shifts to *autoparts and components*, where sourcing from lower-cost suppliers seems most profitable (1). The overview on Brazil's overall export performance and on the structure of overseas sales in Section B.II.2 provides empirical evidence in these latter respects.

### 1. *The Role of Brazil in International Automobile Production*

Despite the dramatic increase in the volume of automobile production during the last three decades (2), Brazil still does not figure prominently in the top ranks of motor-vehicle producing countries. In the first half of the 1980s, the major Western industrialized countries continued to account for more than four out of five passenger cars produced worldwide (Table 2) and three out of four commercial vehicles [UN, c, various issues; VDA, c, 1986].

*Passenger cars:* Considering the structural shifts in passenger-car production, the following trends emerge from Table 2. During the first decade, i.e. 1965-1975, industrialized countries lost 10 percentage points in world production. Slightly more than half of the corresponding increase accrued to the rather heterogeneous set of developing countries (3), whose world-market share rose from 3.8 (1965) to 9.6 per cent (1975). Until the mid-1970s, the small group of third-world beneficiaries of worldwide relocation of passenger-car production mainly consisted of Spain (plus 1.8 percentage points), Brazil (1.3) and Mexico (0.7).

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(1) Laing, Rahn [1983, pp. 36 ff.]; Maxcy [1981, p. 159]; Sinclair [1983, p. 67]; OECD [1983, pp. 81 f.].

(2) Total Brazilian automobile production developed as follows (number of passenger cars, trucks and buses, in 1000): 1957: 30.5; 1967: 225.5; 1977: 921.2; 1985: 966.7 [ANFAVEA, b, p. 67].

(3) The designation "developing countries" is intended for statistical convenience and largely follows the UN-classification; all those economies are subsumed under this heading which neither belonged to the major industrialized countries listed in note (c) of Table 2 nor to the group of centrally planned economies.

Table 2 - Production of Passenger Cars (a) by Regions and Selected Developing Countries, 1965-1985

	1965	1970	1975	1980	1981	1982	1983 (b)		1984 (b)	1985 (b)
Industrialized countries (c)										
1000 units	18868	21832	22818	25528	24594	23811	26419	(25217) (d)	25791 (d)	27277 (d)
per cent	94.1	90.1	83.8	82.0	82.4	81.9	83.0	(83.4)	83.2	83.3
Centrally planned economies										
1000 units	411	711	1792	2142	2032	2011	2055	(2046)	2117	2150
per cent	2.0	2.9	6.6	6.9	6.8	6.9	6.5	(6.8)	6.8	6.6
Developing countries										
1000 units	766	1678	2624	3448	3216	3266	3355	(n.a.)	n.a.	n.a.
per cent	3.8	6.9	9.6	11.1	10.8	11.2	10.5	(n.a.)	n.a.	n.a.
Latin America										
1000 units	371	652	1119	1360	1273	1280	1153	(n.a.)	n.a.	n.a.
per cent	1.8	2.7	4.1	4.4	4.3	4.4	3.6	(n.a.)	n.a.	n.a.
Argentina										
1000 units	141	169	185	218	138	110	131	(129)	137	114
per cent	0.7	0.7	0.7	0.7	0.5	0.4	0.4	(0.4)	0.4	0.3
Brazil										
1000 units	113	255	525	652	605	686	685	(774)	707	777
per cent	0.6	1.1	1.9	2.1	2.0	2.4	2.2	(2.6)	2.3	2.4
Mexico										
1000 units	67	136	262	316	369	324	214	(207)	245	297
per cent	0.3	0.6	1.0	1.0	1.2	1.1	0.7	(0.7)	0.8	0.9
Asia										
1000 units	n.a.	222	355	418	378	397	464	(n.a.)	n.a.	n.a.
per cent	n.a.	0.9	1.3	1.3	1.3	1.4	1.5	(n.a.)	n.a.	n.a.
India										
1000 units	35	45	23	30	42	43	45	(67)	86	129
per cent	0.2	0.2	0.1	0.1	0.1	0.1	0.1	(0.2)	0.3	0.4
South Korea										
1000 units	0	13	19	57	72	99	128	(122)	159	264
per cent	0.0	0.1	0.1	0.2	0.2	0.3	0.4	(0.4)	0.5	0.8
Malaysia										
1000 units	0	21	39	80	87	84	98	(n.a.)	n.a.	n.a.
per cent	0.0	0.1	0.1	0.3	0.3	0.3	0.3	(n.a.)	n.a.	n.a.
Africa										
1000 units	148	240	259	375	453	433	373	(n.a.)	n.a.	n.a.
per cent	0.7	1.0	1.0	1.2	1.5	1.5	1.2	(n.a.)	n.a.	n.a.
South Africa										
1000 units	128	195	206	268	324	292	275	(273)	269	204
per cent	0.6	0.8	0.8	0.9	1.1	1.0	0.9	(0.9)	0.9	0.6
Other										
1000 units	194	562	891	1295	1112	1156	1365	(n.a.)	n.a.	n.a.
per cent	1.0	2.3	3.3	4.2	3.7	4.0	4.3	(n.a.)	n.a.	n.a.
Spain										
1000 units	160	455	711	1048	877	944	1136	(1142)	1177	1230
per cent	0.8	1.9	2.6	3.4	2.9	3.2	3.6	(3.8)	3.8	3.8
Yugoslavia										
1000 units	34	107	180	247	235	212	229	(210)	236	218
per cent	0.2	0.4	0.7	0.8	0.8	0.7	0.7	(0.7)	0.8	0.7
Total										
1000 units	20059	24221	27234	31117	29841	29088	31829	(30235)	30985	32728
per cent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	(100.0)	100.0	100.0

(a) ISIC 3843-07 and 3843-10 (1965-1983) in thousand units and in per cent of total world production; assembly included. - (b) 1983 (in parentheses) as well as 1984 and 1985 as reported in VDA. Due to differences in the definition of passenger cars and trucks and buses respectively, the VDA-data are not fully comparable to UN-data. In most cases, only minor differences are to be observed in 1983. For Brazil, however, the differences are considerable, the VDA reporting a significantly higher (lower) production of passenger cars (trucks and buses) than the UN. The latter observation indicates that the VDA considers as passenger cars a large part of Brazilian vehicle production of ISIC 3843-16. - (c) Canada, United States, Japan, EC, EFTA, Australia, and New Zealand. - (d) Without New Zealand.

Source: UN [c, various issues]; VDA [c, 1986]; own calculations.

Apart from Spain, however, third-world economies did not succeed to any significant extent to further enlarge their role in worldwide passenger-car production since 1975 (1). In particular, the market share of Latin American producers stagnated during the last decade. Though Brazil was slightly better off than countries like Mexico and Argentina, it also failed to attract a significantly larger share than 2-2.5 per cent of world production. In 1981, Brazil's motor-vehicle production suffered from a drastic set-back, which was due to both slackening domestic demand and depressed market conditions in the neighbouring Latin American countries [Doleschal, 1986, p. 123]. According to national data, the number of cars (2) produced dropped abruptly from 0.93 million in 1980 to 0.59 million units; to date, production has not regained the level of 1980 [ANFAVEA, b, p. 67].

*Commercial vehicles:* Though at a higher level of world-production shares, a similar pattern was to be observed for commercial vehicles [UN, c, various issues; VDA, c, 1986]. Again it was only in the 1965-1975 period that the industrialized countries suffered considerable losses in market shares, and the Third World benefited substantially from relocation of worldwide production of buses and trucks. Rather than further strengthening their world-market position, the developing countries' market share of about 15 per cent, achieved in the second half of the 1970s and early 1980s, was somewhat eroded in the recent past. The latter development was only due to Latin American producers falling behind. Brazil was no exception to this pattern. The production of heavy commercial vehicles in 1982/83 was less than half of that in 1980, and production recovered only very slowly in the following years [ANFAVEA, b, p. 67].

Brazil's position in worldwide vehicle production may be clarified further, if the hypothesis according to which the automobile industry is increasingly relocated from industrialized to newly industrializing economies such as Brazil is subjected to a statistically more rigorous

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- (1) South Korea stands for another exception in the most recent past, starting from negligibly small market shares in the early 1980s.
  - (2) Passenger cars and station wagons included; light commercial vehicles, such as vans, jeeps and pick-ups, excluded.

empirical test. The relocation hypothesis would be supported if the following regression analysis reveals a negative relationship between vehicle production in major traditional supplying countries and in Brazil. West Germany, Japan and the United States have been selected to represent the former group of countries. Additionally, Table 3 presents estimates where the Brazilian production has been confronted with that of Spain. In this case, the sign of the regression coefficient is expected to be positive, since Spain represents another new competitor in world-automotive markets and is to be supposed to benefit from the relocation of vehicle production as well.

Two alternative definitions of the production variable were applied in time-series regressions for the 1970-1985 period. In the first variant, actual vehicle production per 1000 inhabitants in the reference countries mentioned above stands for the explanatory variable for actual vehicle production in Brazil (BAVEH in Table 3)(1). Alternatively, the difference between actual and "normal" production per capita in Brazil (BDVEH) and in the reference countries was considered in the regressions. The normal pattern of production provides a reference system based on cross-country regressions on the relationship between vehicle production and gross national income per capita. Hypothetical production volumes for individual countries are then calculated by applying the cross-country-regression parameters to country-specific developments in per-capita income (for details of calculation and illustrations, see the Appendix 1).

To test the relocation hypothesis, controlling variables have to be included in the regressions; otherwise, short-term influences and the rather long-term impact of structural relocation on Brazilian automobile production would be blurred:

- To isolate the structural relationship between per-capita production of traditional suppliers and of Brazil, the impact of cyclical variations in worldwide automobile production (VEHW) on the industry's activity

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(1) Automobile production per capita of population was calculated to account for the different size of producing countries and to adjust for the increase in production which was merely due to population growth.



Table 3 - The Relationship between Brazilian Automobile Production and Production in Major Industrialized Countries 1970-1985 - Regression Results (a)

Dependent variable	Const.	D	BMAN	BGNPPC	VEHW	GVEH (b)	JVEH (b)	UVEH (b)	SVEH (b)	R <sup>2</sup> N	F D.W.
BAVEH	4.91 (1.38)			0.005*** (4.30)		-0.10* (-1.79)				0.55 15	9.58 0.95
BAVEH	-1.81 (-1.39)			0.009*** (7.79)			-0.10*** (-5.08)			0.82 15	32.76 2.09
BAVEH	-4.29 (-1.66)			0.005*** (4.56)				0.07** (2.24)		0.60 15	11.43 1.36
BAVEH	-1.17 (-0.50)			0.006** (2.85)					-0.10 (-1.03)	0.48 15	7.37 0.96
BAVEH	3.51 (1.20)	-1.60** (-2.87)			0.40*** (5.03)	-0.17** (-3.02)				0.65 16	10.47 1.10
BAVEH	-0.10 (-0.04)	-3.69*** (-3.95)			0.06 (0.54)		0.09** (2.32)			0.58 16	7.93 0.78
BAVEH	-1.56 (-0.67)	-3.88*** (-4.98)			0.44*** (5.25)			-0.13*** (-3.23)		0.68 16	11.39 0.76
BAVEH	4.20 (1.31)	-3.01*** (-4.58)			-0.08 (-0.58)				0.27** (2.82)	0.63 16	9.69 1.27
BAVEH	5.09*** (3.33)	-2.31*** (-7.74)	0.05*** (6.47)		0.13* (2.14)	-0.11*** (-4.20)				0.93 15	45.71 2.28
BAVEH	2.78 (1.53)	-1.23 (-1.70)	0.10*** (5.08)		0.04 (0.57)		-0.10** (-2.35)			0.87 15	24.58 2.06
BAVEH	5.65* (2.14)	-1.11 (-1.26)	0.12*** (3.84)		-0.48* (-1.94)			0.16* (1.98)		0.86 15	21.75 1.94
BAVEH	1.94 (0.74)	-2.67*** (-5.05)	0.06** (3.10)		-0.01 (-0.05)				-0.01 (-0.04)	0.80 15	14.93 1.11
BAVEH	0.98 (0.62)	-2.05*** (-6.92)		0.005*** (6.14)	0.12* (1.92)	-0.09** (-3.05)				0.92 15	41.86 2.25
BAVEH	-2.76 (-1.60)	-1.51* (-2.21)		0.007*** (5.13)	0.04 (0.60)		-0.05 (-1.40)			0.87 15	24.93 1.72
BAVEH	-1.91 (-1.09)	-2.07** (-2.85)		0.006*** (3.71)	-0.05 (-0.35)			0.02 (0.40)		0.85 15	20.84 1.33
BAVEH	-0.51 (-0.22)	-2.52*** (-5.61)		0.005*** (4.20)	-0.05 (-0.56)				0.07 (0.83)	0.86 15	22.05 1.27
BDVEH	1.17 (0.83)	-2.36*** (-8.25)			0.16*** (4.53)	-0.12*** (-4.69)				0.85 15	27.90 2.18

Table 3 continued

Dependent variable	Const.	D	BMAN	BGNPPC	VEHW	GVEH (b)	JVEH (b)	UVEH (b)	SVEH (b)	R <sup>2</sup> N	F D.W.
BDVEH	-0.98 (-0.42)	-2.47*** (-3.67)			0.09 (1.00)		0.03 (0.76)			0.58 15	7.43 0.98
BDVEH	-2.38 (-1.18)	-2.94*** (-4.49)			0.16** (2.94)			-0.05 (-1.70)		0.65 15	9.64 0.89
BDVEH	1.59 (0.51)	-2.48*** (-4.70)			0.01 (0.09)				0.12 (1.36)	0.62 15	8.64 1.10
BDVEH	1.61 (1.16)	-2.49*** (-8.61)	0.01 (1.40)		0.09 (1.56)	-0.10*** (-3.34)				0.86 15	23.25 2.10
BDVEH	0.43 (0.28)	-1.55*** (-3.26)	0.06*** (4.22)		0.02 (0.43)		-0.10** (-2.69)			0.83 15	18.53 2.18
BDVEH	5.44 (1.67)	-1.25 (-1.55)	0.08** (2.76)		-0.28 (-1.67)			0.10 (1.76)		0.78 15	13.47 1.64
BDVEH	0.09 (0.03)	-2.46*** (-5.39)	0.03* (2.15)		0.01 (0.07)				-0.03 (-0.24)	0.71 15	9.76 1.03

(a) Definition of variables as follows (t-statistics in parentheses; \*\*\* significant at 1 per cent level of confidence; \*\* 5 per cent level; \* 10 per cent level, two-tailed t-test):

BAVEH : actual Brazilian production of passenger cars, trucks, and buses per 1000 inhabitants (number);

BDVEH : difference between actual Brazilian production of passenger cars, trucks, and buses per 1000 inhabitants and normal pattern (for the calculation of the latter, see the text);

Const. : constant term;

D : dummy variable (1970-1980=0; 1981-1985=1; for explanation, see the text);

BMAN : index of total manufacturing production in Brazil at constant prices;

BGNPPC : gross national income per capita of Brazil at constant prices (in 1983 US \$);

VEHW : world production of passenger cars, trucks, and buses (million) of 1983;

GVEH, JVEH : production of passenger cars, trucks, and buses per 1000 inhabitants in West Germany, Japan, the United States, and Spain respectively (number); see also footnote (b). - (b) In case of BAVEH, actual production of West Germany, Japan, the United States, and Spain respectively; in case of BDVEH, difference between actual production and normal pattern of West Germany, Japan, the United States, and Spain respectively.

Source: MVMA [1986]; VDA [c, various issues]; ANFAVEA [unpubl. data on motor-vehicles production of Brazil]; IMF [1986]; UN [c, various issues]; IBGE [a, 1985]; own calculations.

levels in Brazil must be controlled for. VEHW is likely to be positively related to BAVEH and BDVEH (1).

- To account for short-term variations in Brazilian automobile production which were due to cyclical swings in overall industrial activity in Brazil, BMAN was introduced in some regressions, additionally. Again a positive relationship is expected.
- To capture the drastic and persistent set-back in automobile production of Brazil in 1981, the dummy-variable D was introduced (1970-1980: 0; 1981-1985: 1). Evidently, D should have a negative sign.
- Finally, the increase in Brazilian automobile production that was due to per-capita growth in Brazil's gross national income had to be separated from other influences. However, BGNPPC was only included in regressions with BAVEH as dependent variable; in the case of BDVEH, income effects were captured indirectly by calculating the difference between actual production and the normal pattern.

With only minor exceptions in the case of VEHW, the controlling variables show the expected signs. Brazilian automobile production was positively related to per-capita income, the overall activity level in Brazilian manufacturing, and cyclical swings in worldwide automobile production, although the evidence is less straightforward in the latter respect. The shift-dummy is significantly negative (2).

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- (1) Regression results may be subject to problems of multi-collinearity due to the introduction of both worldwide vehicle production and per-capita production in major industrialized countries. Correlation coefficients were particularly high between VEHW and SVEH (0.85) and JVEH (0.69), but considerably lower for West Germany (0.57) and the United States (0.34). For the two latter cases, problems of multi-collinearity were completely avoided if the differences between actual and normal production (rather than actual per-capita production) were considered as explanatory variables for BDVEH. The interpretation of estimation results is thus concentrated on these regressions, reported in the lower part of Table 3.
- (2) Most of the regressions perform reasonably well in terms of adjusted  $R^2$ ; on average, the included variables explain more than 70 per cent of the variation in BAVEH and BDVEH respectively. In some cases, Durbin-Watson statistics point to auto-correlated residuals. However, this is mainly the case in regressions where the coverage of controlling variables is not complete.

As concerns the structural relationship between automobile production in the four reference countries and in Brazil, the evidence is mixed. As expected, a negative relationship did not prevail in the case of Spain. The coefficients of UVEH do not support the hypothesis of a significant relocation of automobile production from the United States to Brazil. Four possible explanations may apply, which are complementary rather than excluding each other.

Firstly, US-automobile production fluctuated heavily during the 1970-1985 period (see Figure A1) so that longer-term structural trends were largely obscured. Secondly, US-based multinationals operating in Brazil followed a strategy which differed markedly from the approach taken by European companies (for details, see pp. 37 f.). The former largely concentrated on outsourcing of autoparts, which is not captured in the regressions presented in Table 3 (1). Thirdly, the competitive pressure on the US-automobile industry originated mainly from Japanese and, to a lesser extent, from European producers in the 1970s [U.S. Department of Transportation, 1981, pp. 35 ff.]. Consequently, other traditional suppliers rather than new competitors such as Brazil were likely to benefit from declining US-production (2). Fourthly, the negative impact of intensified Japanese and European efforts to penetrate US-markets on production and employment of US-automobile companies rendered it politically difficult for US-based multinationals to proceed with the relocation of production facilities to countries such as Brazil, provided that it was economically favourable altogether (3). Actually, US-firms attempted to meet the Japanese challenge mainly by automatization of plants in the United States, rather than by shifting activities to lower-cost locations [Anderson, 1982; Womack, 1981; Kommission, 1981, p. 21] (4).

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- (1) Due to the rather poor data on international autoparts production, the relocation hypothesis could not be tested in this respect.
  - (2) Such trends can hardly be identified by running regressions like those of Table 3, which are based on structural production changes between countries rather than between companies of different nationality. To an increasing degree, Japanese and European companies entered the US-market via direct investments rather than exporting from their home countries.
  - (3) For the employment consequences of rising market shares of foreign companies in the United States, see Kommission [1981, p. 20].
  - (4) This statement was supported in interviews with officials of Brazilian subsidiaries of US-based automobile multinationals.

Contrary to the United States, the relocation hypothesis is supported in the case of West Germany and, though to a lesser extent, for Japan as well. The negative relationship between Japanese and Brazilian production may be surprising, since Japanese companies played only a negligible role in the automobile industry of Brazil. However, relatively strong indirect links were likely to exist. For example, Brazilian automobile exports to Latin America and the Middle East (for details, see Section B.II.2) may have affected Japanese sales to these regions.

The hypothesized relocation from traditional suppliers to Brazil is most evident for West Germany, irrespective of the regression specification. Moreover, problems of auto-correlation and multi-collinearity can be largely ruled out, so that unbiased estimates are most likely to be achieved in this case. Table A2 indicates significantly negative relationships in both *passenger-car* and *commercial-vehicle* production. This result is due to the operations of VOLKSWAGEN DO BRASIL (VWB) in passenger-car production and MERCEDES-BENZ DO BRASIL (MBB) in the production of buses and trucks (1). Both companies were among the first starting production in Brazil (2) and persistently dominated the market for passenger cars and commercial vehicles respectively (3). Moreover, automobile exports from Brazil, to a large extent, consisted of overseas sales of VWB and MBB. During the second half of the 1970s, VWB shipped nearly two thirds of exported automobile units, though the

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- (1) As regards passenger-car production, some effects may be attributed to the Brazilian engagement of FORD and GENERAL MOTORS as well. If these companies shifted production from their European subsidiaries to Brazil, this would affect the regressions for West Germany rather than for the United States. In this context, considerable exports of Escorts by FORD to Scandinavian countries in 1983-1985 provided an interesting case in point (information from internal documents). In order to match Japanese competition in these countries, FORD launched Brazilian-built Escorts, whose retail prices were 6-7 per cent below those for the European version [Gooding, 1984].
- (2) See e.g. Latini [1984, p. 99] and, for the development of VOLKSWAGEN, VWB [1978].
- (3) See e.g. Saes [1986, p. 23]; Guimarães, Gadelha [1980, Statistical Appendix]; during the first two decades of the Brazilian automobile industry, the average share of VWB in passenger-car production amounted to about 58 per cent; MBB accounted for 33 per cent of truck production and 80 per cent of bus production [ibid., Tables 2.5 and 2.6].

company's role in exports declined significantly during this period. MBB contributed another 7.5 per cent [Crissiuma, 1986, p. 96, based on ANFAVEA-data]. Particularly, third-world markets were increasingly supplied from Brazil, rather than from West Germany. According to Table A2, the negative coefficient of GACV, i.e., German production of commercial vehicles, is more than three times as high as in the production of passenger cars (GACAR). This result may support the notion that it is mainly in the production of *trucks and buses* where Brazil can penetrate world markets successfully. In Section B.III.1, this issue will be analysed more systematically.

All in all, the relocation of automobile production from traditional suppliers to new competitors such as Brazil proceeded more slowly than might have been expected, and has virtually been interrupted since the second half of the 1970s (1). The preceding analysis has not dealt with causalities, which are the topic of Sections B.III.2 and B.IV. Against the background of evidence presented, however, it seems plausible to argue that it has become increasingly difficult to shift production from industrialized to newly industrializing economies, when the overall expansion of world-automobile markets slowed down considerably. Rather than closing down plants in developed countries, new production facilities adding to the existing capacities were built up in Brazil and other developing countries in the 1960s and early 1970s. Facing global over-capacities later on, the process of relocation might have been seriously impeded.

This reasoning refers to the relocation of automobile production from industrialized countries to NICs in general. Though Brazil fits reasonably well into the pattern observed for other third-world suppliers, factors other than political obstacles in the industrialized countries may

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(1) As far as the location of recent auto investments is concerned, "the general trend seems to be to place the great bulk of new facilities in the developed countries ..., and less than 10 per cent overall will presumably go to the developing countries" [UN Centre on Transnational Corporations, 1983, p. 100]. This leads to a rather sceptical view as regards future relocation to countries such as Brazil as well, notwithstanding that most of the automotive investments in the Third World was destined to be concentrated in Brazil and Mexico [for details, see Prud'homme, 1984b].

be responsible for the retarded relocation in this particular instance. Economic policies of the Brazilian government represent the most important candidate in this respect, since they may have added to the reluctance of foreign companies to intensify their engagement in this country (for internally created bottlenecks, see Section B.V.3).

## *2. Export Performance of Brazilian Automobile Producers*

Almost certainly, the retarded relocation of automobile production also influenced the developing countries' role in international trade of automotive items. Overseas sales were likely to be affected to varying degrees, depending on the export structure in terms of both export markets and automotive products. For example, the formerly strong concentration of Brazilian automotive exports on developing countries required for adjustment, when widespread foreign debt problems of third-world economies caused severe economic tensions in the early 1980s. Since developing countries mainly demanded finished vehicles (including CKDs) rather than autoparts and components, the product structure of Brazilian exports was likely to change as well.

### *a. Destination of Exports*

The dramatic shift in the relative importance of major export markets for Brazil's automobile industry is shown in Table 4 (1). When the industry began to look for foreign markets in the early 1970s, nearly 90 per cent of overseas sales went to Latin American countries. Apart from supplying the domestic market of Brazil, the production facilities of automobile multinationals in Brazil served as an export platform for the surrounding region in the first place. This strategy was obvious since preferential trading arrangements favoured trade within the LAFTA and discriminated against imports from third countries. LAFTA attempted to elevate national import-substitution policies to the regional level.

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(1) For firm-specific exports to individual countries in the period 1965-1985, see MBB [1985].

Table 4 - Destination of Brazilian Exports of Road-Motor Vehicles (a), 1972-1984 (per cent) (b)

	1972	1975	1980	1982	1983	1984
Industrialized countries	12.2	12.7	22.8	43.9	41.6	43.4
United States	8.1	6.1	10.1	8.2	11.0	15.1
Europe(c)	3.5	6.1	11.5	33.6	28.3	27.4
Developing countries	87.8	87.3	77.2	56.1	58.4	56.8
ALADI	87.0	45.4	46.5	35.1	18.9	30.5
Africa	0.6	31.0	22.0	14.5	9.9	7.6
Middle East	-	3.2	3.6	4.9	27.7	15.3
Asia, other	-	3.4	1.7	0.6	0.7	1.0

(a) SITC 732 (rev. 1), i.e., passenger cars, commercial vehicles and motor cycles. - (b) Total export value (US \$) = 100. - (c) EC (10) and EFTA.

Source: UN [a]; own calculations.

However, LAFTA did not succeed to liberalize trade between the 11 member countries as envisaged in the 1960s. Subsequently, export conditions were increasingly characterized and complicated by bilateral trading arrangements between member countries of the rather loose cooperation ALADI, which replaced LAFTA in 1980. Presumably, the abandonment of the regional liberalization approach in Latin America enforced the need for the automobile companies to diversify their export sales regionally. The experience gained in markets surrounding Brazil might have rendered it easier to approach new markets in the mid-1970s. Until 1980, developing countries continued to account for the great bulk of automobile exports, however, although their share dropped by 10 percentage points. It was mainly other third-world regions that gained in relative importance at ALADI's expense: Africa emerged as an important market in the second half of the 1970s; later on, the Middle East absorbed significant amounts of Brazilian exports. But the latter export successes were due to exceptional ad-hoc sales of individual companies in specific countries, frequently based on barter-trade arrangements, rather than pointing to a longer-term regional re-orientation in overseas sales of the



Brazilian automobile industry as a whole (1). The heavily fluctuating shares indicate that Africa and the Middle East did not provide a solid and stable basis for a systematically planned export strategy.

In the early 1980s, the need for re-thinking the export strategy was dramatically increased by the seriously depressed demand conditions in most of Brazil's traditional markets in the Third World [Stevens, 1987, p. 25]. The share of automobile exports shipped to developing countries fell abruptly by 20 percentage points as compared to 1980. As regards both *passenger cars and commercial vehicles*, it was mainly to Europe that the Brazilian companies directed their efforts to enter the more sophisticated markets of industrialized countries. Shipments of *autoparts and components* were largely directed towards Northern America. In 1983-1985, the United States accounted for about 57 per cent of total Brazilian exports of autoparts and components (2). Other developed countries, particularly Italy, West Germany and the United Kingdom, absorbed another 22 per cent of Brazilian exports of autoparts and components in 1985.

In summary, the analysis on the destination of Brazilian automotive exports underlines the growing importance of developed-country markets which is most evident for autoparts. The future of the Brazilian automobile industry thus heavily depends on economic prospects in the advanced economies and on Brazil's readiness to successfully compete in rather sophisticated automobile markets. Both future demand and supply conditions may differ considerably between the most important automotive items, so that a closer look at the product structure of Brazilian automotive exports seems to be in place.

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(1) This is most evident in the case of exports of VWB to Iraq in 1983-1985, which amounted to more than 20 per cent of total Brazilian exports of passenger cars in the respective period. In 1974-1976, Brazilian exports of buses mainly consisted of exceptionally high sales by MBB to Nigeria and Sudan [MBB, 1985].

(2) SINDIPEÇAS [1985]; SINDIPEÇAS, ABIPEÇAS [1985], on the basis of data from CACEX.

## b. Product Structure of World-Market Sales

It was hypothesized that world trade in automotive items would increasingly take place in the form of autoparts and major components rather than finished vehicles [OECD, 1983, pp. 81 f.; Black, 1983]. Frequently, this presumption explicitly referred to the so-called world-car strategy of automobile multinationals. In order to reap economies of scale as far as possible and, in particular, to spread the increasingly high development costs for product innovations over as many vehicles as possible, the standardization of parts and components was considered as crucial. It follows that common parts for similar models would be produced on a worldwide scale at the lowest-cost location and then be shipped for assembly or further processing to other countries [Dankbaar, 1984, p. 231].

On the aggregate level of automotive exports of OECD-countries, Dankbaar [1983, pp. 27 ff.] found hardly any evidence supporting the aforementioned hypothesis. Apart from considerable differences in the export strategies of the major producing countries (1), this may be due to the restriction to OECD-exports. Presumably, NICs such as Brazil were best prepared to benefit from the assumed trend towards trade in parts and components. Autoparts may be better suited for standardization than finished vehicles, especially when passenger cars are concerned the design of which is subject to frequent changes in consumer preferences. Consequently, technologies applied in the production of autoparts are likely to be fairly standardized as well and will not draw too much on the relatively poor human-capital endowment of developing countries.

However, Table 5 lends only limited support to this reasoning. The developing countries' participation in world trade was significantly lower than in world production of automotive items. Irrespective of whether

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(1) Traditionally, US-exports of autoparts accounted for more than half of total automotive exports of the United States, whereas Japan reported only negligible overseas sales of parts. The major European suppliers were in-between, of which the United Kingdom, Italy and France significantly increased the share of autoparts in total automotive exports in the 1970s, however [Dankbaar, 1984, Table 24].

Table 5 - Automotive Exports and World-Market Shares by Region and Selected Developing Countries, 1971-1984

		1971	1975	1980	1982	1984
		passenger cars (a)				
Industrialized countries (b)	US \$ million	13405	24464	56551	57935	69119
	per cent	99.2	98.0	95.7	95.9	95.6
Developing countries (c)	US \$ million	103	491	2530	2498	3153
	per cent	0.8	2.0	4.3	4.1	4.4
ALADI	US \$ million	4	116	400	492	(469) (d)
	per cent	0.0	0.5	0.7	0.8	(0.6)
Brazil	US \$ million	2	63	327	460	561
	per cent	0.0	0.3	0.6	0.8	0.8
Mexico	US \$ million	0	3	31	10	119
	per cent	0.0	0.0	0.1	0.0	0.2
Asia (f)	US \$ million	24	124	451	602	505
	per cent	0.2	0.5	0.8	1.0	0.7
South Korea	US \$ million	0	0	50	49	174
	per cent	0.0	0.0	0.1	0.1	0.2
Africa	US \$ million	9	15	56	28	6
	per cent	0.1	0.1	0.1	0.0	0.0
Spain	US \$ million	54	214	1496	1249	2044
	per cent	0.4	0.9	2.5	2.1	2.8
Yugoslavia	US \$ million	3	17	118	121	127
	per cent	0.0	0.1	0.2	0.2	0.2
Total	US \$ million	13508	24955	59081	60433	72272
	per cent	100.0	100.0	100.0	100.0	100.0
		trucks and buses (f)				
Industrialized countries (b)	US \$ million	3279	10588	20549	19366	19505
	per cent	98.6	95.6	94.1	93.2	96.3
Developing countries (c)	US \$ million	46	484	1278	1403	753
	per cent	1.4	4.4	5.9	6.8	3.7
ALADI	US \$ million	4	190	483	432	(155) (d)
	per cent	0.1	1.7	2.2	2.1	(0.8)
Brazil	US \$ million	2	135	430	394	397
	per cent	0.1	1.2	2.0	1.9	2.0
Mexico	US \$ million	0	6	13	6	33
	per cent	0.0	0.1	0.1	0.0	0.2
Asia (e)	US \$ million	18	158	449	518	339
	per cent	0.5	1.4	2.1	2.5	1.7
South Korea	US \$ million	0	1	44	30	35
	per cent	0.0	0.0	0.2	0.1	0.2
Africa	US \$ million	12	27	30	43	41
	per cent	0.4	0.2	0.1	0.2	0.2
Spain	US \$ million	9	81	245	340	141
	per cent	0.3	0.7	1.1	1.6	0.7
Yugoslavia	US \$ million	2	26	69	63	65
	per cent	0.1	0.2	0.3	0.3	0.3

Table 5 continued

		1971	1975	1980	1982	1984
Total	US \$ million	3325	11072	21827	20769	20258
	per cent	100.0	100.0	100.0	100.0	100.0
motor-vehicle parts, nes.(g)						
Industrialized countries (b)	US \$ million	6573	14369	39339	29475	36153
	per cent	97.6	96.9	(31236) 95.1 (95.0)	(30356) 94.5 (94.4)	(37227) 95.2 (95.1)
Developing countries (c)	US \$ million	161	454	1546	1706	1801
	per cent	2.4	3.1	(1646) 4.8 (5.0)	(1801) 5.5 (5.6)	(1906) 4.7 (4.9)
ALADI	US \$ million	54	133	569	570	673
	per cent	0.8	0.9	(616) 1.8 (1.9)	(617) 1.8 (1.9)	(729) 1.8 (1.9)
Brazil	US \$ million	8	45	220	243	272
	per cent	0.1	0.3	(252) 0.7 (0.8)	(241) 0.8 (0.7)	(361) 0.7 (0.9)
Mexico	US \$ million	32	55	n.a.	n.a.	n.a.
	per cent	0.5	0.4	(244) n.a. (0.7)	(317) n.a. (1.0)	(317) n.a. (0.8)
Asia (f)	US \$ million	41	100	263	290	272
	per cent	0.6	0.7	(337) 0.8 (1.0)	(364) 0.9 (1.1)	(352) 0.7 (0.9)
South Korea	US \$ million	0	2	21	31	51
	per cent	0.0	0.0	(20) 0.1 (0.1)	(31) 0.1 (0.1)	(52) 0.1 (0.1)
Africa	US \$ million	15	25	51	33	18
	per cent	0.2	0.2	(56) 0.2 (0.2)	(36) 0.1 (0.1)	(20) 0.0 (0.1)
Spain	US \$ million	30	126	414	515	589
	per cent	0.4	0.9	(418) 1.3 (1.3)	(515) 1.7 (1.6)	(590) 1.6 (1.5)
Yugoslavia	US \$ million	20	65	n.a.	n.a.	n.a.
	per cent	0.3	0.4	(220) n.a. (0.7)	(278) n.a. (0.9)	(225) n.a. (0.6)
Total	US \$ million	6734	14823	31907	31204	37973
	per cent	100.0	100.0	(32882) 100.0 (100.0)	(32157) 100.0 (100.0)	(39133) 100.0 (100.0)

Table 5 continued

		1971	1975	1980	1982	1984
		internal combustion engines (h)				
Industrialized countries (b)	US \$ million	n.a.	6707	13377	13122	15149
	per cent	n.a.	95.4	96.2	96.0	92.8
Developing countries (c)	US \$ million	n.a.	324	535	545	1181
	per cent	n.a.	4.6	3.8	4.0	7.2
ALADI	US \$ million	n.a.	146	(8) (i)	(8) (i)	(640) (i)
	per cent	n.a.	2.1	(0.1)	(0.1)	(3.9)
Brazil	US \$ million	n.a.	91	349	326	830
	per cent	n.a.	1.3	2.5	2.4	5.1
Mexico	US \$ million	n.a.	45	n.a.	n.a.	n.a.
	per cent	n.a.	0.6	n.a.	n.a.	n.a.
Asia (e)	US \$ million	n.a.	78	222	203	188
	per cent	n.a.	1.1	1.6	1.5	1.2
South Korea	US \$ million	n.a.	2	14	8	13
	per cent	n.a.	0.0	0.1	0.1	0.1
Africa	US \$ million	n.a.	4	22	19	8
	per cent	n.a.	0.1	0.2	0.1	0.0
Spain	US \$ million	n.a.	61	200	224	264
	per cent	n.a.	0.9	1.4	1.6	1.6
Yugoslavia	US \$ million	n.a.	35	81 (j)	90 (j)	82 (j)
	per cent	n.a.	0.5	0.6	0.7	0.5
Total	US \$ million	n.a.	7030	13912	13667	16330
	per cent	n.a.	100.0	100.0	100.0	100.0
<p>(a) SITC 781 (rev. 2) or 7321 (rev. 1). - (b) Mainly Canada, United States, EC (10), EFTA, Japan, Australia, and New Zealand. - (c) Spain, Yugoslavia and South Africa included. - (d) UN estimates reported in International Trade Statistics Yearbook, on the basis of an estimate of Brazilian exports of US \$ 317 million (passenger cars) and US \$ 110 million (trucks and buses); since export figures for all developing countries are based on the UN estimates for ALADI exports, the Third World's market share in 1984 is understated as well. - (e) Middle East included; in both the Middle East (e.g. Saudi Arabia, Kuwait, Oman) and the Far East (e.g. Singapore, Hong Kong) reported exports are likely to consist largely of re-exports. - (f) SITC 7821, 7831 (rev. 2) or 7323, 7322 (rev. 1); for 1971, trucks only. - (g) SITC 7842, 7849 (rev. 2) or 7328 (rev. 1); 1980, 1982, and 1984 largely based on estimates on the basis of exports of SITC 784; in parentheses: SITC 784. - (h) SITC 7132, 7133, 7138, 7139 (rev. 2) or 7115 (rev. 1). - (i) UN estimates reported in International Trade Statistics Yearbook, where exports of Brazil and Mexico are not considered; since export figures for all developing countries are based on the UN estimates for ALADI exports, the Third World's market share is understated as well. - (j) SITC 713.</p>						

Quelle: UN [a; d]; own calculations and estimates.

Latin American, Asian or European non-traditional competitors are considered, production was mainly for the domestic market. Until 1975, this was particularly true for passenger cars, which underlines that it was most difficult for new competitors to penetrate world markets for finished automobiles for private use [see also Fujimoto, 1983, p. 28]. World-market shares were somewhat higher in trade of engines, autoparts and commercial vehicles. As concerns the latter, it may be relatively easy for NICs to engage in international trade, since the product design changes rather slowly and scale efficiency can be achieved at relatively low production levels (1). However, during the second half of the 1970s, the increase in world-market shares of developing countries was considerably smaller for commercial vehicles and autoparts as compared to passenger cars, which is in conflict with the hypothesized pattern. Moreover, the development of market shares was disappointing for all items in the recent past, notwithstanding that, in the case of commercial vehicles and parts, world-market shares increased up to 1982; the significant decline in the subsequent years rendered the latter increase obsolete (2).

The principal features observed for developing countries as a whole showed up in the different third-world regions and major producing countries as well. As regards Brazil, Table A3 reveals impressive growth rates for exports of almost all automotive items in an international perspective (in nominal US \$-terms). Brazil performed considerably better than the traditional suppliers, including Japan, and most of the remaining new competitors in world markets as well (3). However, the production of motor vehicles continued to be mainly directed towards the internal market, despite the drastically increased export shares reported in Table 6 (see Table 2 for the Brazilian share in world production of

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- (1) UN Centre on Transnational Corporations [1983, p. 39]; Fujimoto [1983, p. 30].
  - (2) The development in world-market shares for engines showed a different picture. But the considerable increase in recent years does not yet provide strong evidence in favour of the expected trade structure, since the developing countries' role in trade of motors stagnated in 1975-1982.
  - (3) Only South Korea outperformed Brazil, but Korean export sales were extremely low in 1973.

Table 6 - Share of Brazilian Automobile Production Devoted to Exports, 1965-1985 (a) (per cent)

	1965-1971	1972-1974	1975-1980	1981-1985
Road-motor vehicles, total	0.1	4.5	9.4	22.0
Passenger cars	0.0	3.1	9.3	19.9
Cars for mixed use(b)	0.0	7.8	8.4	22.5
Pick-ups and utility cars(c)	0.2	5.1	9.7	30.3
Trucks				
total	0.2	7.8	12.6	16.1
light and medium	0.2	8.2	12.7	15.6
heavy	0.2	2.5	11.8	19.5
Buses	1.4	10.3	13.0	19.9

(a) Period averages; the economic rationale for the separation of sub-periods is as follows: 1965-1971: period before the BEFLEX-program was implemented; 1972-1974: final years of the rapid cyclical upswing of automobile production in Brazil (for the identification of cyclical sub-periods in the Brazilian automobile sector, see World Bank [1983, pp. 117 ff.]); 1975-1980: period of slow growth; 1981-1985: severe contraction of automobile production in Brazil in 1981 and slow growth in the following years. - (b) Automóveis de uso misto. - (c) Camioneta de uso misto, utilitários, camioneta de carga.

Source: ANFAVEA, unpubl. data on Brazilian automobile production and exports; own calculations.

passenger cars and Table 5 for its share in world trade) (1). As regards the hypothesized product structure in international trade, the evidence is rather weak. The highest growth rates were achieved for engines and passenger cars, whereas the rates for other autoparts and commercial vehicles were somewhat below the average (Table A3).

(1) Similar information was not available for autoparts. Throughout the 1970s, exported production shares were highest for trucks and buses, as was to be expected considering the relative easiness to reach scale-efficient production levels. Subsequently, however, exports of commercial vehicles, relative to production, expanded less quickly than for other motor vehicles. The most significant increase in export shares was calculated for multiple-use pick-ups and utility cars. Presumably, this was due to strong similarities in demand between Brazil and other developing countries, although Brazilian exports suffered from the depressed demand conditions in many third-world economies. The Brazilian production of such vehicles was best adapted to the rough and multiple-purpose usage of cars in developing countries.

Starting from very low export values in the early 1970s, the differences in growth rates were too small to change the product structure of Brazilian automotive exports dramatically. From Table 7, short-term cyclical shifts in the relative importance of different automotive items emerge, rather than a stable trend towards autoparts and components (1):

- Considering period averages for 1972-1974, 1975-1980 and 1981-1985 (2), the combined share of *engines and other parts* in total Brazilian automotive exports was relatively high at the beginning of the export boom (47.6 per cent); the share declined to 41.5 per cent in the second half of the 1970s, and recovered to slightly more than 45 per cent in the recent past.
- Exports of *finished vehicles* continued to consist mainly of passenger cars; since 1974, they accounted for about three quarters of total vehicle units shipped abroad. If any, a longer-term trend emerged over the past decade within the rather heterogeneous group of *commercial vehicles*, namely from heavy trucks and buses to relatively light commercials.

A major conclusion to be drawn from the analysis of the Brazilian export performance in automotive items is that Brazil was no exception to the general pattern observed for the Third World as a whole. The increase in world-market shares was also largely restricted to the 1970s, the doubling of market shares for engines in 1982-1984 standing for the

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- (1) This holds true even though Brazilian exports of autoparts are significantly understated in Table 7, where only exports of ANFAVEA-members are reported. In 1985, for example, total exports of parts and components amounted to US \$ 1.4 billion according to CACEX data [reported in SINDIPEÇAS, 1985], as compared to US \$ 0.86 billion in exports of engines and other parts shipped by ANFAVEA-members. In terms of growth rates, however, ANFAVEA-members performed slightly better than the remaining exporters of autoparts (1974-1985: 23 versus 21 per cent annually, in nominal terms), so that changes in the product structure, as indicated in Table 7, are hardly affected.
- (2) The economic rationale for calculating averages for the sub-periods indicated is as follows: 1972-1974, final years of the rapid cyclical upswing in automobile production in Brazil; 1975-1980, period of slow growth; 1981-1985, severe contraction of automobile production in 1981 and slow growth in the subsequent years.



Table 7 - Product Structure of Brazilian Automotive Exports (a), 1972-1985 (per cent)

	Vehicles (b)				Engines	Other components
	total	passenger cars (c)	light commercials (d)	heavy commercials (e)		
1972	46.0	(48.9)	(21.1)	(30.1)	0.3	53.7
1973	52.8	(56.7)	(19.0)	(24.3)	0.5	46.7
1974	58.3	(73.6)	(14.3)	(12.1)	8.5	33.2
1975	55.5	(72.0)	(15.3)	(12.7)	24.3	20.2
1976	60.5	(77.2)	(10.3)	(12.5)	17.5	22.0
1977	49.0	(80.9)	(4.8)	(14.4)	27.7	23.3
1978	61.2	(80.5)	(7.3)	(12.2)	21.6	17.2
1979	58.5	(72.4)	(12.2)	(15.4)	26.5	15.0
1980	66.3	(73.5)	(12.9)	(13.6)	19.1	14.6
1981	68.1	(73.9)	(15.4)	(10.7)	12.0	19.9
1982	62.0	(69.4)	(26.9)	(3.7)	16.4	21.6
1983	50.0	(78.7)	(18.9)	(2.4)	24.8	25.2
1984	46.7	(77.3)	(18.1)	(4.6)	24.4	28.9
1985	46.5	(77.4)	(17.6)	(5.0)	25.4	28.1

(a) Exports by ANFAVEA-members, exclusively; exports of autoparts and components are thus significantly understated (see also the text). The calculation of shares is based on export values in US \$ (total automotive exports = 100), except for the sub-groups of motor vehicles. - (b) For the three sub-groups of motor vehicles, the calculation of shares is based on the number of exported vehicles (number of total vehicle exports = 100). - (c) Station wagons included. - (d) Vans, jeeps and pick-ups. - (e) Trucks and buses.

Source: ANFAVEA [b]; own calculations.

principal exception (Table 5)(1). The stagnating participation of Brazil in international trade in the first half of the 1980s was at least partly due to depressed demand conditions in the traditional third-world export markets and the difficulties in immediately re-directing exports to industrialized countries.

- (1) The corresponding increase observed above for the Third World as a whole was mainly due to Brazilian exports of engines. Firm-specific information provided by major suppliers indicate that engine exports by the Brazilian subsidiaries of General Motors and Ford to the United States accounted for most of the jump in world-market shares in 1982-1984. However, export sales of engines projected for 1990 by one company point to a significant decline in the coming years.

### c. Differences in Firm-Strategies

As compared to passenger cars, Brazil's role in international trade was relatively pronounced for commercial vehicles and engines in the early 1980s; contrary to the hypothesized changes in the product composition of trade, this did not apply to other autoparts, however. This may indicate that the automobile multinationals had not yet fully embarked in the world-car strategy of worldwide sourcing at the lowest-cost location.

Actually, distinct differences emerge between the major suppliers operating in Brazil. Exports of *finished vehicles* figured prominently in overseas sales of European-based companies, whereas US-based multinationals were reluctant to export completely built-up vehicles or CKDs from Brazil to the United States. This does not necessarily mean that Brazilian producers failed to match the competition of traditional suppliers in Northern America. The US-based multinationals operating in Brazil rather followed a different strategy. The *motor-vehicle industry* of the United States imported considerable amounts of *autoparts and components* from Brazil for assembly in the United States, rather than using its production facilities in Brazil to supply finished vehicles for the US-market [Laing, Rahn, 1983; Cohen, 1982]. US-imports of parts amounted to US \$ 0.8 billion in 1985 and thus slightly exceeded the total amount of foreign currency earned by Brazil through exports of road-motor vehicles.

Firm-specific information on the share of production devoted to exports and on the product structure of overseas sales underlines the differences in export strategies of the major producers operating in Brazil (Table 8). Export shares of 1986 were highest for FIAT (32 per cent) and GENERAL MOTORS (21 per cent). Though largely restricted to engines, the US-based companies were clearly the pioneers in outsourcing parts and components to Brazil for assembly in other countries, whereas finished vehicles accounted for three quarters of exports of the subsidiaries of German multinationals (1).

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(1) See also Crissiuma [1986, p. 97], and the company profiles in Stevens [1987, pp. 44 ff.].

Table 8 - Export Shares (a) and the Structure of Exports (b) of Major Brazilian Automobile Companies, 1986

	FORD	GENERAL MOTORS	FIAT	VWB	MBB
Total exports (US \$ million)	168.5	268.9	249.2	226.9	104.3
thereof (per cent):					
Vehicles	42	45	64	77	74
Parts	11	5	10	22	15
Components(c)	47	50	26	1	11
Export share (per cent)	14	21	32	13	12
(a) Share of exports in total sales (US \$) in per cent. - (b) Total exports (US \$) = 100. - (c) Mainly engines.					

Source: Unpubl. data provided by a major Brazilian automobile company.

### III. Brazil's Position in World-Automotive Markets and Relative Production Costs

#### 1. Quantitative Assessment of Brazil's Revealed Comparative Advantages in World-Automotive Markets

The pressing need for the Brazilian automobile industry to enter new markets has recently induced spectacular attempts to meet this challenge. Particular attention was focused on VOLKSWAGEN'S assault on the US-market, where the company expected to sell 10000 Foxes annually, starting in 1987 [Stevens, 1987, p. 26]. It is still too early to definitely judge the success or failure of such projects. Whether the stagnation of Brazil's participation in international trade of automotive items since 1980 was mainly due to short-term adjustment problems rather than persistent problems in further penetrating world-automotive markets will critically depend on the country's export performance in the advanced US- and European markets.

The following quantitative assessment of Brazil's revealed comparative advantages (RCAs) and the development of its competitive position over

the past 15 years may provide some first impressions as concerns the future export prospects as well. Subsequently, its export performance will be traced to major cost factors, in order to test the hypothesis that, in an international perspective, Brazil's advantages in labour costs are sufficiently large to compensate for lower productivity and other cost disadvantages.

The analysis of the competitive position of Brazilian automobile producers in world markets refers to two different approaches: firstly, export-performance ratios are presented as a frequently applied measure of RCA; secondly, export unit values (as an approximation of export prices) are calculated for automotive items shipped to the United States and the EC-countries, in order to gain further insights into the price competitiveness of Brazil relative to other suppliers. Both measures do not tell whether Brazil's favourable export performance was artificially created by policy interventions of the government or whether it was rather due to comparative advantages, i.e., the country's specialization in activities that absorb relatively much of its relatively abundant factors of production. Instead of referring to factor endowments, the concept of *revealed* comparative advantage relates to the actually observed export performance. This is why the following analysis has to be supplemented in Section B.IV, where relative factor intensities of Brazilian automobile production will be calculated and the role of economic policies be assessed, in order to clarify the relevance of the conflicting hypotheses on the causes of the Brazilian export performance.

#### a. Export-Performance Ratios for Major Export Markets

A number of indices of RCA have been applied in the literature (1). Frequently, the performance of an industry is assessed by calculating the excess of its exports over its imports, relative to total net exports of the country's manufacturing sector. However, this net-trade measure

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(1) For an overview on the pros and cons of the different approaches, see UNIDO [c, pp. 4 ff.]. Empirical applications concerning Brazil's manufactured export performance include Tyler [1972; 1976]; Savasini [1978]; Nishijima [1980]; Fasano-Filho et al. [1987].

is likely to produce seriously biased results in the case of the Brazilian automobile industry, since imports of automotive items were largely banned by tariff and non-tariff barriers. Hence, an indicator that incorporates export data only is favoured in the following. Export-performance ratios (EXPR) compare Brazil's commodity structure of manufactured exports to the corresponding structure of world exports:

$$\text{EXPR} = \frac{X_{ij}}{X_{mj}} / \frac{XW_{ij}}{XW_{mj}}$$

where: X = Brazilian exports;

XW = world exports;

i = automotive items (SITC-categories 732, 7321, 7322, 7323, 7328, and 7115 respectively);

j = destination of exports;

m = total manufactured exports.

The basic notion of this approach is that Brazil enjoys a competitive advantage if the share of automotive exports in Brazil's total manufactured exports exceeds the share of automotive items in world exports of manufactures (EXPR > 1).

As was to be expected, Table 9 indicates considerable differences in export-performance ratios between major export markets and automotive products. With the beginning of the export strategy in the early 1970s, Brazil penetrated third-world markets successfully. This did not only apply to the protected and near-by ALADI-markets, but also to other regions. Intra-firm trade played a significant role, for example from Brazilian to African subsidiaries of multinationals based in West Germany (1). Similarities in the demand profiles of developing countries are likely

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(1) For trade flows, see MBB [1985]; for the activities of VOLKSWAGEN and MERCEDES-BENZ in Africa, in particular in Nigeria and the Republic of South Africa, see the companies' annual reports; for a detailed presentation of overseas manufacturing, assembly and licensing activities of major automobile firms, see Chambre Syndicale des Constructeurs d'Automobiles [various issues]; Schnell [1981, pp. 142 ff.].

Table 9 - Export-Performance Ratios (a) for Brazilian Automotive Exports to Major Markets, 1971-1984 (b)

Destination	1971-1975	1976-1980	1981-1984	1971-1975	1976-1980	1981-1984
	road-motor vehicles			trucks		
World	0.71	1.11	1.18	1.75	2.86	2.25 (c)
Developed countries	0.16	0.36	0.58	0.30	1.08	1.55 (c)
United States	0.12	0.30	0.22	0.60	1.87	0.36 (c)
Europe (d)	0.22	0.42	1.37	0.15	0.37	4.67 (c)
Developing countries	1.79	2.28	2.21	2.44	3.03	2.34 (c)
ALADI	1.92	1.73	2.04	2.60	2.50	6.93 (c)
Africa	2.11	3.21	1.78	2.63	4.19	1.93 (c)
Middle East	1.48	2.51	1.66	2.27	5.81	1.20 (c)
Asia, other	1.68	2.50	0.79	1.73	1.51	0.11 (c)
	passenger cars, excl. buses			motor-vehicle parts		
World	0.31	0.60	0.99	0.70	0.89	0.98
Developed countries	0.02	0.08	0.45	0.43	0.70	0.67
United States	0.00	0.00	0.00	0.45	0.71	0.94
Europe (d)	0.01	0.20	1.46	0.68	0.95	0.72
Developing countries	1.49	2.27	3.13	1.48	1.32	1.56
ALADI	1.31	1.92	3.83	1.53	0.75	0.82
Africa	2.77	4.62	2.74	0.79	1.49	1.17
Middle East	2.32	1.22	1.88	0.24	1.04	1.22
Asia, other	3.09	5.64	0.98	1.46	3.14	2.00
	buses		internal combustion engines (e)			
World	9.07 (f)	6.52	n.a. (g)	2.03 (f)	3.44	4.17
Developed countries	0.00 (f)	0.14	n.a. (g)	2.30 (f)	4.82	4.84
United States	0.00 (f)	0.02	n.a. (g)	0.01 (f)	2.06	4.91
Europe (d)	0.00 (f)	0.16	n.a. (g)	2.50 (f)	7.07	6.66
Developing countries	8.47 (f)	5.66	n.a. (g)	1.38 (f)	1.36	1.36
ALADI	8.04 (f)	7.38	n.a. (g)	1.58 (f)	2.11 (h)	1.78
Africa	20.38 (f)	7.19	n.a. (g)	0.09 (f)	0.56 (h)	1.38
Middle East	0.00 (f)	0.25	n.a. (g)	0.00 (f)	0.49 (h)	1.02
Asia, other	0.00 (f)	0.60	n.a. (g)	0.00 (f)	0.22 (h)	0.33
(a) Calculated according to the following formula: $EXPR_{ij} = \frac{X_{ij}}{X_{mj}} / \frac{XW_{ij}}{XW_{mj}}$ ; where						
X = Brazilian exports; XW = world exports; i = SITC categories 732, 7321, 7322, 7323, 7328, and 7115 respectively; j = destination; m = total manufactured export items (i.e., SITC categories 5 + 6 - 67 - 68 + 7 + 8). - (b) Period averages. - (c) 1982-1984; buses included. - (d) EC (10) plus EFTA. - (e) Other than aircraft engines, i.e., engines for ships included. - (f) 1974-1975. - (g) Separate data on Brazilian exports of buses not available. - (h) 1976, 1977, and 1980.						

Source: UN [a; b; d; e]; own calculations.

to have contributed a lot to Brazil's favourable export performance in the Third World.

Similarities in demand can be assumed to be most relevant for completely *built-up vehicles and CKD-sets* or assembly. This would explain why export-performance ratios for passenger cars and commercial vehicles exported to developing countries exceeded the corresponding ratios for autoparts and engines (Table 9). Moreover, Brazil did not face strong competition from other non-traditional suppliers in exporting vehicles to third-world markets throughout the 1970s. Table A4 shows that South Korea did not yet play any significant role in world-automobile markets, irrespective of which market or which product is considered. A different picture emerged for Spain: though successful in world markets since the mid-1970s, in particular as concerns passenger cars, Brazil's market position was hardly challenged by Spain, since Spanish exports were mainly directed towards developed countries in Europe (1). Competitive pressures from other low-cost locations than Brazil were much stronger in the case of *autoparts*. For example, Mexico and Taiwan largely concentrated on parts and components in their attempt to enter world-automotive markets (2).

Probably, it was partly due to Mexico's success that Brazil's performance ratios deteriorated significantly for exports of autoparts to ALADI-countries. In the early 1980s, some losses were also incurred for trucks, but most of the ratios calculated for finished vehicles continued to be significantly above 1. Whereas Brazil's market position in vehicles was most seriously affected in the Far East, it rather improved in the ALADI region. From the latter result, it appears that the drastic trade restrictions introduced by many Latin American economies facing unmanageable foreign debt problems were mainly aimed at the relatively sophisticated or even luxury imports of automobiles from advanced countries. The remarkable decline of Brazil's export-performance ratios in the Far East was probably caused by intensified attempts of Asian countries to estab-

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- (1) In 1981-1984, the EC and EFTA together accounted for more than 80 per cent of total Spanish exports of road-motor vehicles; see UN [a].
  - (2) In 1975, for example, finished vehicles accounted for only 7 per cent of total automotive exports from Mexico [O'Brien, Lobo Aleu, 1984, p. 138; see also Jenkins, 1977, pp. 215 ff.].

lish a domestic automobile industry (1). Many Asian producers entered into joint ventures or licencing arrangements with major automobile companies, in particular Japanese multinationals, which is likely to affect the market shares of third countries in Asia in the future as well (2). Brazilian automotive exports to Asia may also suffer from this development. To a lesser extent and with some delay, this may also apply to other regions (3). The competitive pressure may still increase, when the South-Korean attack on world-automobile markets (not yet reflected in the EXPR-calculations of Table A4, but recently launched in Canada and the United States (4)) gains impetus and extends to third-world markets.

Brazil's competitive edge in third-world markets may be eroded further, if similarities in demand become less strict, with Brazil turning to the more sophisticated markets of developed economies. From Table 9, it appears that the country's revealed comparative advantage in advanced markets has considerably improved since the early 1970s, although notable differences prevailed between different items shipped to the United States and Europe. EXPRs were:

- by far the highest for exports of engines to both regions,

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- (1) See e.g. The Economist Intelligence Unit (EIU) [1985]; Odaka [1983]; O'Brien [1983]. In Asia, "South Korea and Taiwan have captured the limelight in the short to medium term, while presumably China is the long term target for the corporations" [EIU, 1985, p. 1]. Within the Association of South-East-Asian Nations (ASEAN), Malaysia has by now become the centre for passenger-car production and Indonesia the centre for production of commercial vehicles. The preponderance of those two countries is likely to increase [ibid, p. 9]. Malaysia has recently announced its project of a "national car" and Indonesia is pushing ahead with investments for domestic production of major components.
  - (2) For the dominance of Japanese companies as regards foreign participation in ASEAN-automotive industries, see EIU [1985, pp. 13 ff.]; for a broader overview on the multinationals' involvement in developing countries, see Schnell [1981, pp. 142 ff.]; O'Brien, Lobo Aleu [1984, p. 118].
  - (3) For example, Japanese multinationals are trying to break into the Latin American automotive markets (e.g. by joint ventures in Mexico and the ANDEAN region; O'Brien, Lobo Aleu [1984, p. 119].
  - (4) For further information on the Korean strategy, see Oh [1986]; Becker [1987]; Odrich [1986]; Frankfurter Allgemeine Zeitung, January 7, 1987.



- below "1" for other autoparts,
- extremely volatile for trucks and very poor for buses,
- virtually "0" for exports of passenger cars to the United States,
- drastically improving for exports of passenger cars to Europe.

High EXPRs for engines were due to the export strategy of US-based multinationals, whose sales to the United States consisted of engines in the first place, and FIAT's exports to Italy. FORD and GENERAL MOTORS did not ship passenger cars and commercial vehicles to any significant extent to the United States (1). On the contrary, FIAT'S exports to Europe were not restricted to engines, but consisted to a considerable degree of finished cars as well. It was mainly due to FIAT that EXPRs reached levels considerably above 1 in the early 1980s, whereas VWB was most reluctant to enter European markets (2). Firm-specific differences in export strategies represent the major reason responsible for the remarkably high differences in export-performance ratios for the United States on the one hand and Europe on the other hand, especially as regards passenger cars.

From the relatively low EXPRs for autoparts, other than engines, it appears that most of the multinationals did not fully integrate their Brazilian plants into the worldwide sourcing of parts and components. However, low EXPRs may also indicate that the international competitiveness of part suppliers was not as favourable as was sometimes assumed [see e.g. Stevens, 1987, p. 35]. The principal focus continued to be on the internal market of Brazil. The bulk of parts and components produced in Brazil was absorbed by the domestic assemblers, so that the country's integration into the pattern of worldwide sourcing (predicted by the world-car scenario) remained largely restricted to engines. Re-

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(1) As regards trucks, high EXPRs for the United States have to be attributed to exports by MBB (firm-specific information on exports of all major suppliers to different regions are from MBB [1985]).

(2) In the literature, it was especially referred to VOLKSWAGEN when arguing that the parent companies of multinationals set limits to the subsidiaries' world-market activities [see e.g. Dicke, 1978, p. 36]. It is interesting to note, however, that VWB in its recent attempt to enter the US-market by exporting Foxes will provide a first test as concerns Brazil's competitive position in the United States.

cently, the assemblers faced considerable shortages in parts and components. Apart from short-term frictions in deliveries due to price distortions in the aftermath of the "Plano Cruzado", some observers are also concerned that investments in autoparts production were insufficient to keep pace with the expansion in demand of the domestic "montadores". Consequently, a significantly greater role of Brazil in world-autopart markets would be unlikely in the near future.

All in all, it is plausible to argue that Brazil's export potential was not fully realized in the past. The parent companies in the industrialized countries seemed reluctant to see their traditional markets usurped by their Brazilian subsidiaries. Moreover, misguided economic policies of the Brazilian government may have caused serious internal bottlenecks to a more favourable export performance. This refers especially to restrictions of automotive imports. Worldwide sourcing and going ahead with the world-car strategy would have required that automotive items could easily flow at world-market prices to Brazil as well.

#### b. Price Competitiveness in Europe and the United States

A country's competitive position in world markets depends on a composite of price and various non-price parameters, such as quality, aftersales service, timeliness of deliveries etc. Whereas the export-performance ratios presented in the preceding section reflected the combined impact of all these elements, the focus is on price competitiveness in the following. This is appropriate since the product price can be assumed to be the most important element within the bundle of factors influencing a country's export performance. For automotive items produced in Brazil, this was most likely to be true in the recent past; most observers agree that former disadvantages in the quality of automobiles and major parts have been largely overcome in the meantime (1). Moreover, a closer look at price competitiveness is required because, in the subsequent sections,

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(1) See e.g. Stevens [1987, p. 35]; Gooding [1984]. For example, it is said that engines for the Monza produced by GENERAL MOTORS DO BRASIL were of a higher quality than those produced in Europe and the United States.

we aim at tracing price and cost differentials to major cost elements such as labour and material costs.

Due to data availability, the analysis is restricted to the US- and European markets, where the market shares of Brazil were still very low for many items. The evidence presented in Tables 10 and 11 refers to the most disaggregated level reported in US- and EC-import statistics. However, Brazilian exports may have been of a very specific nature and thus not representative of the import items subsumed under the respective category. This is most likely to happen where import categories consisted of a rather heterogeneous set of products. The analysis is based on unit values rather than import prices, for which comparable information was not available. The former were calculated by dividing import values (in US \$ and Ecu respectively) by the weight of imports or the number of imported items. The degree of distortions caused by this approximation is again closely connected with the degree of heterogeneity inherent in the trade classification.

International trade in automotive items to a considerable degree consisted of intra-firm trade. This was particularly true for Brazilian exports to developed countries. Hence, it depends on internal transfer-pricing practices of multinationals whether Brazil's price competitiveness is correctly reflected in the following calculations. For example, the competitive position of Brazil in US- and European markets would be overstated, if the parent companies imported inputs from their Brazilian subsidiaries at prices which were more favourable than market terms. However, the approach is clearly superior to conceivable alternatives, when the focus is on price competitiveness in an international perspective (1). Tables 10 and 11 concentrate on the 1980s, since it was only then that Brazil's exports to the United States and Europe reached notable amounts. Moreover, due to the concentration on autoparts in exporting to the United States, price comparisons for finished vehicles are confined to European importing countries (Table 10).

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(1) To support the notion of increasing efficiency of the Brazilian automobile industry, the World Bank [1983, pp. 122 ff.] referred to declining retail prices for cars, relative to the Brazilian consumer-price index, for example.

Table 10 - Unit Values of EC-Imports of Motor Vehicles and Selected Automotive Parts (a) from Brazil and Other Countries, 1982-1985 (Ecu)

Item	Nimesxe classification	Brazil					World (b)				
		unit values				market share (e)	unit values				market share (e)
		1982	1983	1984	1985		1982	1983	1984	1985	
Buses (engine cap. < 2500 cm <sup>3</sup> )	8702.12	-	-	3.7 (3221)	3.9 (3280)	1.86	-	-	5.7 (7933)	5.6 (8149)	100
Cars (engine cap. max. 1500 cm <sup>3</sup> )	8702.21	4.9 (3947)	4.8 (3890)	5.0 (3992)	4.9 (3971)	1.50	4.2 (3336)	4.4 (3569)	4.8 (3731)	5.0 (3941)	100
Cars (engine cap. 1500 - 3000 cm <sup>3</sup> )	8702.23	5.9 (5071)	4.4 (4138)	4.2 (3692)	4.6 (3945)	0.03	5.5 (5719)	6.1 (6371)	6.3 (6620)	6.9 (7152)	100
Dumpers (engine cap. > 10000 cm <sup>3</sup> )	8702.76	-	5.9 (62444)	-	-	-1.11	-	4.1 (87868)	-	-	100
Lorries (engine cap. > 2500 cm <sup>3</sup> )	8702.81	5.5 (39208)	-	-	3.8 (24585)	0.17	4.5 (19871)	-	-	5.5 (20089)	100
Lorries (engine cap. max. 2500 cm <sup>3</sup> )	8702.86	4.4 (3614)	4.6 (3847)	5.2 (4495)	5.5 (4859)	4.26	4.2 (5013)	4.4 (5168)	4.8 (4934)	5.0 (5962)	100
Motor veh. for transport of goods with engines other than spark or compression ignition	8702.91	-	8.9 (3579)	-	-	28.19	-	4.4 (5917)	-	-	100
Concrete-pumping vehicles	8703.40	-	-	8.9 (115333)	-	2.65	-	-	4.0 (61825)	-	100
Chassis for motor veh. (pass. cap. < 15 or engine cap. > 2500 cm <sup>3</sup> )	8704.11	8.6 (3420)	-	-	-	12.76	6.5 (14648)	-	-	-	100
Parts for industrial assembly of tractors, pass. veh. and lorries	8706.11	5.3	6.4	6.0	6.2	0.23	2.9	3.4	3.7	4.0	100
Wheel stars(g)	8706.21	-	2.7	-	-	1.35	-	2.3	-	-	100
Bumpers and parts(g)	8706.26	2.6	3.7	5.5	4.0	0.44	4.8	5.2	5.4	6.2	100
Other parts of bodies(g)	8706.28	4.4	7.6	3.8	5.1	0.40	3.6	3.6	3.6	3.8	100
Gear boxes(g)	8706.31	-	8.5	-(f)	-	0.04	-	7.7	8.2	-	100
Wheels and parts(g)	8706.41	2.4	2.5	2.5	2.2	0.66	1.8	1.9	2.0	2.0	100
Non-driving axles(g)	8706.49	-	-	-	1.0	0.32	-	-	-	3.6	100
Shock absorbers(g)	8706.51	2.7	2.6	2.9	2.5	0.75	4.7	5.0	5.2	5.4	100
Radiators and parts(g)	8706.55	12.7	-	11.8	10.3	0.17	5.2	-	5.7	5.8	100
Mounted pads for disc brakes(g)	8706.71	2.4	4.1	2.2	2.3	3.52	4.3	4.7	4.4	3.5	100
Parts and accessories of motor vehicles nes.	8706.99	1.6	2.9	3.6	4.1	0.46	3.9	4.1	4.3	4.4	100
Compression-ignition engines for veh. of power of max. 50 kw	8406.70	11.6 (2386)	9.3 (1072)	9.8 (1054)	9.7 (1131)	79.54	4.0 (830)	6.2 (905)	7.8 (975)	9.1 (1124)	100
Compression-ignition engines for veh. of power of 50-100 kw	8406.71	9.0 (3621)	8.4 (1567)	9.5 (3683)	-(h)	9.09	6.7 (1839)	7.5 (-)	7.8 (1633)	9.1 (1996)	100
Compression-ignition engines for veh. of power of 100-200 kw	8406.72	6.3 (5339)	3.6 (2395)	5.1 (4483)	4.7 (2965)	3.46	5.8 (3486)	6.6 (3454)	6.9 (4715)	7.4 (5334)	100
Compression-ignition engines for veh. of power of > 200 kw	8406.73	-	-	-	6.8 (9268)	1.59	-	-	-	11.4 (10503)	100

(a) Import values (Ecu) divided by the weight of imports (in parentheses: divided by the number of imported items); "-" where imports from Brazil are not reported. - (b) Intra-EC trade included. - (c) Non-EC countries. - (d) Brazil excluded. - (e) For years for which Brazilian exports are reported (per cent). -

Table 10 continued

Item	Nimex classification	Industrialized countries (c)					Developing countries (d)				
		unit values				market share (e)	unit values				market share (e)
		1982	1983	1984	1985		1982	1983	1984	1985	
Buses (engine cap. < 2500 cm <sup>3</sup> )	8702.12	-	-	4.6 (5408)	5.4 (6133)	12.75	-	-	-	-	0.00
Cars (engine cap. max. 1500 cm <sup>3</sup> )	8702.21	3.9 (3012)	4.3 (3312)	4.8 (3541)	4.9 (3768)	34.54	3.7 (3016)	3.8 (3065)	4.0 (3193)	4.4 (3674)	0.58
Cars (engine cap. 1500 - 3000 cm <sup>3</sup> )	8702.23	4.5 (4793)	5.0 (5323)	5.5 (5941)	5.8 (6224)	19.50	5.3 (6397)	7.4 (9436)	5.3 (5405)	6.5 (6599)	0.09
Dumpers (engine cap. > 10000 cm <sup>3</sup> )	8702.76	-	4.5 (111641)	-	-	46.02	-	1.6 (32261)	-	-	1.46
Lorries (engine cap. > 2500 cm <sup>3</sup> )	8702.81	5.0 (19659)	-	-	6.3 (24204)	20.33	5.0 (40636)	-	-	5.1 (22429)	0.04
Lorries (engine cap. max. 2500 cm <sup>3</sup> )	8702.86	3.8 (3653)	4.1 (4325)	4.5 (3308)	4.7 (4880)	31.53	3.7 (3303)	4.0 (3637)	-(f)	4.0 (4064)	0.31
Motor veh. for transport of goods with engines other than spark or compression ignition	8702.91	-	6.4 (4662)	-	-	11.78	-	-	-	-	0.00
Concrete-pumping vehicles	8703.40	-	-	2.2 (32450)	-	4.98	-	-	1.9 (45500)	-	1.40
Chassis for motor veh. (pass. cap. < 15 or engine cap. 2500 cm <sup>3</sup> )	8704.11	5.7 (12000)	-	-	-	1.12	-	-	-	-	0.00
Parts for industrial assembly of tractors, pass. veh. and lorries	8706.11	4.0	4.6	4.8	5.9	23.91	1.9	2.7	2.4	2.8	0.44
Wheel stars (g)	8706.21	-	2.3	-	-	45.92	-	-(f)	-	-	0.20
Bumpers and parts (g)	8706.26	5.5	5.8	6.2	6.4	36.09	3.6	5.4	5.6	5.5	0.59
Other parts of bodies (g)	8706.28	4.5	4.2	4.3	4.1	16.97	2.4	4.6	4.1	4.1	0.65
Gear boxes (g)	8706.31	-	7.4	8.8	-	29.09	-	8.5	10.9	-	0.08
Wheels and parts (g)	8706.41	1.7	1.7	1.8	1.8	18.72	3.2	4.5	5.5	4.4	0.53
Non-driving axles (g)	8706.49	-	-	-	2.3	5.50	-	-	-	4.1	0.26
Shock absorbers (g)	8706.51	3.7	3.8	4.1	4.1	15.30	5.3	4.1	4.4	3.8	0.23
Radiators and parts (g)	8706.55	5.0	-	5.9	5.3	27.32	4.4	-	4.5	2.2	2.25
Mounted pads for disc brakes (g)	8706.71	3.9	4.1	4.2	2.6	13.88	-(f)	-(f)	7.9	-(f)	0.15
Parts and accessories of motor vehicles	8706.99	4.2	4.4	4.7	4.5	17.85	4.4	5.0	3.9	5.9	0.34
Compression-ignition engines for veh. of power of max. 50 kw	8406.70	2.8 (715)	2.1 (442)	2.3 (506)	4.4 (991)	2.23	-(f)	-(f)	-(f)	-(f)	0.09
Compression-ignition engines for veh. of power of 50-100 kw	8406.71	6.3 (973)	11.5 (2121)	11.5 (2259)	11.9 (2259)	32.06	-(f)	-(f)	-(f)	2.2 (i) (1544)	0.23
Compression-ignition engines for veh. of power of 100-200 kw	8406.72	5.4 (2899)	7.0 (3569)	7.7 (5580)	7.7 (4981)	34.27	-(f)	-(f)	-(f)	4.8 (3793)	0.10
Compression-ignition engines for veh. of power of > 200 kw	8406.73	-	-	-	11.9 (11374)	22.82	-	-	-	10.8 (6703)	0.20

(f) Not calculated since only minimal imports are reported. - (g) Not for industrial assembly. - (h) Not calculated because of apparently wrong figures or inconsistencies in the source. - (i) Brazil included.

Source: EUROSTAT [a, various issues]; own calculations.

Table 11 - US-Imports of Selected Automotive Items (a): Unit Values, Transport Costs (b) and Market Shares (c) of Brazil, Mexico and Japan, 1980-1984 (d)

Imported item (TSUSA classification)	Total exporting countries		Brazil			Mexico			Japan			
	unit value	average transport costs	unit value	average transport costs	market share	unit value	average transport costs	market share	unit value	average transport costs	market share	
	US \$				per cent	US \$		per cent	US \$		per cent	
Automobile, truck and bus engines, piston-type, except diesel (6604850)	1980	613.4	12.1	373.7	13.6	9.5	695.3	0.04	10.7	834.0	36.5	27.6
	1981	631.4	14.6	372.0	16.4	6.6	706.8	0.04	24.5	778.0	29.3	40.8
	1982	799.6	16.6	934.4	36.1	23.1	822.0	-	40.8	725.1	28.8	24.3
	1984	776.4	20.8	615.8	39.1	19.4	942.0	0.10	50.9	750.8	40.4	11.5
Connecting rods for piston-type auto engines, except diesel (6606707)	1980	2.9	0.13	17.0	0.67	8.8	-	-	-	3.7	0.22	57.1
	1981	3.2	0.14	-	-	-	-	-	-	3.1	0.22	51.6
	1982	(1.8)	(0.08)	-	-	-	-	-	-	(1.5)	(0.11)	-
	1984	5.4	1.50	-	-	-	-	-	-	4.4	1.90	57.5
		(2.2)	(0.59)	-	-	-	-	-	-	(1.7)	(0.74)	-
	1984	4.7	0.26	5.4	0.34	5.4	6.4	-	34.7	4.2	0.44	43.9
		(1.5)	(0.08)	(1.0)	(0.07)	-	(1.7)	(-)	-	(1.3)	(0.13)	-
Crankshafts for piston-type auto engines, except diesel (6606713)	1980	35.3	2.5	19.6	1.4	8.2	-	-	-	34.7	2.9	63.9
	1981	38.8	2.6	103.9	4.0	4.2	-	-	-	34.6	2.5	0.7
	1982	(0.90)	(0.06)	(4.7)	(0.18)	-	-	-	-	(0.77)	(0.06)	-
	1984	31.0	2.1	22.0	2.8	15.4	-	-	-	41.6	2.5	52.6
		(0.95)	(0.06)	(n.a.)	(n.a.)	-	-	-	-	(1.60)	(0.10)	-
	1984	15.4	1.0	19.8	2.3	22.0	43.8	-	21.0	16.1	1.8	26.1
		(0.62)	(0.04)	(0.52)	(0.06)	-	(1.83)	(-)	-	(1.20)	(0.14)	-
Connecting rods for piston-type auto diesel engines (6607107)	1980	8.3	0.23	-	-	-	-	-	-	6.8	0.38	43.7
	1981	(1.1)	(0.03)	-	-	-	-	-	-	(0.92)	(0.92)	-
	1982	6.8	0.31	-	-	-	-	-	-	6.0	0.34	63.7
	1984	(0.97)	(0.04)	-	-	-	-	-	-	(0.86)	(0.05)	-
		6.2	0.23	-	-	-	-	-	-	5.8	0.32	55.0
		(1.2)	(0.05)	-	-	-	-	-	-	(0.88)	(0.05)	-
	1984	2.9	0.18	8.4	0.32	10.3	-	-	-	4.4	0.27	39.7
		(1.4)	(0.09)	(2.2)	(0.08)	-	-	-	-	(0.90)	(0.05)	-
Crankshafts for piston-type auto diesel engines (6607113)	1980	74.6	5.4	-	-	-	-	-	-	67.9	5.2	81.5
	1981	(0.70)	(0.05)	-	-	-	-	-	-	(0.78)	(0.06)	-
	1982	187.1	13.3	53.6	9.1	1.3	-	-	-	162.9	12.4	61.2
	1984	(0.73)	(0.05)	(0.43)	(0.07)	-	-	-	-	(0.63)	(0.05)	-

Table 11 continued

	1982	154.4	8.7	225.8	5.8	10.2	-	-	-	104.6	7.7	44.3
		(0.85)	(0.05)	(2.46)	(0.06)					(0.69)	(0.05)	
	1984	103.5	7.3	200.8	8.8	14.0	-	-	-	59.8	5.1	41.9
		(0.82)	(0.06)	(1.50)	(0.06)					(0.68)	(0.06)	
Motor-vehicle pumps	1980	9.5	0.44	8.3	0.34	7.2	13.9	0.10	0.7	6.8	0.46	3.7
for liquids	1981	9.5	0.38	10.2	0.49	9.2	-	-	-	6.6	0.38	37.5
(6609702)	1982	7.7	0.37	9.3	0.45	9.5	7.6	0.27	0.3	5.5	0.33	39.6
	1984	5.9	0.31	5.6	0.48	2.8	14.2	0.52	2.4	6.1	0.40	41.0
Starting motors	1980	31.1	0.91	9.7	1.21	0.5	-	-	-	28.1	1.0	41.9
(6836040)	1981	29.7	1.33	6.0	0.34	0.2	-	-	-	31.7	1.2	50.0
	1982	28.8	0.96	16.1	0.77	0.5	-	-	-	29.8	1.0	55.1
	1984	27.3	1.17	21.0	1.46	0.5	-	-	-	27.3	1.3	54.0
Chassis for trucks,	1980	10358.5	1849.6	9962.6	2236.8	74.2	10696.0	-	3.6	4582.1	350.8	1.6
exc. gasoline,	1981	10381.7	1301.6	10159.1	1345.8	92.4	14082.0	73.8	5.3	-	-	-
19500-26000 lbs.	1982	11390.0	1374.0	11066.7	1398.8	85.8	11385.7	171.4	3.6	-	-	-
(6922054)	1984	13921.1	1107.9	9446.9	1078.5	35.1	-	-	-	12000.0	1108.1	1.3
Chassis for trucks,	1980	13562.6	3058.3	12207.8	6413.7	36.4	13000.0	-	3.4	-	-	-
exc. gasoline,	1981	13906.3	1571.8	12817.8	1672.0	57.0	-	-	-	-	-	-
26000-33000 lbs.	1982	11683.3	1204.6	13822.8	1391.7	18.7	-	-	-	-	-	-
(6922056)	1984	13197.1	1513.1	10163.3	1081.6	35.9	-	-	-	10397.5	906.8	3.2
Axle spindles for	1980	13.6	1.0	-	-	-	-	-	-	-	-	-
motor vehicles		(0.8)	(0.06)									
(6923207)	1981	15.8	0.94	27.6	4.2	1.8	-	-	-	-	-	-
		(0.8)	(0.05)	(1.9)	(0.29)							
	1982	30.9	0.88	-	-	-	-	-	-	418.4	4.8	55.4
		(2.0)	(0.06)							(7.2)	(0.08)	
	1984	42.8	2.4	47.1	5.6	0.2	-	-	-	160.9	8.8	73.2
		(1.7)	(0.10)	(0.9)	(0.10)					(2.4)	(0.13)	
Complete radiators												
for motor vehicles												
(6923242) (e)	1984	52.8	3.4	32.1	3.6	1.4	102.3	0.2	2.5	49.1	5.4	25.5

(a) Only those items are presented in the table for which Brazilian exports to the United States are significant. APTA-imports from Canada are neglected, i.e., market shares for some items are significantly overstated. - (b) Unit values and transport costs are in US \$ per number of imported item (in parentheses: per pound of imports); transport costs are approximated by "charges" for imports as reported in the source, i.e., by the difference between cif-value of imports and customs value. - (c) As indicated by the custom value of imports. - (d) No statistical information was available for 1983. - (e) 1980-1982: not available.

Quelle: U.S. Department of Commerce [b, various issues]; own calculations.

For both *passenger cars* and *commercial vehicles*, EC-import statistics differentiate between vehicles of different engine capacity. Though considerably reduced, the heterogeneity of products belonging to an import category remains significant, in particular in the upper-size classes where Brazilian market shares were extremely low altogether. As regards vehicles of lower engine capacity, the calculations point to clear advantages of Brazil for buses, irrespective of whether trade values were divided by the weight of imports or the number of imported units. It is interesting to note that the production of buses is frequently considered to be more labour-intensive than the production of trucks and passenger cars (for an empirical investigation, see Section B.IV.1). For lorries, the results are less straightforward. Per unit of imported lorries, prices of imports from Brazil were considerably below prices for intra-EC trade in lorries (1). However, unit values per ton of EC-imports were slightly higher for Brazilian products. Since the latter measure seems better suited to reduce distortions arising from product heterogeneity, the former result is rather likely to overstate the price competitiveness of Brazilian lorries in EC-markets. As concerns relatively small passenger cars, price disadvantages appeared for Brazil in the magnitude of roughly 15-30 per cent in 1982 and 10-15 per cent in 1983 as against imports from industrialized countries (2). Subsequently, price differentials were further reduced so that only very small differences in prices of imports from different sources prevailed in 1985. Brazil's competitive position improved most significantly relative to industrialized countries, both within and outside the EC.

For EC-imports of autoparts, disaggregated information was only available for spare parts, i.e., imports for the aftermarket rather than industrial assembly. Table 10 shows that the price competitiveness of Brazilian *parts suppliers* varied widely between different items. Clearly

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- (1) Most of world exports into EC countries originated from other EC countries.
  - (2) The lower-end figures applied when Brazil's exports were compared with intra-EC trade, which accounted for the bulk of world exports to the EC, whereas the upper-end figures were mainly due to relatively cheap EC-imports from Japan. Price differentials were also relatively high, when Brazil was compared with other developing countries, which was presumably due to Spanish exports in particular.



competitive prices were calculated for Brazilian exports of bumpers, shock absorbers and pads for disc brakes, whereas radiators and wheels from other sources than Brazil were relatively cheap, for example. Apart from distortions due to the aforementioned conceptual limitations, various other factors may have caused the contrasting results (1).

- Exporters of automotive items may have benefited to different degrees from export incentives provided by the Brazilian government. For example, firm-specific BEFIEEX-programs (2) were concentrated on a small number of relatively large companies and may have discriminated small and medium-sized parts suppliers [World Bank, 1983, p. 58].
- Presumably, the production of autoparts was subject to economies of scale to different degrees, and the potential of per-unit-cost reductions in the autoparts industry was realized to different degrees as well.
- Most importantly perhaps, factor intensities varied between different branches of the autoparts industry [see also Johnston, 1982].

The relative importance of these factors in explaining the differences in Brazil's competitive position between sub-branches of the autoparts industry can hardly be assessed at this fairly disaggregated level. However, Sections B.III.2 and B.IV will provide a more general analysis of the issues involved.

The results of Tables 10 and 11 have to be interpreted with considerable caution in the case of *engines*, because of the overriding importance of intra-firm trade and distortions arising from under or over-invoicing in internal transfer pricing. Actually, it is hardly plausible from a macro-economic standpoint that unit values of EC-imports from Brazil were relatively low for high-powered engines, vis-à-vis imports from other

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(1) For a detailed discussion of major factors determining the competitive position of NICs in autoparts production, see Johnston [1982]; Fujimoto [1983, pp. 32 ff.]; the latter source also presents product-specific price comparisons of South-Korean-made parts and imported parts for 1976.

(2) BEFIEEX stands for Benefícios Fiscais a Programas Especiais de Exportação and is a system of enterprise-specific export-incentive packages provided in return for a commitment to reach agreed export targets over a specific period.

sources, but considerably higher for the lower size classes, whereas the penetration of EC-markets by Brazil was by far the strongest for engines of up to 50 kw. Probably, parent companies shifted resources to Brazilian subsidiaries by paying for inputs at better than market terms, for example in order to comply with export commitments previously agreed upon in BEFIEX-programs (1).

Brazilian exports of engines to the United States appeared to be cheaper than US-imports from other sources (Tables 11 and A5). The price differences were very high in 1979-1981, so that it is rather unlikely that they have to be attributed to product heterogeneity exclusively. Apart from changes in the product mix (2), the heavy fluctuations in unit values of US-imports of engines from Brazil to be observed in the 1980s were partly caused by casual maxi-devaluations on the one hand and interim-periods of an overvalued Cruzeiro on the other hand (3). The impact of exchange-rate variations is also felt for other automotive items exported to the United States. Consequently, Brazil's competitive position varied considerably over time. Moreover, no general conclusion can be drawn on the price competitiveness of different autoparts, as was the case for EC-markets as well (4). Apart from engines, Brazil was most

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- (1) The first round of BEFIEX-programs, involving the most important automobile producers, was approved in the first half of the 1970s [for detailed information, see Guimarães, Gadelha, 1980, Table 2.9; Crissiuma, 1986, p. 138]. With export targets generally agreed for a period of 10 years, the pressure to fulfill the commitments culminated in the early 1980s, when the demand for Brazilian exports in the traditional third-world markets was seriously depressed. But it was most important to comply with previously agreed export targets, in order to qualify for follow-up programs and because otherwise fiscal incentives and remitted import duties had to be paid back.
  - (2) Firm-specific information on Brazilian exports to the United States for one major company indicate that high-powered engines gained in importance after 1981, the export prices of which were more than twice as high as for smaller engines.
  - (3) Up to the late 1970s, Brazilian authorities implemented a passive crawling peg that closely followed a purchasing-power-parity rule. Subsequently, however, the exchange-rate policy became more volatile [for details, see Nunnenkamp, Fasano-Filho, 1986, pp. 78 ff.; see also Section B.IV.2.a].
  - (4) Conflicting results are also to be observed when unit-value calculations of Table 11 are compared with figures for similar items in Table 10. For example, unit values for radiators imported from Brazil were relatively low in the United States, but relatively high in Europe.

likely to have a competitive edge for starting motors and chassis for trucks (1).

Despite the remarkable differences at the product level indicated by the preceding unit-value calculations, the quantitative assessment of the revealed comparative advantages of the Brazilian automotive industry rather supports the notion that the country has established a fairly firm footing in world markets in the past. Apart from largely maintaining its position in third-world markets, Brazil succeeded to open up non-traditional markets in Europe and Northern America. Presumably, the country's export performance of the most recent past would have been improved, if Brazil had continued its exchange-rate policy of the 1970s, i.e., reducing uncertainties by foreseeable nominal devaluations, sufficiently strong to correct for international differences in inflation, and if the home countries of automobile multinationals had been better prepared to allow for a larger flow of imports from countries like Brazil. Section B.V will provide a more detailed discussion of the issues involved, since also the future export prospects of Brazil are likely to depend on the Brazilian course in economic policies and on the companies' ability and readiness to shift production to and export from the most competitive locations.

## *2. Production Costs in the Brazilian Automobile Industry: Major Cost Elements in International Perspective*

Most analyses of the Brazilian automobile industry in the early 1980s concluded that the industry has improved its efficiency and has recently produced vehicles at fairly high quality and competitive prices (2). Such results contrast sharply with earlier investigations, which generally agreed that vehicle prices and the costs of automobile production were significantly higher in developing countries as against the traditional suppliers. Thus, the question arises as to how the competitive position

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(1) International differences in transport costs are disregarded; for a discussion, see Section B.III.2.a.

(2) See e.g. Stevens [1987, p. 35]; World Bank [1983, pp. 122 ff.]; Mericle [1984, p. 1].

of automobile production in countries such as Brazil could have changed within 10-15 years. Though several hypotheses were raised in the literature, they were rarely subjected to empirical tests. The subsequent analysis aims at narrowing this gap, mainly by discussing the following hypotheses:

- Though no longer a typical third-world country, Brazil is still assumed to be relatively abundant of labour. Advantages in labour costs can thus be supposed to have outweighed remaining disadvantages in labour productivity (Section B.III.2.b).
- Generally, efficiency in automobile production was thought to be closely related to large production runs. In Section B.III.2.c, it is discussed to what extent economies of scale have been realized in the Brazilian automobile industry.
- The rich endowment with raw materials, in particular iron ore, may represent another cost advantage of Brazil, since automobile production is heavily dependent on inputs of steel and various non-ferrous metals (1). On the other hand, the resources available in Brazil may prevent the country from taking full advantage of lower priced world-market supplies. Section B.III.2.d tries to shed some light on these conflicting hypotheses.

Before dealing with the aforementioned major cost elements in some detail, a short overview on international cost comparisons, which were presented in the literature, will be given in the subsequent paragraphs.

#### a. Overview on International Cost Comparisons

Surprisingly enough, it was mainly in the late 1960s and early 1970s that international cost comparisons figured prominently in the literature. More recent information was hardly available so that, until the early 1980s, most studies continued to refer to the rather outdated evidence. The principal focus was placed on cost and price comparisons between tradi-

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(1) See e.g. Câmara de Comércio e Indústria Brasil-Alemanha [1986, p. 24].

tional automobile producers, in particular the United States, and Latin American countries, which were among the first in the Third World attempting to establish a domestic automobile industry. Apart from some country-specific studies (1), the pioneering work on international cost comparisons was done by Baranson [1968a; 1968b] and UN, Economic Commission for Latin America (CEPAL) [1974](2). Confronting Argentina, Brazil and Mexico with the United States, Baranson [1968b, p. 52] concluded that "production costs of the three leading automotive manufacturing countries in Latin America in 1965 ranged between 60 and 150% more than in the United States. A vehicle that costs approximately \$ 1660 to manufacture in Detroit averages about ... \$ 3000 in Brazil" (3). For light trucks, Brazilian production costs amounted to 171 per cent of those in the United States [ibid., 1968a]. High Brazilian import duties and taxes accounted for a significant share of the difference; net of surcharges, the cost differential was reduced to 28 per cent.

In the early 1970s, local content in Brazilian automobile production was near 100 per cent. As concerns total production costs, relative to developed countries, Brazil achieved the most favourable position among Latin American producers (CEPAL [1974, pp. 70 ff.]; for a summary, see Table A6). The cost differential of 35 per cent was considerably smaller than for the other producing countries (ranging from 45 and 53 per cent in Venezuela and Mexico to 164 per cent in Chile)(4). Due to

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- (1) For Argentina, see Sourrouille [1980, pp. 112 ff.], who summarized evidence presented by Baranson and the Argentine Asociación de Fábricas de Automotores; for Mexico, see Jenkins [1977, pp. 204 ff.].
  - (2) For a summarizing presentation, including evidence for India as well, see UN Centre on Transnational Corporations [1983, pp. 112 ff.].
  - (3) However, price differences (exclusive of value-added and excise taxes) varied significantly between specific models. Whereas for the FORD GALAXIE only half of the Brazilian price was to be paid in the United States in 1969, the price differential amounted to less than 40 per cent for the VW 1200 [Moore, 1980, p. 142].
  - (4) Cost differentials vis-à-vis world-market levels were likely to be somewhat understated for all Latin American producers, since it was mainly the United States which served as the reference country. US-production costs substantially exceeded Japanese production costs in particular [see e.g. Anderson, 1982; Altshuler et al., 1984, pp. 155 ff.; de Mautort et al., 1981].

extremely high sales taxes for automobiles, however, retail prices in Brazil were nearly twice as high as in developed countries (1).

Apart from domestic-market size as well as model and plant proliferation, the cost differences were mainly a function of local-content requirements imposed by the governments (for a graphical presentation, see Figure A4 in the statistical annex; for country-specific graphs, including Brazil, see Baranson [1968a, p. 32]). The latter factor was clearly reflected in the cost structure. In the production of light trucks, for example, total material inputs accounted for 72 per cent of total costs in Brazil, as against 46 per cent in the United States (for details, see Table A7). Evidently, the policy-imposed increase in domestically produced inputs caused considerable cost disadvantages for the Brazilian automobile industry, since the national autoparts industry was not prepared to provide its products at internationally competitive prices (2). Although the efficiency in autoparts production improved later on and some important policy changes were introduced (3), the principal lesson to be drawn from the experiences with local-content requirements seems still of some relevance. Presently, it is difficult or even impossible for Brazilian producers to import specific items at world-market terms (4), not to speak of the administrative costs to qualify for duty exemptions. Thus, the import policy of Brazil is still likely to be cost-increasing and creates a possible bottleneck to future export growth (see also Section B.V.3). Moreover, the high share of materials in total costs casts some doubts on the assumption that the rich domestic endowment with raw

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- (1) For conceivable repercussions of high domestic taxes on the export performance of the Brazilian automobile industry, see Section B.III.2.d.
  - (2) The automobile assemblers operating in Brazil were obliged to increase the local content of their production from 25-50 per cent in 1956/57 to 90-95 per cent within less than four years [Almeida, 1972, p. 38].
  - (3) Most importantly, duty-free imports were allowed for exporting enterprises, since the drawback system was put in operation in 1969.
  - (4) This refers especially to imports of machinery and equipment. Recently, the "Lei da Informática" defined the electronics industry as an area reserved for Brazilian-owned companies [Stevens, 1987, p. 33]. The import of machines may be illegal if it contains some form of electronic control.

materials necessarily was an advantage in automobile production (see also Section B.III.2.d).

More recent information on the production costs of automobile companies is extremely sketchy, so that a sound basis for a systematic up-date of earlier international comparisons is largely lacking. Yet, it was concluded in the literature that the cost effectiveness has improved remarkably in Brazilian automobile production. This statement was based on price rather than cost comparisons (1).

- In 1980/81, direct price comparisons indicated that the prices of Brazilian vehicles were lower than those of similar foreign models [World Bank, 1983, p. 122]. According to implicit-tariff calculations, international prices exceeded internal prices by 23 per cent on average. For commercial vehicles, the difference was even twice as high. Some of these differences were probably due to the fact that local vehicles were not strictly comparable to foreign vehicles. The remaining quality-adjusted price differences were attributed to relatively low prices of components (such as engines), autoparts and major materials (such as iron and steel) in Brazil (2).
- Based on ANFAVEA-figures, Stevens [1987, p. 35] presented price comparisons for a middle-range car which pointed to significantly lower car prices in Brazil as well, relative to major industrialized countries (Table 12). The price advantage was attributed to very low labour costs, low raw-material, energy and environmental costs, generous investment and export incentives, as well as efficient autoparts supplies. It was supposed that high capital and financial costs were over-compensated. The relative importance of cost factors remained unclear, however (3).

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- (1) Retail prices were also compared for Asian countries; results for the late 1970s were presented by Fujimoto [1983, pp. 29 ff.]; Prud'homme [1984b, p. 68].
  - (2) Price comparisons of 1980/81 resulted in implicit tariff rates for pig-iron alloys and primary steel of -13.7 per cent, for iron and steel sheets of -8.5 per cent, and for forgings of -16.4 per cent; only for castings, Brazilian prices exceeded international prices by 31.3 per cent [Tyler, 1981].
  - (3) The aforementioned price comparisons referred to ex-factory prices plus the dealers' margin. Including sales taxes, the situation was reversed. Taxes represented 63 per cent of the price of a new car

Table 12 - Retail Prices of a Middle-Range Car in Brazil and Major Industrialized Countries, July 1985 (Brazil = 100)

	Brazil	United States	Japan	West Germany
Excluding taxes	100	155	144	122
Including taxes (a)	163	162	156	148

(a) Before the tax increases of 1986.

Source: Stevens [1987, p. 35], based on ANFAVEA-figures.

It was argued in the literature that, in third-world countries, automobiles were sold at high prices in the protected domestic market, in order to allow for below-cost pricing for exports (1). International comparisons of retail prices would thus understate the cost effectiveness of automobile production in developing countries. However, price comparisons may be biased in the opposite direction as well. In Brazil, the possibilities of automobile firms to raise domestic prices were frequently limited by official price regulation (2). Sometimes only incurred cost increases could be passed on to the consumer; recently, the "Plano Cruzado" introduced an outright price stop which prohibited any price increases for automobiles [Fischer, 1986]. It is thus likely that the "price advantages" of Brazil indicated by negative implicit tariff rates were partly the result of government interventions into the price mechanism, rather than cost advantages.

The conceptual limitations of international price comparisons render cost analyses indispensable. As concerns NICs like Brazil, recent evidence on production costs is extremely limited for automobiles, but somewhat better for major components such as engines. Based on data provided by FORD, Crissiuma [1986, pp. 138 f.] confronted production costs for a Brazilian and a Japanese car in US \$-terms (Table 13). The cost disad-

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in Brazil in July 1985, as against 4 per cent (United States) to 33 per cent (France) in major developed countries [Stevens, 1987, p. 36].

- (1) For the South-Korean example, see Fujimoto [1983, pp. 29 ff.]; Becker [1987].
- (2) For details and the different systems of price-control policies adhered to in Brazil during the 1970s and 1980s, see Saes [1986, pp. 45 ff.].



Table 13 - Cost Comparison between a Japanese and a Brazilian Car, 1984 (US \$)

	Japan	Brazil
Labour costs	200	300
Materials	2500	3350
Administrative overheads	15	50
Other production costs(a)	80	165
Freight etc.	700	600
Total	3495	4465

(a) Presumably, mainly machine and capital costs.

Source: Crissiuma [1986, p. 139], on the basis of FORD-data.

vantage of roughly 1000 US \$ calculated for Brazil was mainly caused by significantly higher material costs, which again conflicts with the hypothesis that resource-rich countries such as Brazil enjoy cost advantages vis-à-vis resource-poor countries such as Japan. The high difference in material costs also casts some doubts on the notion that the autoparts industry contributed "more to the cost competitiveness of Brazilian vehicles than the automotive (assembly) industry itself" [Stevens, 1987, p. 35]. Labour and capital costs were also higher in Brazil, although the latter appeared to be less important than was to be expected. Most interestingly, the example presented in Table 13 does not support the hypothesis that industrial wages in Brazil were sufficiently low to compensate for disadvantages in productivity; Japan provided the most challenging yardstick in this respect, however.

Notwithstanding the disadvantages in production costs, Brazilian cars could be assumed to compete successfully with Japanese cars in world markets from a price standpoint. Brazilian export incentives were estimated to amount to about 1000 US \$ per unit, so that subsidy-adjusted costs for exported vehicles were roughly the same in Japan and Brazil [Crissiuma, 1986, pp. 138 f.]; (for a detailed analysis of the impact of policy interventions on export performance, see Section B.IV.2.) (1).

(1) The relevance of government incentives in third-world countries is also evident from an example of FORD's engine-sourcing alternatives, presented by Johnston [1981]. Without extra-benefits provided by

As regards major *components and autoparts*, international cost differences prevailing in the early 1980s were analysed in several studies on outsourcing of automotive inputs by US-manufacturers [Johnston, 1982; Laing, Rahn, 1983, pp. 38 ff.]. Differences in manufacturing costs were supposed to be largely a function of nominal wages and the productivity rate. "Thus, it would appear attractive to outsource products where the input of labour represents a large share of the value added. Any savings secured, however, must be offset against the cost of shipping the component to (probably) an assembly plant in Michigan" [Laing, Rahn, 1983, p. 38].

- In 1982, hourly wages (in US \$-terms) in the motor-vehicle industry were by far the highest in the United States (1). In Japan, Brazil, Mexico and South Korea, wages amounted to 37, 19, 18 and 10 per cent of US-wages respectively (2).
- In order to calculate productivity-adjusted labour costs, assumptions on the productivity ratio of competing countries, relative to the United States, are most critical. Whereas it was widely agreed that labour productivity in the Japanese automotive industry was higher than in the United States, the estimates presented in the literature for NICs varied widely. The cost comparisons of Laing and Rahn [1983] were based on assumed productivity ratios of 0.80 for Brazil, 0.85 for Mexico, and 0.90 for South Korea (United States = 1.00)(3). Thus,

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the Mexican government, only marginal differences in landed costs (cif Detroit) emerged, irrespective of whether the engines were purchased in Japan, built in the United States or built in Mexico. Accounting for increased import allowances and tax reductions, however, the Mexican alternative was clearly superior, since per-unit-engine costs were reduced by more than 30 per cent.

- (1) Data are from U.S. Department of Labor [1985b]; for more recent information, see Section B.III.2.b.
- (2) Evidently, international wage comparisons are sensitive to exchange-rate fluctuations. A strong (weak) US-Dollar increases (reduces) the differences for those countries whose currencies are not pegged to the US-Dollar. For a detailed discussion, see Picht [1987], Mayer [1983], and Section B.III.2.b.
- (3) These estimates were lower than those presented by Johnston [1982, Table II], who claimed that productivity in Brazil and Mexico was the same as in the United States in 1980, and even 20 per cent higher in South Korea. On the contrary, information on annual car production per employee, presented by Crissiuma [1986, p. 142], pointed to greater disadvantages of Brazil in labour productivity

productivity-adjusted labour costs were calculated at 27 per cent of those in the United States for Japan, 22-24 per cent for Mexico and Brazil, and 11 per cent for South Korea.

- Apart from differences in relative labour costs, the potential of cost reductions to be derived from outsourcing depends on the labour share in value added, which varied considerably between different autoparts and components (1). In US-manufacturing, the labour content was particularly high for starter motors, radiators, engine-wiring harnesses and front-coil springs (83-73 per cent), but significantly lower for transmissions (50 per cent) and engines (42 per cent).

From the preceding information, gross labour-cost savings for US-manufacturers from outsourcing could be calculated (Table 14)(2). If gross savings are set against the shipping costs, which varied from country to country (Table A8), net labour-cost savings per unit of the outsourced item can be compared between different locations. Brazil, Mexico, South Korea and Japan were assumed to benefit from outsourcing of US-production in the first place. The greatest potential of labour-cost savings existed for engines and transmissions (3). Ignoring transport costs, potential savings were of similar size in all locations. But Mexico had a clear advantage as against Brazil and Japan in net savings (4). This was due to significantly lower transport costs in the case of Mexico, whereas the Brazilian policy to keep freight rates high reduced the country's labour-cost advantage in world markets. The same pattern emerged for starter motors.

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(see Section B.III.2.b); relative to Japan, Brazilian productivity was less than 40 per cent.

- (1) Differences in material costs were neglected. According to the evidence presented earlier, the cost comparisons may thus be biased in favour of Brazil (see Section B.III.2.d).
- (2) This was done by multiplying the relative labour costs by the value of the labour content of the component in question.
- (3) As regards the extremely bulky car bodies, freight costs were excessive so that outsourcing was rather unlikely, with the possible exception of Mexico.
- (4) Laing, Rahn [1983, p. 41] considered it unlikely that US-manufacturers would import engines and transmissions to a considerable degree from South-East-Asian locations like South Korea. According to the calculations presented by Johnston [1982, p. 9], however, South Korea emerged as the country where the potential of net labour-cost savings was even higher than in Mexico.

Table 14 - Labour-Cost Savings for US-Manufacturers from Outsourcing of Various Autoparts and Components to Selected Countries, 1982 (US \$ per unit)

	Brazil		Mexico		South Korea		Japan	
	gross (a)	net (b)	gross (a)	net (b)	gross (a)	net (b)	gross (a)	net (b)
Engines	73	25	75	53	(89) (c)	(45) (c)	70	26
Transmissions	45	22	46	38	(55) (c)	(34) (c)	43	22
Starter motors	2.48	0.61	2.54	1.57	2.90	1.25	2.38	0.73
Radiators	1.09	-2.89	1.12	-0.02	1.28	-2.22	1.05	-2.43
Engine-wiring harnesses	1.12	-0.98	1.15	0.56	1.31	-0.41	1.07	-0.75

(a) Gross labour-cost savings were calculated by multiplying the relative productivity-adjusted wages (United States = 1.00) by the value of the labour content in US-manufacturing costs of the component in question. - (b) Gross labour-cost savings minus transport costs; for details as regards the latter, see Table A8. - (c) Not fully comparable to other figures, since the calculations are for 1980 rather than 1982, and based on Johnston's more optimistic productivity ratios for South Korea.

Source: Laing, Rahn [1983, pp. 41 f.]; Johnston [1982, p. 9]; Table A8.

Transport costs from São Paulo to Detroit were on average about three times as high as in the Mexican case and even higher than from Far-Eastern locations (Table A8)(1). The negative impact on Brazil's competitive position was most evident for radiators and engine-wiring harnesses, where net labour-cost savings were significantly negative. It is thus important for Brazil to remove this bottleneck to further export growth in the future, by allowing for more competition in the transportation of Brazilian automotive exports. The liberalization of officially regulated freight rates would narrow the locational advantage of Mexico in exporting to the United States and would also provide Brazil with an additional competitive edge in meeting the challenge from Far-Eastern countries like South Korea.

As concerns the future prospects of outsourcing automotive items to countries such as Brazil, it should be kept in mind, however, that the

(1) From Table 11, it is evident as well that Brazilian transport costs were generally higher than for the average of all other exporting countries, though the evidence was less straightforward as concerns the comparison between Brazil and Japan.

preceding calculations indicated the potential of cost savings. The extent to which possible cost savings will be realized depends on the ability and willingness of multinational automobile companies to relocate the production of components and parts to the countries offering cost savings. The rather slow and retarded path of relocation to be observed for the recent past (Section B.II) and excess capacities, for example in engine production, in both the United States and Europe render a large-scale transfer of parts production to Brazil and other NICs rather unlikely [Laing, Rahn, 1983, p. 40; Johnston, 1982, p. 10]. This is because the companies are reluctant to incur the high costs of redundant investments (sunk costs) when existing plants are abandoned. An even more sceptical view on future outsourcing was expressed by Altshuler et al. [1984, p. 177]: They concluded that the main aim of transfers of production was not to produce cost savings for multinationals in OECD-markets, but rather to gain access to the markets of developing countries; cost savings were supposed to decline "as OECD factories are more highly automated and OECD production systems are more tightly centralized" (for a more detailed discussion of technological change and its implications on the international division of labour in future automobile production, see Section B.V.2).

#### b. International Comparison of Unit-Labour Costs in Motor-Vehicle Production

In the literature, relatively low unit-labour costs in automobile production were assumed to be a weak argument in judging the competitive position of NICs such as Brazil in world markets [see e.g. Altshuler et al., 1984, p. 177]. This reasoning basically refers to the rather low share of labour costs in total production costs of automobiles. Actually, labour costs accounted for only 17-21 per cent of production costs in Brazil in the mid-1980s (1). However, labour shares were higher in the

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(1) These figures are based on firm-specific information of some Brazilian automobile producers and include the wages of directly productive workers, salaries, and employers' contributions to pension and health-insurance schemes, etc. Labour shares were relatively low (high) for passenger cars (commercial vehicles, in particular buses), due to relatively low (high) labour intensity. Lower labour shares

industrialized countries, except Japan (1). Moreover, accounting for labour incorporated in automotive inputs, the labour share in total production costs is dramatically increased. For a small US-car, direct and indirect labour costs were estimated to amount to two thirds of production costs and nearly three fourths of value added [Prud'homme, 1983a]. It can thus be assumed that differences in unit-labour costs represent an important factor as concerns the world-market position of a country's automobile industry.

In order to compare unit-labour costs in motor-vehicle production, international differences in both nominal wages and labour productivity have to be considered. Due to the conceptual difficulties involved (for a more detailed discussion, see the literature given on page 61), results must be interpreted with caution and only considerable differences in unit-labour costs should be taken as a clear indication of labour-cost advantages and disadvantages. The calculations are sensitive to the definition of labour costs, the productivity measures applied and exchange-rate variations. They may be biased and not fully comparable across countries, due to the aggregated perspective in the following tables. The data situation rendered a further sectoral breakdown into various sub-branches of the motor-vehicle industry (ISIC 3843, if not otherwise stated) impossible; such a disaggregation would be favourable since particularly labour productivity is likely to differ, for example between passenger-car and commercial-vehicle production (2).

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were calculated for an average Brazilian passenger car by the automobile workers' organization DIEESE (about 11 per cent of ex-factory prices, i.e., profits included; published in Transnationals Information Exchange [1984, p. 29]) and for Mexico (12.5 per cent; Mayer [1983, p. 193]). Even lower shares appeared from Table 13. The exact magnitudes of labour shares are subject to the definition of variables which is not fully consistent across countries and which differs between different analyses of a specific country as well [Mayer, 1983, pp. 190 ff.].

- (1) Firm-specific data presented by Schnell [1981, p. 167] pointed to average labour shares of 26 per cent in West Germany and more than 30 per cent in the United States in 1979 (for West Germany, an equally high share was calculated for 1984 by Statistisches Bundesamt [a, p. 88]).
- (2) The problem of product heterogeneity was further accentuated, where the calculations had to be based on data for total transport-equipment industries rather than the motor-vehicle industry (for country-specific information, see the notes of Tables 15-16).

In the following, the results of two different approaches are presented, which both have specific advantages and disadvantages. In Table 15, the *level* of unit-labour costs in selected automobile producing countries is compared for 1982 (1). Subsequently, indices are calculated which portray the *development* of unit-labour costs during the 1975-1985 period, ignoring international differences in the level of unit-labour costs as they prevailed in 1975.

The major advantage of the former approach is that the transformation of country-specific data on labour costs and productivity, expressed in national currencies, into US \$-values does not create any problems for the comparison of unit-labour costs. For both elements, i.e., labour costs and productivity, the same exchange rate was applied, so that distortions due to overvalued or undervalued currencies are neutralized (2). The calculation of labour costs per capita in Table 15 refers to data on wages and salaries of total employees; other labour costs (employers' social-security contributions, etc.) were excluded, since adequate statistical information was not available for most countries. Two variants of labour productivity are presented: value added per capita and value of production per capita. Relative to the United States (=100), differences between the two measures reflect varying degrees of vertical integration between the motor-vehicle industries of the selected countries. As concerns the question of buy or make, West Germany and Japan stood for the two extremes within the group of industrialized countries (see Column (12) in Table 15). With a considerably higher vertical integration than in the United States, the German productivity index was relatively high (60.2) when productivity was measured by value added per capita, and relatively low (43.2) when productivity was measured by output per

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- (1) Calculations were not possible for more recent years, because of lacking comparable data; even for 1982, various estimations were required to fill gaps in the available industrial statistics, particularly in the Brazilian case (for details, see the notes of Table 15). Unit-labour costs were also calculated for 1972 and 1979. The detailed results that are not reported in this volume are available upon request from the authors.
  - (2) Distorted exchange rates, of course, affect the international comparison of labour costs and labour productivity, taken separately. Hence, the interpretation of Table 15 is largely restricted to the quotient of both, i.e., unit-labour costs.

Table 15 - The Motor-Vehicle Industry (a) in Selected Producing Countries: Wages, Value Added and Output per Employee, Unit-Labour Costs and Vertical Integration, 1982

	Wages and salaries per person engaged			Value added per person engaged			Output per person engaged		Unit-labour costs (b)			Degree of vertical inte-gration (c)
	national curr. (1000)	US \$(d)	United States =100	national curr. (1000)	US \$(d)	United States =100	national curr. (1000)	US \$(d)	United States=100			per cent
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<b>Industrialized countries</b>												
West Germany (e)	42.34	17448	66.9	78.77	32461	60.2	182.2	75084	43.2	111.1	154.9	43.2
Japan(f)	3552	14260	54.7	9761	39188	72.7	34838	139866	80.4	75.2	68.0	28.0
United Kingdom(g)	7.13	12481	47.9	12.25	21444	39.8	32.80	57417	33.0	120.4	145.2	37.3
United States(g,h) 1981	24.55	24550	.	49.66	49660	.	158.9	158900	.	.	.	31.2
1982(i)	26.08	26080	100.0	53.90	53900	100.0	173.9	173900	100.0	100.0	100.0	n.a.
<b>Developing countries</b>												
<b>Latin America</b>												
Argentina(h,j)	136914	5282	20.3	n.a.	n.a.	n.a.	363544	14025	8.1	n.a.	250.6	n.a.
Brazil(k)	1083	6033	23.1	3811	21230	39.4	12487	69561	40.0	58.6	57.8	.
	1044	5816	22.3	.	18720	34.7	.	54342	31.2	64.3	71.5	n.a.
Mexico(h)	318.3	5643	21.6	2285	40513	75.2	6 500	115245	66.3	28.7	32.6	35.2
<b>Asia</b>												
India(g,l)	14.70	1698	6.5	35.48	4097	7.6	138.2	15958	9.2	85.5	70.7	25.7
Indonesia(m)	1560	2359	9.0	7798	11790	21.9	27339	41335	23.8	41.1	37.8	28.5
South Korea	2929	4006	15.4	12067	16506	30.6	33524	45856	26.4	50.3	58.3	36.0
Malaysia(g,n)	7.28	3117	12.0	21.32	9129	16.9	61.58	26368	15.2	71.0	78.9	34.6
<b>Other</b>												
Spain(g,l)	990.3	10727	41.1	1660	17981	33.4	5090	55135	31.7	123.1	129.7	32.6
Yugoslavia(e,l)	128.2	3666	14.1	351.3	10047	18.6	1210	34605	19.9	75.8	70.9	29.0
Turkey	686.0	4220	16.2	2359	14512	26.9	6402	39384	22.6	60.2	71.7	36.8

(a) ISIC 3843 if not otherwise stated. - (b) Column (10): on the basis of value added per person, i.e., column (3) divided by column (6); column (11): on the basis of output per person, i.e., column (3) divided by column (9). - (c) Share of value added in output in producers' prices. - (d) The exchange rate applied is the period-average rate. - (e) Transport equipment without shipbuilding. - (f) Motorcycles included. - (g) Value added and output in factor values. - (h) Per employee. - (i) Estimates on the basis of average growth rates of 1981/82 for the remaining three industrialized countries. - (j) Transport equipment. - (k) Estimates based on employment trends in the automobile industry rather than ISIC 3843 (motor vehicles). In case A, wage and salary payments of ISIC 3843 are estimated by projecting 1979-values on the basis of hourly compensation costs for production workers in Brazilian motor-vehicle and equipment manufacturing (as published by the U.S. Department of Labor) and employment trends in the Brazilian automobile industry (as published by ANFAVEA). The estimate of the development in productivity since 1979 is based on value of production per person engaged rather than value added (the former calculated by multiplying physical production in the automobile industry with wholesale prices for motor vehicles as published by IBGE). In case B, unpublished data on total labour costs and total sales (in US \$) per employee provided by a major Brazilian automobile firm are applied to estimate wage and productivity trends since 1979. - (l) 1981. - (m) Value added in factor values; including employers' contributions to pension and health-insurance schemes; including motorcycles (ISIC 3844). - (n) Malaysia, Peninsular.

Source: UN [c]; U.S. Department of Labor [1985b]; IBGE [a]; unpubl. data by ANFAVEA and a major Brazilian automobile firm; own calculations.



capita. The opposite (72.7 versus 80.4) was true for Japan, where automobile producers bought in a larger share of inputs than their German and US-competitors (1). As regards Brazil, the degree of vertical integration was somewhat higher than in US-automobile production in the late 1970s, whereas it was roughly comparable to US-standards in 1972 (see p. 66, footnote (1)).

Since two productivity measures were calculated, Table 15 presents two unit-labour-cost indices as well (Column (10): labour costs per capita, relative to the United States, divided by value added per capita, relative to the United States; Column (11): the former variable divided by output per capita, relative to the United States). The figures based on value-added data are considered superior in the context of international cost comparisons. This is because they are better suited to reduce the distortions arising from differences in the degree of vertical integration between the selected automobile producing countries. In the case of high (low) vertical integration, both the number of persons engaged and value added is relatively high (low); hence, the distorting effect on value added per capita is minimized. The opposite is true for output per capita since the value of production is hardly affected by differences in vertical integration. Thus, the differences in vertical integration can be assumed to distort international comparisons of unit-labour costs more seriously when productivity calculations are based on production-value data.

According to Column (10) of Table 15, unit-labour costs in Brazilian motor-vehicle production amounted to about 59 per cent of costs in the United States, when the necessary estimates were based on employment and production trends for the automobile industry as a whole (for details, see note (k) in Table 15). The difference to the United States

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(1) Both measures, however, indicate productivity advantages of the United States vis-à-vis both West Germany and Japan, which sharply contrasts with conventional wisdom [see e.g. Laing, Rahn, 1983, p. 39, and the discussion in the preceding section]. Equally implausible, labour productivity in Mexican automobile production appears to be about twice as high as in Brazil and Spain in Table 15. Apart from exchange-rate effects, various other factors may have contributed to such strange results, of which product heterogeneity probably figured most prominently [see also Picht, 1987].

was somewhat narrowed, when data provided by one major producer operating in Brazil were used to update published statistical information for the Brazilian motor-vehicle industry. In any case, however, the difference was sufficiently large to conclude that Brazil enjoyed a significant labour-cost advantage against the traditional automobile suppliers in the early 1980s. As hypothesized, Brazilian wages and salaries were sufficiently low to more than compensate for the relatively poor productivity in motor-vehicle production. The unit-labour-cost advantage appeared to be most pronounced vis-à-vis the United Kingdom and West Germany, whereas a rather weak advantage emerged as against Japan. Brazil's position in relative unit-labour costs changed only marginally during the 1970s and early 1980s. Calculations for 1972 and 1979 showed advantages of a similar size vis-à-vis the industrialized countries, as emerged for 1982 from Table 15. Improvements in productivity were large enough to outweigh the slightly deteriorating wage position.

In 1972, Brazil had a clear unit-labour-cost advantage against all other non-traditional suppliers as well, although average nominal wages were significantly below Brazilian wages in all Asian developing countries. Subsequently, Brazil's position vis-à-vis some other new competitors on world markets deteriorated significantly, however. Apart from Indonesia, Mexico succeeded to reduce its (relative) unit-labour costs most dramatically in the 1970s. In 1982, unit-labour costs in the South-Korean automobile industry were also lower than in Brazil (1). From the labour-cost standpoint, Brazil's competitive position thus continued to be fairly strong vis-à-vis the traditional suppliers of automobiles, but it was increasingly challenged by a small group of other NICs.

Distortions in the results derived from the first approach to compare unit-labour costs are likely if the product structure within the automobile industry and the definition of variables differed markedly between the selected countries. The impact of such distorting factors is considerably reduced by the second approach. The calculation of unit-labour-cost

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(1) On the contrary, Brazil continued to have a clear labour-cost advantage as against Spain.

indices ignores international differences in the level of labour costs at the beginning of the period under consideration, i.e., 1975. The focus is on the changes in unit-labour costs during the last decade. Consequently, the international comparison of unit-labour-cost indices is only biased, if the structure of automobile production in the selected countries and country-specific definitions of variables varied considerably over time.

The indices of unit-labour costs presented in Table 16 are based on indices of nominal wages and labour productivity (1):

- As regards nominal wages, data on hourly labour compensation for production workers in motor-vehicle and equipment manufacturing, as published by the U.S. Department of Labor [1985b], were applied, in addition to UN-data on wage and salary payments per capita.
- Labour-productivity indices were calculated on the basis of a) output per capita in constant prices of 1980, and b) the number of automobiles produced per employee.

Unit-labour-cost indices represent a) the quotient of hourly labour compensation in US \$ and the volume of automobile production per capita (I in Table 16), and b) the quotient of wages and salaries per capita in US \$ and output in constant prices per capita (II in Table 16) respectively. Only the indices of nominal labour costs had to be converted into US-Dollars, whereas the productivity indices are based on national currency units, since production was measured in volume terms and in terms of constant prices respectively. Consequently, the major advantage of the first approach presented in Table 15, i.e., the neutralization of exchange-rate effects, turns out to be the major disadvantage of the alternative approach. Exchange-rate variations strongly affected the development of unit-labour-cost indices. This was especially true for countries, where domestic inflation was high and exchange-rate policies failed to accommodate continuously to international inflation differentials.

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(1) The calculation of the latter which is not presented here is available upon request from the authors.

Table 16 - Indices of Unit-Labour Costs (a) for the Motor-Vehicle Industry in Selected Producing Countries, 1975-1985 (1975 = 100)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
West Germany I(b) A	100.0	90.6	113.4	141.6	169.4	209.6	176.7	169.3	166.7	n.a.	n.a.
	B	100.0	92.5	109.7	139.0	167.2	205.8	172.0	166.0	155.8	149.3
Japan II	100.0	97.4	116.0	140.6	158.7	177.0	138.6	132.2	128.8	n.a.	n.a.
	I	100.0	103.4	115.5	158.7	151.3	138.2	153.1	151.1	159.7	n.a.
United States II	100.0	113.3	132.9	193.9	196.2	178.7	189.8	188.4	216.5	n.a.	n.a.
	I	100.0	97.0	107.3	122.9	143.0	196.8	203.2	n.a.	n.a.	n.a.
Brazil II	100.0	104.2	112.7	116.9	118.2	136.7	142.5	n.a.	n.a.	n.a.	n.a.
	I(c) A	100.0	116.8	141.9	154.5	159.0	156.2	234.7	260.3	156.6	140.5
Mexico B	100.0	116.1	139.2	153.4	155.3	153.6	227.2	251.3	150.3	131.0	138.5
	I	100.0	122.6	105.1	92.5	110.9	134.5	151.4	115.7	88.3	n.a.
South Korea II	100.0	98.2	74.5	82.5	97.7	121.6	154.7	99.7	70.3	n.a.	n.a.
	I	100.0	137.1	182.9	222.2	240.2	303.8	276.8	224.4	n.a.	n.a.
II	100.0	126.6	172.1	225.3	281.2	306.5	203.4	181.0	n.a.	n.a.	n.a.
Brazil (I B) relative to average of remaining countries(d) (per cent)	100.0	105.1	112.2	104.3	95.6	78.4	118.8	(153.0) (e)	(109.2) (e)	(84.1) (e)	(92.8) (e)

(a) Two different indicators are presented: I: based on hourly labour-compensation costs in US \$ and production volume of automobiles per capita; II: based on wages and salaries per capita in US \$ and output in constant domestic prices per capita. - (b) A: productivity index based on production volume of automobiles and the employment index of ISIC 384 without ISIC 3841; B: on the basis of employment in automobile production as published by VDA. - (c) Based on production-volume data as given by ANFAVEA; A: employment index based on employment in ISIC 3843 in 1979 and employment trends in automobile production (tractors included) as given by ANFAVEA; B: employment index based on employment in automobile production (without tractors) as given by ANFAVEA. - (d) Denominator based on average value of index I of producing countries, except Brazil (West Germany: I B). - (e) Not fully comparable to previous years; relative to remaining countries without the United States (1982), to West Germany, Japan and Mexico (1983), and to West Germany (1984, 1985), respectively.

Source: U.S. Department of Labor [1985b; 1986a]; UN [c]; VDA [c]; ANFAVEA, unpubl. data on production volume and employment in the Brazilian automobile industry; IBGE [c, 1979; d]; IMF [1985]; own calculations.

The impact of exchange-rate variations is clearly reflected in the case of Brazil. Relative to the average of the remaining countries considered in Table 16, annual index figures of unit-labour costs indicated a favourable or considerably improved competitive position of Brazil (index figures < 100, or significantly reduced compared to the preceding year) when the Cruzeiro was devalued in real terms (1979/80; 1983); index figures were high or increasing when the Cruzeiro was overvalued (1976/77; 1981). Calculating the average index position of Brazil after 1975, relative to its major competitors, reveals the following picture (Brazil in per cent of the reference country indicated) (1):

- West Germany : 108 (1976-1985)
- Japan : 119 (1976-1983)
- United States : 112 (1976-1981)
- Mexico : 148 (1976-1983)
- South Korea : 77 (1976-1982).

From this calculation, it appears that Brazil's competitive position improved relative to South Korea, which conflicts with results presented above. However, the Korean development in both nominal labour costs and labour productivity varied drastically depending on the indicators considered, so that the comparison between Brazil and South Korea is subject to a large margin of error (2). Relative to the remaining four competing countries, the margin of error seems to be smaller, since the development of the alternative indicators of nominal labour costs and labour productivity did not differ as much as in the Korean case. Brazil's competitive position deteriorated most significantly as against Mexico, which is in accordance with the results of the first approach. Though to a considerably smaller extent, labour-cost advantages were eroded vis-à-vis the industrialized countries as well. Thus, a less favourable picture emerged from the index calculations, compared to the first approach. This was mainly due to the rather disappointing devel-

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(1) The calculations are based on indices I, as presented in Table 16; Brazil and West Germany: IB.

(2) If the calculation of the Korean unit-labour-cost index is based on wages and salaries per capita and the volume of automobile production per capita, the Brazilian advantage in the development of unit-labour costs is completely eroded.

opment in Brazilian productivity in real terms. All indicators considered showed a declining trend vis-à-vis most of Brazil's competitors.

The analysis of unit-labour costs underlines that the position of the Brazilian automobile industry in world markets in the future critically depends on two important factors. First of all, labour productivity has to be improved, in order to counterbalance the negative impact of higher wages on export prospects. This is most important since wage increases in Brazil are likely to exceed the wage increases to be expected in most industrialized countries. Moreover, Brazilian exchange-rate policies must be flexible enough to accommodate to international inflation differentials. This is particularly relevant because Brazil presently seems to be on the verge of another inflationary surge.

#### c. Scale Efficiency of Automobile Production in Brazil

It was argued elsewhere that countries with large domestic markets may find it relatively easy to realize economies of scale, since the economic costs incurred by entering foreign markets render it more difficult to reduce per-unit costs through exporting [Hufbauer, 1970]. According to this reasoning, Brazil may have a strong advantage in automobile production against other NICs such as South Korea, which are characterized by relatively small domestic markets. This is because economies of scale were supposed to be of fundamental importance in this industry (1). On the other hand, disadvantages may persist relative to the mass-producers of automobiles in the industrialized world, though probably reduced since the 1960s and early 1970s.

In evaluating the hypothesis that scale efficiency of the Brazilian automobile industry has improved to the point that remaining disadvantages no longer exert a strongly negative impact on the industry's position in world markets, we mainly refer to the recent study by Lücke [1987](2).

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(1) See e.g. Prud'homme [1984a, p. 9]; Doz [1981]; Jones, Prais [1978, p. 149]; for an opposite view, see Berg [1982, p. 76].

(2) This study provides a detailed account of available estimates of minimum-efficient scale and long-run average cost functions in motor-

The following presentation concentrates on scale efficiency in *passenger-car* production. The diversity of products as well as the differences in the production structure of firms render it difficult to draw definite conclusions as concerns commercial vehicles (for the limited evidence, see Lücke [1987]). The discussion is restricted to technology-induced economies of scale which are supposed to be of overriding importance, notwithstanding that economies of scale can also be achieved in procurement, marketing, finance, and research and development. Scale efficiency is assessed at the model and the firm level, since - apart from mass-producing specific models - economies of-scale can also be reaped from mounting standardized components and parts into different models produced by the company.

The degree of interchangeability of parts and components matters because the minimum-efficient scale of production varies across the different stages in car manufacturing. Various studies broadly agree that the minimum-efficient scale is relatively low in final assembly, but considerably higher in casting, machining and stamping. The figure of 200000-250000 vehicles per annum given for assembly operations can also be considered as the minimum-efficient scale of producing one basic passenger-car model, provided that the engine and the transmission (each with a minimum-efficient production scale of about half a million units per annum) are used in other models as well. Otherwise, the model minimum rises accordingly. The minimum-efficient scale for a company supplying a range of three to four basic models to cover the mini, small, medium and large-segments of the market is assumed to lie between one and two million units per annum, depending on the number of basic engines and types of power train used. Various estimates of the long-run average cost function in passenger-car manufacturing indicate that per-unit costs decrease considerably as annual production per model increases from 100000 units to about a quarter of a million; the decrease in per-unit costs slows down remarkably when model production rises further to half a million units [Pratten, 1971; White, 1971; Rhys, 1977;

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vehicles production, which serve as a reference point in assessing scale efficiency in Brazil, and discusses in detail the conceptual limitations involved in such an analysis.

Doz, 1981]. At the firm level, reductions in per-unit costs become rather small beyond a production volume of one million vehicles per annum.

Defining 250000 units per model and one million per firm as the reference case for scale-efficient production, it is evident that Brazilian passenger-car production is still far from approaching these benchmarks (1). Average installed capacity of the four mass-producing companies amounted to roughly a quarter of a million units annually per firm in the 1980-1985 period (Table 17). Applying Pratten's [1971] estimate of the long-run average cost function, this involved extra per-unit costs of about 20 per cent compared with scale-efficient production. Notable differences prevailed between the Brazilian producers of passenger cars (2). But even the largest producer supplied less than one third of the annual production volume considered as scale-efficient.

Firm-specific differences are considerably reduced at the (basic) model level, since the larger companies covered a broader model range (3). Table 17 shows that, on average, installed capacity per basic model reached a maximum of 80000 units in 1978 and fell subsequently to about 50000 units in the mid-1980s. The latter figure again involved a disadvantage in per-unit costs of roughly 20 per cent against scale-efficient production of 250000 units. The deterioration in scale efficiency at the model level was mainly due to the continuous increase in the number of basic models produced by the Brazilian manufacturers.

Evidently, considerable scope still exists for Brazil to improve on scale efficiency in passenger-car production, both at the firm level (mainly relating to economies of scale in the production of major components,

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- (1) The following information relate to models whose annual production exceeded 5000 units. Installed capacity rather than actual production is considered; for the economic rationale and the calculation of the former, see Lücke [1987].
  - (2) In 1985, actual production was highest for VOLKSWAGEN (307000 units), followed by GENERAL MOTORS (191000), FORD (146000), and FIAT (114000).
  - (3) On the basis of information provided by Lücke [1987, Tables A1 and 8], actual production per basic model in 1985 amounted to slightly less than 40000 units for FORD and GM and somewhat exceeded this figure in the case of VOLKSWAGEN.



Table 17 - The Scale of Production (a) of Passenger Cars and Light Multiple-Usage Vehicles at the Firm and Model Level in Brazil, 1960-1985

	Total passenger-car production	Mass-producing firms	Mass-produced basic models (b)	Volume of mass production	Basic models per firm	Average production per firm	Average installed capacity per firm (c)	Average production per basic model	Average installed capacity per basic model (c)
	1000 units	number		1000 units	average number	1000 units			
1960	46	2	4	39	2.0	20	n.a.	10	n.a.
1965	118	3	7	109	2.3	36	n.a.	16	n.a.
1970	305	3	7	290	2.3	96	n.a.	41	n.a.
1975	706	3	12	690	4.0	230	244	58	61
1976	747	3	12	731	4.0	244	260	61	65
1977	719	4	13	711	3.3	178	214	55	66
1978	858	4	11	839	2.8	210	221	76	80
1979	900	4	12	891	3.0	223	235	74	78
1980	927	4	14	918	3.5	229	254	66	73
1981	585	4	15	581	3.8	145	227	39	61
1982	673	4	17	668	4.3	167	287	39	67
1983	749	4	19	743	4.8	186	284	39	60
1984	679	4	21	674	5.3	169	268	32	51
1985	759	4	21	752	5.3	188	266	36	51

(a) Only includes basic models with an annual production of more than 5000 vehicles. - (b) A basic model is defined here to include all different versions of one model irrespective of the number of doors, or type of engine, etc. - (c) Data from Lücke [1987, Table A2] on capacity utilization for the whole industry was used for the calculation of this column.

Source: Lücke [1987].

such as engines and transmissions) and the model level. However, as far as the relative position in world markets is concerned, the scale of production achieved in Brazil has to be compared with that of its major competitors, rather than the hypothetical minimum-efficient scale. Since comparable information on capacity utilization was not available, the cross-country analysis had to be based on actual production data (Table 18). At the firm level, production in Brazil was clearly more scale-efficient than in other NICs such as Mexico, South Korea and India, and only slightly worse than in Spain. South Korea, however, by concentrating its relatively small volume of total production on a very limited number of models, outperformed Brazil at the basic-model level (1). It is hard to decide as to what extent economies of scale achieved in Brazil by producing common components for various models compensated for this disadvantage.

Both at the firm and the model level, Brazilian production of passenger cars continued to be substantially lower than in the major industrialized countries. Referring to estimates on the relationship between the scale of production per model and per-unit costs presented in the literature, this can be assumed to imply a cost disadvantage in the order of 10 per cent. This estimate is likely to be on the low side, given that in the United States, for example, the three major companies often produced very similar models in their separate divisions. Yet it seems safe to conclude that scale efficiency in Brazilian passenger-car production has improved to the point that the country's competitive position in world markets is no longer seriously impaired by its relatively small scale of production, as was the case in the 1960s and early 1970s.

But the remaining disadvantages leave much to be done, in particular at the model level where the increase in the number of basic models caused scale efficiency to deteriorate in the recent past (2). This has implications for firm strategies as well as government policies. As concerns the

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(1) Korea's present advantage in this respect is likely to be understated in Table 18, since the 1984-data do not fully reflect HYUNDAI's recent success in introducing its Pony2 model in Northern-American markets.

(2) The more important problem in the short run is of course the underutilization of existing capacities.

Table 18 - The Scale of Production of Passenger Cars and Light Multiple-Usage Vehicles at the Firm and Model Level in Selected Countries, 1984

	Total passenger-car production	Mass-produced cars (a)			Basic models per firm	Average volume of production per firm	Average volume of production per basic model
		firms	mass-produced basic models	volume of mass-production			
	1000 units	number		1000 units	average number	1000 units	
Brazil	679	4	21	676	5.3	169	32
Mexico	232	6	17	216	2.8	36	13
South Korea	159	2	4	156	2.0	78	39
India (b)	86	4	4	85	1.0	21	21
Spain	1225	6	n.a.	1254 (c)	n.a.	209 (c)	n.a.
United States (d)	7952	4 (e)	64	7742	16.0	1935	121
West Germany	3754 (f)	4	24	2819 (g)	6.0	705	117
Japan (h)	7771 (i)	5 (i)	n.a.	7071 (i, j)	18.0 (k)	1414 (i)	134 (g, k)

(a) Only includes basic models with an annual production of more than 5000 vehicles. - (b) Including jeeps. - (c) Production figures were not available for individual models. Figures relate to the firms' total production. - (d) Retail sales of domestically produced cars. No data were available relating to individual models of VOLKSWAGEN or HONDA. - (e) AMERICAN MOTORS, CHRYSLER, FORD, GENERAL MOTORS. - (f) BMW, MERCEDES-BENZ and PORSCHE not included, as these firms catered for particular market segments with only limited relevance to Brazilian conditions. - (g) Excludes completely knocked-down kits, for which no data were available at the model level. - (h) Production figures for individual models were only available for TOYOTA. - (i) Relates to total production by HONDA, MAZDA, MITSUBISHI, NISSAN, TOYOTA. - (j) Including knocked-down sets. - (k) TOYOTA only.

Source: Lücke [1987].

former, three possible instruments figure prominently in strengthening scale efficiency: reducing the number of models; lengthening model runs; and improving the interchangeability of parts and components. The first alternative is problematic insofar as individual firms may then be forced to give up serving certain segments of the automobile market, given that the Brazilian government continues its policy of effectively closing the domestic market to imports. Government policies rather than firm-strategies have thus to be blamed for giving rise to model proliferation and the deteriorating scale efficiency at the model level. The protection of domestic car production, the persistency of which conflicts with the frequently stated infant-industry argument, prevents intra-firm specialization and trade and renders it impossible to reap the full benefits from economies of scale.

As concerns the second alternative, cursory evidence presented by Lücke [1987] indicates that the traditional notion according to which model runs are distinctly longer in developing than in industrialized countries cannot be upheld in general. The lengthening of model runs, which allows to reduce per-unit costs by spreading model-specific fixed costs over larger production volumes sold during longer life times, is subject to limitations as well. This is especially so if a favourable performance in world markets is aimed at, since consumers in the most important export markets seem to demand for rather frequent model changes. Thus, the prospects of improving scale efficiency critically hinge on the third alternative, i.e., further increasing the production of standardized parts and components to be used in different models. Recent experience shows that this strategy goes far beyond strengthening the interchangeability of parts within individual companies. A clear trend exists towards increasing scale efficiency through inter-firm cooperation in the procurement and production of components [see e.g. O'Brien, Lobo Aleu, 1984, pp. 87 ff.]. As concerns Brazil, the agreement between VOLKSWAGEN and FORD to establish AUTOLATINA is a case in point.

Apart from firm-strategies, economic policies bear the main responsibility as to what extent economies of scale can be achieved. The Korean example demonstrates that small domestic markets not necessarily create a

serious obstacle to reach scale efficiency. The pressure for small economies to export may indeed induce policies that are better suited to reap benefits from economies of scale. The governments of countries with large domestic markets seem more inclined to discount the potential of unit-cost reductions to be achieved through exports. In Brazil, high local-content requirements may create policy-induced bottlenecks to further improving scale efficiency, even though restrictions are somewhat relaxed for cars destined for export. The recent law on informatics (1), for example, requires considerable adaptations when models designed by automobile multinationals in industrialized countries are produced in Brazil. In turn, the Brazilian versions' suitability for sale in developed countries may be seriously impaired [Stevens, 1987, pp. 33 and 42].

Moreover, high Brazilian sales taxes on automobiles render it difficult to improve on scale efficiency. According to ANFAVEA [b, p. 39] (see also Table 12), taxes represented 63 per cent of the price of a new car in Brazil in July 1985 (2), as against 4-33 per cent in major developed countries. International tax differences do not affect exports in a direct way, provided that the drawback of domestic taxes for exporters is complete. Indirectly, however, the extraordinarily high and recently further increased domestic tax burden on automobiles in Brazil may hinder the growth of automobile exports. The domestic demand for automobiles declines due to the tax-induced price increases. Consequently, per-unit costs in automobile production may rise substantially so that it becomes more difficult to penetrate world markets successfully.

#### d. On the Efficiency of Supplying Industries: International Cost Comparisons for Selected Input Items

It is difficult to systematically judge the validity of the supposition that the improved export performance of the major Brazilian automobile companies (montadores) was largely due to the efficiency of the suppliers

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(1) This law covers the electronics industry and its products. Electronics are defined as an area reserved for Brazilian-owned companies.

(2) In November 1986, a massive increase in the Industrial Products Tax (IPI) added further to the tax burden on automobiles in Brazil [Stevens, 1987, pp. 36 f.; see also Sauer, 1987].

of automotive inputs [Stevens, 1987, p. 35]. The operations of the Brazilian car producers were not restricted to pure assembly, but included manufacturing of parts and components as well. Moreover, the suppliers of autoparts covered a wide spectrum of products; it is highly unlikely that any generalizing picture can be drawn as regards the cost effectiveness of automotive supplying industries in Brazil relative to its major foreign competitors. Only recently (March 1986), the Fundação Getulio Vargas started to publish an aggregated price index for automotive components.

We had to step further back and mainly refer to lowly processed materials incorporated in autoparts and components in the following. Although materials such as aluminium and plastics were increasingly substituted for iron and steel, the latter continued to account for the great bulk of automotive material inputs (1). Thus, the cost effectiveness of automotive input suppliers in Brazil was largely determined by the steel sector. Other major (though far less important) materials used in automobile production included non-ferrous metals, rubber, plastics, fluids and lubricants, and paints and varnishes. For these items, the following international cost comparisons portray the *development* of Brazilian prices vis-à-vis international prices in the 1970s and 1980s, rather than differences in the *level* of input costs as they prevailed at the beginning of the period under consideration (2). Additionally, this section presents an international comparison of capital costs, which were often assumed to represent a major disadvantage of the Brazilian industry vis-à-vis its competitors abroad. This hypothesis is tested a) by confronting Brazilian and foreign price trends for capital goods (mainly machinery) and b) by comparing the interest costs of raising credits in different financial markets.

The relevance of discussing the cost effectiveness of automotive input suppliers stems from the fact that automobile producers were frequently

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(1) See e.g. U.S. Department of Transportation [1981, p. 28]; Black [1982a, p. 9].

(2) Differences in the level of costs can only be assessed by detailed sectoral analyses. Since such information was not available, we had to assume that cost levels were roughly the same for the base period of the price indices.

not free to choose the cheapest source for their inputs. This was true for Brazil in particular, as was shown before in the case of transport services. High local-content requirements combined with import protection granted to input-supplying industries may have resulted in cost disadvantages for Brazilian automobile producers, since input suppliers got the chance to raise their prices beyond world-market standards. The degree to which the competitive position of Brazil's automobile industry was affected then depended on the intensity of competition among domestic input suppliers and on the availability of internal drawback systems in the case that domestic prices for specific materials exceeded international prices.

The latter policy was followed by the Brazilian government in the case of steel inputs for products designed for export in some instances. Apparently, this approach was largely successful in preventing cost disadvantages for steel-consuming industries. It was widely agreed that the Brazilian automobile industry bought domestically produced steel inputs at competitive terms, at least relative to the United States and Europe. From international price comparisons of 1980/81 it even appeared that domestic prices for iron and steel inputs were lower than international prices (1). However, other input items were considered "consistently expensive" [Stevens, 1987, p. 36], including glass, some plastics and rubber products (in particular tyres) as well as some electrics and electronics.

The price developments portrayed in Table 19 largely confirm this view, in particular with respect to the most important input item. Iron and steel prices in international currency (price indices in national currencies were transformed into US \$) developed extremely favourable in Brazil. In US \$-terms, they remained practically constant from 1976 to 1982; they declined considerably thereafter, which was partly due to the maxi-devaluation of the Cruzeiro in 1983. The less favourable price trend for forgings indicates that iron and steel-consuming end-producers could not reap the full benefits from cheaper material supplies. However, re-

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(1) World Bank [1983, p. 122 and Appendix Table 11.12]; see also Sauer [1987]; Johnston [1981].

Table 19 - Wholesale Prices (a) for Major Automotive Input Items in Selected Automobile Producing Countries, 1975-1985 (1975 = 100)

	1976	1977	1978	1979	1980
<b>Brazil</b>					
Iron, steel, non-ferrous metals(b)	101.0	100.3	101.3	102.0	95.6
Iron, steel, and derivatives(c)	95.0	97.4	100.1	96.1	84.2
Forgings(d)	95.0	97.8	109.0	109.5	104.7
Non-ferrous metals(c)	132.2	112.0	102.9	127.4	154.6
Rubber products(c)	98.2	108.3	118.0	110.3	108.5
Plastic products(c)	101.8	105.8	107.2	102.0	109.5
Paints and varnishes(c)	103.0	116.6	123.7	119.8	138.9
Fuel and lubricants(c)	121.0	138.0	143.1	161.0	213.6
<b>West Germany(c)</b>					
Iron and steel	102.0	98.0	119.1	136.8	139.4
Non-ferrous metals(e)	112.4	115.8	122.5	163.1	174.6
Rubber products	98.5	112.7	131.1	147.1	163.1
Plastic products	100.4	112.5	135.4	155.0	164.7
Paints and varnishes	100.9	114.0	135.4	157.2	175.1
Fuel and lubricants	109.5	111.5	128.2	170.1	206.2
<b>Japan</b>					
Iron and steel	A(c) 107.5	122.1	160.1	161.8	170.8
	B(b) 112.0	130.9	173.9	170.1	178.1
	A(c) 104.8	113.3	133.6	160.7	200.3
Non-ferrous metals	B(b,e) 105.4	112.5	133.3	153.5	184.1
Rubber products(c)	95.8	107.0	131.3	131.3	144.0
Plastic products(c)	104.1	117.0	146.1	150.9	170.5
Paints and varnishes(c)	100.3	110.5	140.1	144.3	164.1
Fuel and lubricants(c)	109.1	123.3	143.4	162.2	265.8
<b>Spain</b>					
Iron, steel, non-ferrous metals(b)	99.6	103.7	121.9	160.6	173.4
Rubber and plastic products(b)	97.1	104.9	125.0	166.4	185.3
Petroleum products(b)	99.0	103.2	113.9	150.3	210.6
<b>United States</b>					
Iron ore, iron and steel(b)	107.4	114.6	126.2	141.1	151.9
Non-ferrous metals(b,e)	105.8	113.9	121.0	152.5	177.7
Rubber and plastic products(b)	106.0	111.5	116.3	129.4	144.7
Petroleum products(b)	107.3	119.7	124.7	172.7	262.0
	1981	1982	1983	1984	1985
<b>Brazil</b>					
Iron, steel, non-ferrous metals(b)	102.4	97.9	63.1	n.a.	n.a.
Iron, steel, and derivatives(c)	93.4	90.0	55.0	51.3	46.3
Forgings(d)	145.0	158.4	98.7	99.3	92.6
Non-ferrous metals(c)	138.9	128.0	102.8	108.9	110.9



Table 19 continued

	1981	1982	1983	1984	1985
Rubber products(c)	157.2	189.1	136.9	127.7	114.2
Plastic products(c)	139.4	152.3	119.1	127.1	116.5
Paints and varnishes(c)	186.3	198.2	152.5	150.8	142.8
Fuel and lubricants(c)	267.0	255.9	223.6	222.9	189.4
West Germany(c)					
Iron and steel	117.5	134.3	120.3	110.9	109.7
Non-ferrous metals(e)	140.9	123.2	125.5	124.1	117.6
Rubber products	137.2	131.8	130.2	115.6	114.5
Plastic products	137.5	137.1	133.3	122.2	120.6
Paints and varnishes	151.4	151.0	147.7	137.6	137.8
Fuel and lubricants	198.0	185.4	170.2	155.0	154.6
Japan					
Iron and steel	A(a) 174.3	154.6	162.3	162.5	160.3
	B(b) 182.6	161.2	169.2	n.a.	n.a.
	A(c) 181.6	154.8	165.9	162.6	153.6
Non-ferrous metals	B(b,e) 166.9	142.3	152.3	n.a.	n.a.
Rubber products(c)	148.5	134.9	143.8	146.1	146.6
Plastic products(c)	173.1	151.8	157.5	159.6	158.7
Paints and varnishes(c)	171.5	154.6	161.6	160.0	160.4
Fuel and lubricants(c)	309.3	299.4	299.1	280.6	278.1
Spain					
Iron, steel, non-ferrous metals(b)	146.0	139.1	n.a.	n.a.	n.a.
Rubber and plastic products(b)	163.8	155.1	n.a.	n.a.	n.a.
Petroleum products(b)	245.2	229.9	214.9	n.a.	n.a.
United States					
Iron ore, iron and steel(b)	166.2	168.7	170.9	n.a.	n.a.
Non-ferrous metals(b,e)	166.6	153.6	160.8	n.a.	n.a.
Rubber and plastic products(b)	154.9	160.7	162.1	n.a.	n.a.
Petroleum products(b)	313.0	295.6	266.6	n.a.	n.a.
(a) Price indices in national currencies transformed into US \$ by applying period-average exchange rates. - (b) Based on data presented in Statistisches Bundesamt. - (c) Data from national sources. - (d) Based on data provided by a major Brazilian producer. - (e) Semi-manufactures included.					

Source: Statistisches Bundesamt [a]; Conjuntura Económica [various issues]; IMF [1985; 1986].

lative to their competitors in major industrialized countries, they were clearly better off throughout the second half of the 1970s and the first half of the 1980s.

Up to the early 1980s, the Brazilian advantages in the development of input costs were less pronounced for non-ferrous metals (1). Subsequently, the devaluation of the Cruzeiro again helped to establish a significant competitive edge: In 1984/85, Brazilian prices of non-ferrous metals in US \$-terms were only 10 per cent higher than a decade before. Japan and the United States experienced price increases of about 50-60 per cent during the same period; in West Germany, the drastic increase in non-ferrous metal prices in 1979/80 was reversed later on, due to the devaluation of the Deutsche Mark against the US \$ in the early 1980s, but index figures continued to exceed the Brazilian figures. As concerns the remaining input items of Table 19, the relevance of appropriate exchange-rate policies was evident as well. Brazilian price indices for rubber and plastic products, paints and varnishes, and fuel and lubricants peaked in 1981/82, when the Cruzeiro was overvalued. In this period, Brazil experienced clear competitive disadvantages against West Germany (all items), Japan (rubber products, paints and varnishes) and Spain as well (though to a lesser extent). Subsequently, the competitive position of Brazilian input suppliers improved significantly, in particular relative to the United States and Japan. Some disadvantages for rubber products, paints and varnishes, and fuel and lubricants remained with Brazil relative to West Germany, when the price situation of 1983-1985 is compared to the base period of 1975.

With the exception of some products, it appears that Brazilian automobile producers did not suffer from international cost disadvantages in automotive input supplies, provided that overvaluation of the domestic currency was avoided. However, it was often assumed that Brazil's favourable cost position with respect to important material inputs such as steel was eroded by relatively high costs for machinery and other investment goods. Ignoring differences in price levels as they might have prevailed

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(1) Lacking more disaggregated price data, major non-ferrous metals could not be looked at separately.

in 1975, Table A9 reveals a more complex picture in this respect (1). In the late 1970s, prices in US \$-terms for machinery and related goods increased rather modestly in Brazil, compared with the selected reference countries. As was the case with material inputs, Brazil's competitive position deteriorated in 1981/82, mainly relative to West Germany and Japan. For the most recent past, the price increases experienced in Brazil vis-à-vis 1975 were considerably smaller than in the United States, but roughly in line with Japan (machinery and equipment). As concerns West Germany as the third major reference country, broadly similar price increases were calculated for 1983-1985, when comparing machinery in West Germany and industrial machinery and equipment in Brazil; with respect to the broader spectrum of investment goods, however, West Germany was in a more favourable position, indicated by greater price reductions since 1980.

Wholesale-price developments for investment goods represent only one aspect of capital costs. Additionally, the costs of financing investment in national financial markets have to be considered. Table 20 presents a rough indicator in this respect, by calculating real interest rates per annum for commercial-bank lending of prime borrowers such as the automobile companies. Apart from the level of financing costs, high and short-term variations in interest rates and general instability in financial markets may affect the competitive position of borrowers negatively. Predictability in financial policies seems to be a major prerequisite to sound economic planning of production and investment by the firms.

The extent to which financial costs of automobile producers in Brazil were affected by international differences in interest rates depended on the structure of their financing:

- Firstly, it may be argued that differences in national financial costs did not matter, since major companies could approach international financial markets to raise credits. However, the access to overseas financing was frequently restricted by official regulations of capital

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(1) It should be noted, however, that NC-machine tools produced in Brazil costed two to three times the price of their counterparts in the world market in the early 1980s [Tauile, 1987, p. 164] (see also Section B.V.2.b of this study).

Table 20 - Nominal and Real Lending Rates (a) in Selected Automobile Producing Countries, 1975-1986 (per cent)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986 (b)
Brazil nominal	16.8(c)	30.0(c)	52.1(d)	61.7(d)	57.0(d)	120.1(e)	152.4(e)	n.a.	n.a.	n.a.	n.a.	n.a.
real	-10.4	-13.3	9.6	24.1	1.1	(88.0) (d)	(138.1) (d)					
						13.7	44.2	23.8(f)	24.0(g)	31.0(g)	19.0(g)	88.0(g)
						(-18.4)	(29.9)					
West nominal	7.0	6.5	6.0	5.5	9.8	11.5	13.0	8.8	7.8	7.8	7.3	6.8
Germany real	2.4	2.8	3.2	4.4	5.0	3.9	5.2	2.9	6.3	4.9	5.0	n.a.
Japan nominal	8.4	7.4	5.5	4.5	6.5	8.2	7.0	6.3	5.9	5.7	5.7	5.2(h)
real	5.4	2.4	3.6	7.1	-0.8	-9.6	-5.6	4.5	8.1	6.0	6.8	n.a.
South nominal	15.5	17.0	15.0	18.5	18.5	19.5	16.5	10.0	10.0	10.0	10.0	10.0
Korea real	-11.1	4.9	6.0	6.9	-0.3	-19.4	-3.9	5.3	9.8	9.3	9.1	n.a.
Mexico nominal	14.5	15.5	17.0	17.5	19.0	24.3	31.8	46.1	56.4	47.5	65.7	94.2
real	4.0	-6.8	-24.2	1.7	0.7	-0.2	7.4	-10.0	-51.0	-22.8	12.1	n.a.
Spain nominal	9.0	9.0	9.0	9.0	9.0	18.5	17.0	19.0	17.3	15.8	14.8	14.2
real	-0.1	-4.2	-11.2	-7.4	-5.6	1.0	1.4	6.8	3.1	3.6	6.9	n.a.
United nominal	7.3	6.0	7.8	11.8	15.3	21.5	15.8	11.5	11.0	10.8	9.5	7.5
States real	-1.9	1.4	1.7	4.0	2.8	7.4	6.7	9.5	9.7	8.4	10.0	n.a.

(a) Nominal commercial-bank lending rates to prime borrowers at or near end of December as defined by Morgan Guaranty Trust Company. Nominal rates were deflated with the annual increase in wholesale prices, if not otherwise stated. - (b) End of November. - (c) Commercial-bank legal-maximum rate (discount basis) for maturities up to 60 days; in addition, compensating balances were required. - (d) Weighted average investment-bank lending rate. - (e) Prefixed rate applied to working-capital loans. - (f) Monetary-corrected free rate applied to working-capital loans. - (g) Maximal-legal rate reported as a spread above monetary correction which is set every month in relationship to inflation; charges for fees and commissions are often added. - (h) End of September.

Source: Morgan Guaranty Trust Company [various issues]; IMF [1986]; own calculations.

imports. Moreover, Western commercial banks were often no longer willing to provide funds for borrowers located in over-indebted countries.

- Secondly, the dependence on the national financial markets was reduced to the extent that the parent companies helped the financing of their subsidiaries, either by directly adding to their direct investments in Brazil or by intra-firm transfer pricing.
- Thirdly, the costs of raising credits in national financial markets were of only minor importance if the companies succeeded to generate considerable financial resources by their own. Favourable depreciation allowances may have helped this process. In some instances, automobile companies even benefited from high interest rates in Brazil, since they were net suppliers of funds in financial markets.

Brazilian companies that depended on the national financial market to a significant extent had a clear disadvantage vis-à-vis producers in other countries. Due to the complicated regulatory environment and volatile financial policies, it is far more difficult to portray the development of interest rates over time in Brazil than in the reference countries (1). This is not only a statistical problem; it also confused the assessment of financial costs by firms and complicated their decision making as to how to finance investments. The difficulties arising from non-transparent financial markets were further aggravated by various surcharges and non-interest financial costs, such as fees and commissions, compensating balances, and taxes on financial obligations (IOF).

The international comparison of real interest rates points to pronounced disadvantages of borrowers that raised funds in Brazil's financial market. In the second half of the 1970s, such disadvantages remained relatively modest vis-à-vis the major industrialized countries. Real interest rates in Brazil (4.1 per cent, on average, in 1975-1980) only slightly exceeded German interest rates (3.6 per cent); the difference was somewhat higher compared to the United States (2.6 per cent) and Japan

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(1) Since the early 1980s, only monetary-corrected interest rates were presented in the source. These rates were not fully comparable to earlier real interest rates which were calculated by applying whole-sale-price increases as deflator.

(1.4 per cent). Relative to South Korea, Mexico and Spain, which all experienced negative real interest rates in 1975-1980, the difference amounted to 6-9 percentage points. The financial burden of raising investment funds in Brazil increased further in the early 1980s.

Apart from extremely high interest rates, Brazilian borrowers suffered from heavy fluctuations in annual interest charges. Year-to-year changes in interest rates of about 20 percentage points were not exceptional. Except Mexico, the standard deviation for the 1975-1985 period was by far the highest in Brazil (17.4; compared to 9.4 in South Korea, 4-6 in the United States, Japan and Spain, and 1.2 in West Germany). Extraordinarily high and extremely volatile financial costs in Brazil were thus likely to erode the country's cost advantage with respect to major automotive input items at least partly. In the future, the subsidiaries of automobile multinationals operating in Brazil may increasingly depend on Brazilian funds. Parent companies seem reluctant to strengthen their engagement through direct investments considerably (1), and over-indebted countries such as Brazil face difficulties in obtaining credits from international commercial banks. Considering the frequent recourse of governments to capital-market controls, it is rather unlikely that international differences in capital costs will automatically decline in the future (as was assumed by Mayer [1983, p. 189], who referred to the very transparent financial markets around the world). The extent to which the competitive disadvantages of Brazilian producers arising from high capital costs can be reduced rather depends on the future course of economic policies in this country.

#### **IV. Major Determinants of the Export Performance of the Brazilian Automobile Industry**

In the preceding sections, the competitive position of Brazil in world-automotive markets was traced to major cost factors. However, it

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(1) The UN Centre on Transnational Corporations [1983, p. 100] concluded that the great bulk of new auto investments will be placed in developed countries.

depended on the pattern of factor absorption in Brazilian automobile production if, for example, relatively low labour costs constituted a major advantage against other locations. The hypothesis that the establishment of the domestic automobile industry in Brazil was in line with the country's supposed *locational advantages* is discussed in the following. Alternatively, the favourable export performance might have been artificially created by government interventions. *Economic policies* encouraged automotive exports, if export subsidies more than compensated for export-retarding effects arising from import-substituting policy measures. The question of effective incentive rates for domestic and overseas sales of automotive products is dealt with in Section B.IV.2.

Though fairly advanced in terms of overall economic development, Brazil could still be assumed to be relatively rich in supply of unqualified and semi-skilled labour, whereas highly qualified labour continued to be relatively scarce. Moreover, Brazil enjoyed favourable access to international financial markets; up to the early 1980s, physical capital was easily available and did not represent the limiting factor of production. Thus, Brazil may have achieved locational advantages in automobile production, even if this industry's labour intensity was relatively low. It has to be analysed if the production of motor vehicles has become standardized to the extent that it could be handled by NICs such as Brazil, without demanding too much of the relatively poor human-capital endowment. In the literature, the automobile industry was frequently supposed to have joined the group of industries supplying standardized product-cycle goods (1). Section B.IV.1.a provides empirical evidence in this respect by calculating factor intensities in transport-equipment industries of major supplying countries. Subsequently, factor absorption in the Brazilian case is analysed in more detail by looking at various sub-branches of the motor-vehicle industry (Section B.IV.1.b).

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(1) UNIDO [a, Part I, p. 65]; Dicke [1978, pp. 38 f.]; Jones [1981, p. 5]; Sinclair [1982, p. 4; 1983, p. 56].

## 1. Factor Intensities in Automobile Production

### a. Standardization in International Production of Transport Equipment?

According to the product-cycle hypothesis, the locational advantages of countries such as Brazil are not restricted to the production of labour-intensive goods. Provided that domestic savings can easily be supplemented by attracting foreign capital inflows, NICs may also specialize in the production of goods that absorb considerable inputs of physical capital. Standardized product-cycle goods are characterized by minor human-skill requirements. To test the hypothesis that the production of automobiles has become standardized, the frequently used Lary-concept is applied. This concept claims that, under certain assumptions, value added per employee in different industries can be taken as a proxy for (overall) capital intensity [Lary, 1968] (1). Figures above the manufacturing average indicate relatively high capital intensity of specific industries, and vice versa. Furthermore, separate measures of physical and human-capital intensity can be calculated, which is most important in the context of the product-cycle hypothesis. According to Lary, high human-capital intensity is revealed by higher than (manufacturing) average wage content in value added per employee; high physical-capital intensity is shown by relatively high non-wage value added per employee.

Table 21 presents Lary-measures for the transport-equipment industry of major producing countries. Factor intensities could not be calculated for automobile production in an international perspective, since more disaggregated data was not available. However, in most of the selected countries, the motor-vehicle industry accounted for the dominant share of production of transport equipment. Moreover, the results are broadly

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(1) Typically, factor intensities can only be calculated for total production rather than export production, since information on value added or wage content of exports is not available. Furthermore, results may be biased due to differences in factor and product-market distortions between industries. Thus, Lary-measures provide an approximation to reality only [for a more detailed discussion, see Wolter, 1974, pp. 31 ff.].



Table 21 - Relative Factor Intensities (a) of Transport-Equipment Industries in Selected Automobile Producing Countries, 1973-1984

	Value added per employee			
	1973	1973- 1975 (b)	1980	1982- 1984 (b)
<b>Industrialized countries</b>				
France	0.91 (14)	0.88 (14)	1.14 (d) (6)	1.12 (8)
West Germany	1.16 (6)	1.13 (7)	1.11 (7)	1.20 (4)
Japan	1.10 (7)	1.10 (7)	1.20 (d) (6)	1.20 (5)
United Kingdom	0.89 (16)	0.89 (16)	0.87 (18)	0.89 (16)
United States	1.19 (5)	1.13 (8)	1.12 (7)	1.13 (7)
<b>Developing countries</b>				
<b>Latin America</b>				
Argentina	1.07 (7)	n.a.	n.a.	n.a.
Brazil	1.14 (4)	1.10 (7)	1.11 (9)	1.18 (6)
Mexico	1.40 (5)	1.24 (6)	1.27 (7)	1.15 (10)
<b>Asia</b>				
India	0.98 (9)	0.96 (9)	1.15 (e) (9)	1.10 (10)
Indonesia	n.a.	1.70 (3)	n.a.	1.89 (3)
South Korea	1.25 (8)	1.21 (6)	1.08 (8)	1.24 (5)
Malaysia	0.92 (12)	0.91 (13)	1.07 (e) (9)	1.20 (8)
<b>Other</b>				
South Africa	n.a.	0.99 (11)	n.a.	0.91 (13)
Spain	n.a.	1.07 (7)	n.a.	0.92 (15)
Turkey	1.16 (7)	1.00 (8)	1.10 (d) (8)	1.16 (5)
Yugoslavia	0.96 (11)	0.94 (11)	0.91 (15)	0.94 (14)
<b>Non-wage value added per employee</b>				
	1973	1973- 1975 (b)	1980	1982- 1984 (b)
<b>Industrialized countries</b>				
France	n.a.	n.a.	n.a.	n.a.
West Germany	1.03 (11)	0.99 (13)	0.91 (16)	1.01 (12)
Japan	0.99 (11)	0.99 (10)	1.03 (d) (9)	1.03 (9)
United Kingdom	0.68 (24)	0.69 (24)	0.72 (23)	0.77 (23)
United States	0.94 (17)	0.91 (17)	0.86 (23)	0.88 (23)
<b>Developing countries</b>				
<b>Latin America</b>				
Argentina	0.82 (23)	n.a.	n.a.	n.a.
Brazil	0.93 (21)	0.95 (18)	0.99 (17)	0.98 (16)
Mexico	1.14 (5)	1.01 (15)	0.98 (13)	1.04 (13)
<b>Asia</b>				
India	0.78 (21)	0.77 (21)	0.80 (e) (22)	0.77 (21)
Indonesia	n.a.	1.08 (7)	n.a.	1.18 (4)
South Korea	1.02 (10)	0.98 (14)	0.93 (15)	1.00 (11)
Malaysia	0.91 (21)	0.92 (19)	1.00 (e) (15)	1.01 (11)

Table 21 continued

	Non-wage value added per employee			
	1973	1973- 1975 (b)	1980	1982- 1984 (b)
Other				
South Africa	n.a.	0.70 (23)	n.a.	0.73 (23)
Spain	n.a.	0.71 (19)	n.a.	0.77 (24)
Turkey	0.94 (19)	0.95 (18)	0.92 (d) (15)	0.95 (16)
Yugoslavia	0.96 (16)	0.95 (14)	0.93 (20)	0.95 (19)
	Wages (c) per employee			
	1973	1973- 1975 (b)	1980	1982- 1984 (b)
Industrialized countries				
France	n.a.	n.a.	n.a.	n.a.
West Germany	1.19 (3)	1.20 (3)	1.23 (3)	1.23 (3)
Japan	1.20 (4)	1.20 (6)	1.25 (d) (4)	1.24 (5)
United Kingdom	1.23 (2)	1.20 (2)	1.15 (4)	1.14 (4)
United States	1.35 (1)	1.34 (2)	1.39 (2)	1.39 (2)
Developing countries				
Latin America				
Argentina	1.54 (2)	n.a.	1.91 (d) (1)	n.a.
Brazil	1.47 (3)	1.38 (4)	1.22 (6)	1.36 (4)
Mexico	1.21 (5)	1.26 (5)	1.36 (6)	1.16 (8)
Asia				
India	1.31 (6)	1.33 (5)	1.47 (e) (3)	1.40 (5)
Indonesia	n.a.	1.61 (2)	n.a.	1.56 (2)
South Korea	1.38 (3)	1.46 (3)	1.39 (4)	1.41 (2)
Malaysia	1.21 (6)	1.17 (8)	1.22 (e) (7)	1.30 (4)
Other				
South Africa	1.34 (3)	1.31 (5)	1.20 (e) (7)	1.20 (8)
Spain	n.a.	1.40 (3)	n.a.	1.20 (5)
Turkey	1.34 (3)	1.14 (7)	1.34 (d) (4)	1.32 (4)
Yugoslavia	1.05 (7)	1.06 (7)	1.07 (7)	1.06 (7)

(a) Transport equipment relative to the unweighted mean of all manufacturing industries of the respective producing country (mean = 1.00); in parentheses: rank position of transport equipment within the set of about 24 manufacturing industries in the respective producing country. According to the so-called Lary-concept [Lary, 1968], value added per employee stands for overall-capital intensity, non-wage value added per employee for physical-capital intensity, and wages per employee for human-capital intensity. - (b) Weighted average of the years for which data were available for the selected producing countries in the two periods. - (c) Wages and salaries, in cash or in kind. - (d) 1981. - (e) 1979.

Source: UNIDO [b, various issues].

similar between the selected countries, despite differences in the industrial structure within the transport-equipment sector.

The results of Table 21 may be summarized as follows:

- In the early 1980s, overall-capital intensity in transport-equipment industries, relative to the average of total manufacturing (1.0), was high in by far the most of the countries considered. Though somewhat increased compared with the mid-1970s (1), no dramatic change in relative capital intensity could be observed within the last decade, when measured by total value added per employee.
- Contrary to the standardization argument, high overall-capital intensity was hardly due to high physical-capital intensity. Actually, non-wage value added per employee in total manufacturing exceeded non-wage value added per employee in transport equipment in 8 out of 14 countries, for which comparable data was available for 1982-1984 (2). In countries such as the United Kingdom, the United States, South Africa and Spain, transport equipment figured at the bottom of the list of industries on which the calculation of factor intensities was based (see the rank positions given in parentheses in Table 21). Moreover, with the exception of Indonesia, positive differences from the average of total manufacturing remained marginally low (West Germany, Japan, Mexico and Malaysia).
- Contrary to the product-cycle hypothesis, it was rather high human-capital intensity that high overall-capital intensity had to be attributed to (3). In all sample countries, wages per employee in transport equipment significantly exceeded the reference measure for total manufacturing. In 11 out of 14 cases, transport equipment ranked among the top five industries, as concerns relative human-capital intensity in 1982-1984. During the 1980s, the average deviation from total manufac-

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(1) The number of countries with below average overall-capital intensity was slightly higher in the 1970s; for the other countries, positive differences from the average of total manufacturing appeared to be slightly smaller in 1973-1975, compared with 1982-1984.

(2) In the mid-1970s, only Indonesia and Mexico experienced higher than average physical-capital intensities in transport-equipment industries.

(3) Similar results were found by van Dijck [1986, pp. 144 ff.] for a set of 17 developing countries.

turing amounted to about 30 per cent, which was roughly the same as in the 1970s.

The results achieved for transport-equipment industries can be transferred to automobile production without major qualifications: "The product is ... not mature and is unlikely to become so in the foreseeable future" [Jones, Womack, 1985, p. 401] (1). In recent discussions, the non-existence of the formerly assumed strong trend towards standardization was attributed to the main direction the "fourth transformation" in automobile production has taken in the 1980s (2). The different paths of most recent and still on-going transformations were described by Altshuler et al. [1984, p. 12]: a) concentrated production at low-factor-cost locations such as Brazil, Mexico and South Korea; b) mass introduction of flexible manufacturing systems and new forms of "cooperative competition" in industrialized countries [see also Dankbaar, 1984, pp. 242 ff.; Jürgens, 1987, p. 46].

The first scenario refers to the world-car strategy with its strong emphasis on standardization. In the second attempt to strengthen their competitive position, automobile producers in industrialized countries embarked on further automation of the production process and productivity improvements via increasing the flexibility of automobile production (3). The initial costs of switching from dedicated to flexible automation are very high. After computer-controlled production lines and flexible automation (involving robots etc.) are introduced, investment costs for

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- (1) The aforementioned calculations conflict with the conclusion of Dankbaar [1984, p. 242], who claimed: "There is no reason to retreat from our earlier conclusion that the car industry was a mature industry in the early 1970s".
  - (2) For a detailed presentation, see Altshuler et al. [1984, pp. 11 ff.]. The following keywords stand for the three preceding transformations: mass-production systems (up to the 1920s); product differentiation, emphasis on product technology (1950s, into 1960s); corporate groups as a new system of production organization, "just in time" (late 1960s through 1970s).
  - (3) It was consistent with this strategy that major car manufacturers undertook huge investment programs, the bulk of which was directed towards the home countries and other developed countries [see, additionally, Maxcy, 1981; Cohen, 1982]; for the - limited - degree of automation in Brazilian automobile production, see Stevens [1987, pp. 30 f.]; see also Tauile [1984; 1986].

new models and variants are probably lower than in the past, however [Jones, Womack, 1985, p. 401]. This is likely to considerably reduce the minimum-efficient scale of production. Apparently, this move towards flexible automation has already softened the pressure to design ever more dedicated automated lines, geared to mass-output of standardized products. Such technological changes may have interrupted the process towards maturity of the automobile industry. Consequently, the chances of NICs such as Brazil to achieve locational advantages in automobile production may have deteriorated, compared with the very optimistic presumptions based on the product-cycle hypothesis [see also Altshuler et al., 1984, p. 12 and pp. 34 ff.] (1).

#### b. Factor Intensities in Sub-Branches of the Brazilian Motor-Vehicle Industry

##### α. The Results

From the aforementioned recent developments in automobile production it cannot be concluded, however, that Brazil does not enjoy any locational advantages in the production of automotive items at all. The strategy of standardization and the move towards flexible automation are no clear-cut alternatives, in the sense that automobile companies have to decide which avenue to follow and to completely abandon the other. The relative importance of standardization and flexible automation is likely to differ between the various stages in automobile production and different automotive products. For example, technological innovations may strongly affect the modes of passenger-car production, whereas their effect

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(1) Jürgens [1987, p. 35] concluded that the rather sceptical assessment of developing countries' chances to gain locational advantages in automobile production, achieved within the MIT-project on the "Future of the Automobile", was rendered obsolete only shortly after its publication. This clearly indicates the current uncertainty in evaluating the prospects of newly industrializing economies in future worldwide automobile production. However, Jürgens' conclusion was mainly based on South Korea's favourable export performance in recent years, rather than on an analysis of its causes, i.e., the conflicting hypotheses of comparative advantage versus artificially created competitiveness.

remains rather modest in the production of commercial vehicles. In particular for trucks, technical change is relatively slow, so that it may be easier for Brazil to achieve comparative advantages in this branch (1). The production of buses is typically characterized by rather small volumes per annum and additionally requires frequent adaptations to specific consumer demands. This is supposed to result in relatively high labour intensity, which again helps newly industrializing economies to gain comparative advantages. Physical and human-capital intensities are most likely to differ within the very heterogeneous autoparts industry as well.

Thus a fairly detailed analysis of factor intensities prevailing in various sub-branches of the automotive industry is required to definitely judge the validity of the product-cycle hypothesis. In Table 22, this is done by applying the Lary-concept once again. As regards total transport equipment, the 1980-calculations based on national census data (more recent census data was not available) reveal an even higher relative capital intensity (total manufacturing = 100) in Brazil than calculated in Table 21. Wages per employee in transport equipment exceeded the manufacturing average by nearly 50 per cent, compared with 22 per cent according to international industrial statistics for the same year (Table 21). This difference was largely due to the inclusion of small enterprises with less than five employees in the industrial census of 1980. The large number of small enterprises that, typically, produce at higher labour intensity than larger enterprises [see e.g. Steel, Takagi, 1983] reduced the reference figures of average capital intensity in total manufacturing; but the inclusion of small enterprises hardly affected factor intensities in transport equipment, since they played only a minor role in this particular industry. Consequently, relative capital intensity in transport equipment increased (2). In interpreting factor intensities, the size

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- (1) In this context, it is interesting to note that Brazil is assigned a crucial role in worldwide production of trucks by multinational companies [Jürgens, 1987, p. 36].
  - (2) This is also evident from Table 22, when the calculations for 1979 and 1980 are compared. In the 1979-census, enterprises with less than five employees were excluded. This resulted in considerably lower relative factor intensities in transport-equipment industries. The 1979-figures for total transport equipment are very similar to the calculations for 1980 in Table 21. The different treatment of

Table 22 - Factor Intensities (a) in Sub-Branches of the Brazilian Transport-Equipment Industry 1975, 1979 and 1980

	1975			1979			1980		
	overall-capital intensity	physical-capital intensity	human-capital intensity	overall-capital intensity	physical-capital intensity	human-capital intensity	overall-capital intensity	physical-capital intensity	human-capital intensity
Total manufacturing industries	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total transport equipment	106.2	98.7	137.9	107.3	101.1	130.8	132.2	129.0	147.5
Shipbuilding	94.3	84.9	133.5	124.1	121.4	134.3	140.4	139.8	143.1
Railway equipment	100.6	93.2	132.3	98.3	80.5	164.6	89.8	70.7	179.1
Motor vehicles (autoparts included)	120.7	114.5	146.6	114.5	109.8	132.0	164.4	166.2	156.0
Chassis with motors for buses and trucks	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	50.7	23.8	176.5
Motor vehicles	249.0	269.2	164.6	172.5	177.0	155.9	467.1	526.9	186.3
Passenger cars, pick-ups, etc.	239.2	256.9	164.6	149.3	146.6	159.4	375.4	414.9	189.7
Trucks, buses	278.9	306.4	164.0	219.0	237.8	148.9	641.0	739.2	179.7
Autoparts (b)	n.a.	n.a.	n.a.	117.8	113.8	132.7	109.8	100.0	155.8
Motors	167.1	162.8	185.1	186.6	190.6	171.5	180.6	170.5	227.5
Motor parts	140.3	135.9	158.4	135.0	135.3	133.8	122.1	113.4	162.5
Transmissions	357.3	401.8	170.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Transmission parts	105.0	93.0	155.3	97.8	86.0	141.9	72.0	56.4	145.4
Suspensions	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	50.3	33.2	130.2
Suspension parts	140.0	135.9	157.1	140.6	144.2	127.4	110.2	100.7	154.5
Axles, etc.	79.3	77.3	88.2	76.8	74.4	86.0	44.1	36.9	77.6
Wheels, brakes	194.3	204.1	153.4	116.6	111.8	134.4	111.5	103.7	147.9
Parts of wheels and brakes	90.3	80.9	129.2	83.4	80.8	93.2	98.8	95.2	115.9
Steering, switch-gears	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Gas-tanks, exhausts, etc.	68.9	56.7	119.9	66.1	55.5	105.2	69.7	64.1	96.0
Other parts	87.9	73.3	149.7	90.6	79.1	133.2	92.9	79.6	155.1
Overhauling of motors	63.6	52.1	111.8	n.a.	n.a.	n.a.	51.4	41.1	99.7
Maintenance of buses, trucks, taxis, etc.	36.4	18.4	111.8	36.6	18.3	104.8	45.7	25.2	141.6

Table 22 continued

	1975			1979			1980		
	overall-capital intensity	physical-capital intensity	human-capital intensity	overall-capital intensity	physical-capital intensity	human-capital intensity	overall-capital intensity	physical-capital intensity	human-capital intensity
Bodies for motor vehicles	75.5	69.6	100.0	68.3	59.9	99.7	57.0	46.8	105.1
Cabins and bodies for trucks	54.7	47.4	85.7	44.4	34.1	82.7	43.5	36.8	74.9
Bodies for buses	76.6	69.3	106.8	81.2	76.7	97.9	57.0	49.6	92.1
Trailers, etc.	95.6	95.1	97.5	82.2	72.4	118.7	67.4	56.0	120.6
Bodies for passenger and utility cars	114.5	94.7	197.5	126.9	122.9	142.0	75.2	51.9	184.7
Bodies, engine bonnets for other vehicles	72.1	68.0	90.1	44.2	34.1	82.0	64.4	58.3	93.4
Parts of bodies and cabins	57.7	46.5	104.3	46.0	32.5	96.7	61.2	49.8	114.9
Bicycles, motorcycles, etc.	83.9	83.3	86.3	122.2	128.4	99.3	129.2	140.0	78.3
Airplanes	88.0	61.2	200.6	104.8	86.4	173.6	105.7	76.7	241.9
Other vehicles	75.6	71.1	94.4	64.7	56.5	95.2	64.0	54.0	110.9
Seats and upholstery for vehicles	68.3	52.3	135.4	66.4	50.8	124.5	66.6	52.6	132.1

n.a. if data are not disclosed because of confidential treatment of firm-specific data.

(a) According to the Lary-concept, the following indicators are calculated: Value added per person engaged as a proxy for overall-capital intensity, wages per person engaged as a proxy for human-capital intensity, non-wage value added per person engaged as a proxy for physical-capital intensity. Figures for 1975 and 1979 are for establishments of 5 and more persons engaged, figures for 1980 are for all establishments (less than 5 employees included), both relative to total manufacturing industries (100.0). - (b) Electrical parts and parts of rubber, plastic and glass excluded.

Source: IBGE [b, 1975; 1980; c, 1979]; own calculations.



effect and related factors that may distort the results have to be kept in mind (for a detailed evaluation, see pp. 102 ff.).

In order to reduce the bias in relative factor intensities arising from differences in company size between industries, the interpretation of Table 22 is concentrated on the 1979-figures (which are based on data for enterprises with five and more employees). Yet, it remained highly dubious that Brazil enjoyed locational advantages in automobile production (1). Physical and human-capital intensities in motor-vehicle production (autoparts included) not only exceeded the manufacturing average, but were even higher than in total transport equipment. The calculations revealed capital-intensive modes of production for finished vehicles in particular. Overall-capital intensity amounted to 172.5 per cent of the manufacturing average.

It is interesting enough, however, that - contrary to total transport equipment and autoparts production - high overall-capital intensity in the production of finished vehicles was to be attributed to high physical-capital intensity to the larger part. Though wages per employee were extremely high as well, the ratio of index figures for physical and human-capital intensity was above 1; this ratio was below 1 in autoparts production. Within production of finished vehicles, total value added per employee was particularly high for trucks and buses; but wages per employee remained lower than in passenger-car production. This pattern provides some evidence that it may be easier for Brazil to achieve com-

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small enterprises had the most dramatic impact on relative factor intensities in the production of finished vehicles (passenger cars, trucks and buses), where small enterprises did not play any role at all.

- (1) The same applied to South Korea, as shown in Table A10. Moreover, striking similarities between Brazil and South Korea emerged with respect to various other aspects as well (described in the text for Brazil; the only exception was that human-capital intensity in Korean motor-vehicle production remained somewhat below the average for total transport equipment, though it considerably exceeded the average for all manufacturing industries). This is most relevant, since more recent information was available in the Korean case. The Korean experience indicated that relative factor intensities did not change considerably between 1978 and 1983. It is thus unlikely that the position of the Brazilian motor-vehicle industry, as it prevailed at the end of the 1970s, changed drastically in the early 1980s.

parative advantages in production of commercial vehicles. However, from this analysis it seemed rather unlikely that, in the late 1970s, standardization had already proceeded to the point where locational advantages could be supposed to switch from developed to newly industrializing countries such as Brazil.

As concerns autoparts production and bodies, results of Table 22 underline the earlier presumption of considerable differences in relative factor intensities between various Brazilian sub-branches. Concentrating on human-capital intensity, which is most relevant in the context of the product-cycle hypothesis,

- by far the highest figure was calculated for motors (171.5), though, as in production of finished vehicles, relative physical-capital intensity was even higher;
- wages per employee also exceeded the manufacturing average significantly in the case of other major automotive items, such as motor parts, transmission parts, suspension parts, and wheels and brakes;
- figures were below the average for axles, and parts of wheels and brakes; the same applies to bodies for trucks and buses, and parts of bodies.

It was mainly for the latter items that Brazil could be assumed to have achieved locational advantages. The production of these items did not draw extensively on Brazil's relatively poor endowment with highly skilled labour. Overall-capital intensity remained significantly below the average as well (1). It is thus rather surprising that Brazil did not concentrate more strongly on the production of items such as bodies for commercial vehicles and parts thereof, axles, and parts of wheels and brakes. Together they accounted for only about 15 per cent of total employment in motor-vehicle industries in 1979 (autoparts and related items included); their share in production value amounted to less than 6 per cent. On the other hand, nearly one third of autoparts production

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(1) As regards bodies for commercial vehicles and parts thereof, this could be attributed to the operations of many and mostly small body manufacturers, producing at higher labour intensity than the large end-producers [Stevens, 1987, p. 23].

in Brazil consisted of motors and parts thereof; transmissions and suspensions (parts included) figured prominently as well, although the production of these items required considerable inputs of highly skilled labour. The structure of autoparts production in Brazil thus revealed that the country's assumed locational advantages were far from fully exploited in the late 1970s.

### ß. Necessary Qualifications

It has to be analysed to what extent this conclusion, which is based on the calculation of Lary-measures of relative factor intensities, has to be qualified. It is most important to know in which direction the results are likely to be biased. Firstly, it may be objected that the results calculated for the late 1970s were no longer valid in the mid-1980s. To our view, this argument is not of much relevance. The Korean example presented in Table A10 showed that factor intensities in automobile production did not change remarkably between 1978 and 1983. Comparing factor intensities in the sub-branches of the Brazilian motor-vehicle industry in 1975 and 1979/80, a fairly stable pattern emerged as well (Table 23) (1). The inter-temporal comparison of physical and human-capital intensities revealed extremely high rank-correlation coefficients; i.e., sub-branches with relatively high (low) capital intensities in 1975 ranked at the top (bottom) in the late 1970s as well.

As concerns the product-cycle hypothesis, the evidence from rank-correlation analysis is mixed at best. A modest trend towards standardization may be traced from the following observations in Table 23:

- In the second half of the 1970s, human-capital intensity declined in branches with relatively high wages per employee in 1975; a similarly negative relationship was not to be observed for physical-capital intensity.
- More importantly, a significantly negative correlation appeared between the change in human-capital intensity from 1975 to 1979 on the one

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(1) Due to reasons of comparability (see p. 100 above), the interpretation of Tables 23 and A11 is restricted to the comparison of 1975 and 1979.

Table 23 - Factor Intensities in Sub-Branches of the Motor-Vehicle Industry of Brazil 1975, 1979 and 1980 - Rank-Correlation Results (a)

	PCI 75	PCI 79	PCI 80	HCI 75	DPCI 75/79	DPCI 75/80
PCI 79	0.93 (0.001)					
PCI 80	0.81 (0.001)					
HCI 75	0.73 (0.001)					
HCI 79		0.80 (0.001)		0.92 (0.001)		
HCI 80			0.69 (0.001)	0.94 (0.001)		
DPCI 75/79	0.02 (0.463)					
DPCI 75/80	-0.07 (0.378)					
DHCI 75/79				-0.49 (0.017)	-0.42 (0.037)	
DHCI 75/80				0.25 (0.142)		0.39 (0.044)
Variables (for about 20 sub-branches):						
PCI 75, PCI 79, PCI 80: physical-capital intensity in 1975, 1979 and 1980 respectively (total manufacturing = 100);						
HCI 75, HCI 79, HCI 80: human-capital intensity in 1975, 1979 and 1980 respectively (total manufacturing = 100);						
DPCI 75/79, DHCI 75/79, percentage change in physical and human-capital intensity, between 1975 and 1979 and between 1975 and 1980 respectively.						
(a) The calculations of Spearman rank-correlation coefficients are based on data for about 20 sub-branches of the motor-vehicle and auto-parts industry of Brazil; in parentheses: level of significance.						

Source: Tables 22 and All; own calculations.

hand and the corresponding change in physical-capital intensity on the other hand. This indicated some degree of substitution between human and physical capital; in branches such as the manufacturing of motors, suspension parts, other parts, bodies for buses and bodies for passenger cars, where the non-wage content in value added increased, human-capital intensity was considerably reduced (see Table All for details).

However, both non-wage value added and wages per employee decreased to a similar extent (9-10 per cent) when the average of all sub-branches of the Brazilian motor-vehicle industry is considered. Moreover, the positive correlation between human and physical-capital intensity (1975: 0.73) remained similarly strong in 1979 and 1980. The results of Table 23 thus do not reveal a pronounced move towards standardization.

Secondly, it may be objected that inter-industry comparisons of factor intensities must be "normalized" in various respects. Otherwise distortions may arise, insofar as differences in factor intensities were due to the different role various types of enterprise played in specific industries, rather than different modes of production in manufacturing of specific goods. For Brazil, it was shown elsewhere that exporting enterprises applied more capital-intensive technologies than non-exporters (1). At first sight, this result seems to conflict with traditional theory of international trade; ignoring policy-induced effects, a negative relationship between capital intensity and export performance was expected for developing countries according to theory, due to these countries' assumed locational advantages. Actually, however, this theorem is not invalidated by the aforementioned empirical results; since it cannot be concluded from them that higher capital intensity had a positive impact on exports: "Firms that export may be relatively capital-intensive not by virtue of the fact that they sell part of their output to foreign markets, but rather because they are large" (2). Typically, capital intensity is positively related to size (3). Similarly, the production of foreign companies in developing countries is typically more capital-intensive than the production of local firms (4). At the same time, foreign-based companies frequently play a dominant role in exporting. Again this must be attributed to firm-characteristics rather than high capital intensity.

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(1) CEPAL [1985]; for a summary, see Nunnenkamp, Fasano-Filho [1986, pp. 53 ff.].

(2) CEPAL [1985, pp. 31 f.]; see also van Dijck [1986, pp. 207 ff.].

(3) For Brazil, this was shown by CEPAL [1985]; the correlation coefficient of 0.46 between enterprise size and overall-capital intensity was significantly positive.

(4) For Brazil and other Latin American countries, see additionally Sosin, Fairchild [1987]; Willmore [1986].

Therefore, the preceding calculations of relative factor intensities may be misleading as concerns Brazil's locational advantages in motor-vehicle production. Important segments of this industry were dominated by foreign multinationals, which operated at an extremely larger scale than the average of local firms in manufacturing (1). The extent to which relative capital intensity in motor-vehicle production was "overstated" due to the size effect could not be calculated exactly. Table 24 gives some rough indications, by presenting Lary-measures for enterprises of different size in all manufacturing industries of Brazil on the one hand and in transport-equipment industries on the other hand (2). In both total manufacturing and transport equipment, non-wage value added and wages per employee increased with the number of employees engaged by firms (the latter indicating firm-size). From the lower part of Table 24, it appears that overall and physical-capital intensity were actually lower in transport equipment than in total manufacturing when enterprises of a similar size were compared (total manufacturing of the respective size class = 100).

As regards human-capital intensity, differences were considerably reduced when inter-industry comparisons were normalized by size. In Table 22, wages per employee in transport equipment were about 30-50 per cent higher than in total manufacturing; this difference was roughly halved when adjustment was made for the size effect (see the last line of Table 24). But some positive differences in human-capital intensity remained for all size classes (except II and V in 1981). On average, this difference decreased somewhat in the second half of the 1970s, but increased again between 1979 and 1981. Thus, a clear tendency towards reduced relative human-capital intensity in transport equipment could not be identified from the calculations normalized by firm-size either.

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(1) Detailed information on the average size of establishments in various sub-branches of the Brazilian transport-equipment industries was derived from census data (available from the authors upon request). Even relative to the average firm-size in total transport equipment, finished-vehicle producing firms were about ten times as large; the average firm-size was significantly larger in the production of major components such as motors and transmissions as well.

(2) Similar information was not available at a more disaggregated industry level.

Table 24 - Factor Intensities (a) in Total Manufacturing and Transport-Equipment Industries of Brazil, by Size of Establishments (b), 1975, 1979 and 1981

	1975			1979			1981		
	overall-capital intensity	physical-capital intensity	human-capital intensity	overall-capital intensity	physical-capital intensity	human-capital intensity	overall-capital intensity	physical-capital intensity	human-capital intensity
Total manufacturing (Cr \$ thousand)									
Size class: I (5-9)	42.8	33.7	9.1	214.6	159.1	55.5	640.4	442.4	198.0
II (10-19)	55.2	42.9	12.2	245.9	184.9	61.0	837.3	596.8	240.6
III (20-49)	68.9	54.3	14.5	308.7	236.1	72.6	1197.2	911.2	286.0
IV (50-99)	78.3	62.1	16.2	380.9	299.3	81.6	1506.4	1169.6	336.8
V (100-249)	97.8	80.9	16.9	433.8	346.9	86.9	1926.8	1579.9	346.8
VI (250-499)	91.1	74.1	17.0	495.6	403.4	92.2	2045.7	1659.2	386.5
VII (500 and more)	104.4	84.3	20.1	486.1	378.4	107.7	2178.2	1782.7	395.5
unweighted average	76.9	61.8	15.1	366.5	286.9	79.6	1476.0	1163.1	312.9
Transport equipment (Cr \$ thousand)									
Size class: I (5-9)	38.9	27.2	11.6	155.1	90.5	64.7	528.3	267.1	261.2
II (10-19)	46.3	32.3	14.1	199.9	129.2	70.7	553.7	318.7	235.0
III (20-49)	60.9	44.4	16.5	260.5	175.6	84.9	840.3	496.6	343.7
IV (50-99)	70.9	52.5	18.4	304.5	215.1	89.4	1624.3	1177.2	447.2
V (100-249)	84.9	64.4	20.5	380.8	280.7	100.1	1578.9	1233.5	345.4
VI (250-499)	84.5	63.1	21.4	450.3	344.4	105.9	1952.8	1459.5	493.4
VII (500 and more)	107.7	81.5	26.2	523.1	392.7	130.4	3416.5	2818.5	598.0
unweighted average	70.6	52.2	18.4	324.9	232.6	92.3	1499.3	1110.2	389.1
Transport equipment (total manufacturing = 100)									
Size class: I (5-9)	90.9	80.7	127.5	72.3	56.9	116.6	82.5	60.4	131.9
II (10-19)	83.9	75.3	115.6	81.3	69.9	115.9	66.1	53.4	97.7
III (20-49)	88.4	81.8	113.8	84.4	74.4	116.9	70.2	54.5	120.2
IV (50-99)	90.5	84.5	113.6	79.9	71.9	109.6	107.8	100.6	132.8
V (100-249)	86.8	79.6	121.3	87.8	80.9	115.2	81.9	78.1	99.6
VI (250-499)	92.8	85.2	125.9	90.9	85.4	114.9	95.5	88.0	127.7
VII (500 and more)	103.2	96.7	130.3	107.6	103.8	121.1	156.8	158.1	151.2
unweighted average	91.8	84.5	121.9	88.6	81.1	116.0	101.6	95.5	124.4

(a) According to the Lary-concept, the following indicators are calculated: Value added per person engaged as a proxy for overall-capital intensity, wages per person engaged as a proxy for human-capital intensity, non-wage value added per person engaged as a proxy for physical-capital intensity. - (b) Indicated by the number of employees.

Source: IBGE [b, 1975; c, various issues]; own calculations.

It may be argued that relative human-capital intensity in transport-equipment industries is still overstated in Table 24. In addition to size effects, a further adjustment may be required because of the dominance of multinational companies in Brazilian motor-vehicle production. Compared with local firms of similar size, foreign companies were likely to apply even more capital-intensive techniques. Due to strong ties to their parent companies in developed countries, the relatively poor endowment of Brazil with human skills did not constrain the multinationals' choice of production techniques as much as it might have done for national producers. Lacking adequately disaggregated data, this question could not be systematically analysed for Brazil's motor-vehicle industry. Indirectly, some Korean evidence indicated that distortions arising from differences in the importance of different types of ownership were not as strong as might have been expected. According to Table A12, the relative human-capital intensity in the Korean transport-equipment and motor-vehicle industries decreased only slightly more than in Brazil when factor intensities are normalized by size. In case of considerable distortions arising from the prominent role of foreign companies in Brazil, the size-related reduction in human-capital intensity should have been significantly stronger in South Korea than in Brazil, since foreign companies were of only minor importance in the motor-vehicle industry of the former country.

The third objection to the conclusions drawn in the preceding section relates to the theoretical foundation of the Lary-measure on human-capital intensity. Adequate data on labour inputs of different skills is frequently not available; thus the wage content in value added is considered as a proxy for human-capital intensity. The Lary-measure assumes that the higher are the wages per employee, the higher is the skill factor in labour inputs. Though this relationship can safely be assumed to be rather strong, other factors than differences in skills are likely to have an impact on inter-industry differences in average wages as well. If higher wages were paid in the Brazilian motor-vehicle industry for other reasons than higher skill requirements (relative to total manufacturing), this industry may have achieved comparative advantages, although Lary-measures rather indicated the opposite. Most importantly, the relatively high degree of automobile workers' organization



Table 25 - The Structure of Employment and Average Wages in Transport Equipment and Total Manufacturing Industries of Brazil, 1975 and 1980

	1975								1980 (a)						
	total employees (b)	managers (c)	productive staff			non-productive staff		total employees (b)	managers (d)	productive staff (e)			non-productive staff (e)		
			upper level (f)	medium level (g)	workers	upper level (f)	other			upper level (f)	medium level (h)	workers	upper level (f)	other	
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	
per cent	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	
per cent	100.0	5.8	3.4	11.9	67.1	1.4	10.4	100.0	12.1	1.9	6.8	71.2	1.1	6.9	
Average wages (i)															
Cr \$ 1000	22.27	60.87	110.00	51.06	18.07	85.00	26.00	212.3	756.3	720.7	448.5	178.3	587.3	192.9	
total employees = 100	100.0	273.3	493.9	229.3	81.1	381.7	116.7	100.0	356.2	339.5	211.3	84.0	276.6	90.9	
Total manufacturing															
Employment															
1000	3594.4	131.5	22.1	150.4	2897.6	12.1	380.6	4481.4	166.5	25.7	117.3	3746.5	16.4	409.0	
per cent	100.0	3.7	0.6	4.2	80.6	0.3	10.6	100.0	3.7	0.6	2.6	83.6	0.4	9.1	
Salaries															
Cr \$ million	58623	5772	2065	6219	35596	958	8014	682773	96764	16461	38875	455927	8392	66354	
per cent	100.0	9.8	3.5	10.6	60.7	1.6	13.7	100.0	14.2	2.4	5.7	66.8	1.2	9.7	
Average wages (i)															
Cr \$ 1000	16.31	43.89	93.44	41.35	12.28	79.17	21.06	152.4	581.2	640.5	331.4	121.7	511.7	162.2	
total employees = 100	100.0	269.1	572.9	253.5	75.3	485.4	129.1	100.0	381.4	420.3	217.5	79.9	335.8	106.4	
Average wages in transport equipment (total manufacturing = 1.00)	1.37	1.39	1.18	1.23	1.47	1.07	1.23	1.39	1.30	1.13	1.35	1.47	1.15	1.19	

(a) The employment structure of 1980 is not fully comparable to 1975, due to slightly changed definitions of some categories; see also the following notes. - (b) Total number of persons engaged minus proprietors and unpaid family members. - (c) "Presidentes", "diretores", and "gerentes". Probably, mainly managers receive the bulk of gratifications and profit shares not included in regular salaries, so that the latter are relatively low. - (d) "Chefes" and "supervisores" in productive and non-productive activities included (in addition to categories given in note (c)). - (e) Without "gerentes, chefes e supervisores". - (f) "Profissionais de nível superior". - (g) "Técnicos de nível médio", "mestres", and "contramestres". - (h) "Mestres" and "contramestres". - (i) Total salaries divided by number of employees, i.e., annual wage payments per employee in the respective category.

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

in trade unions, was likely to raise wages for specific labour qualifications above the manufacturing average for the same skill category (1).

Table 25 clearly indicates that, for similarly qualified employees, the Brazilian transport-equipment industry (more disaggregated information was not available) paid higher wages than the average of all manufacturing industries. The differences were most pronounced for less qualified productive workers; for them, wages in transport equipment exceeded the average wage by nearly 50 per cent. This provides strong evidence that the Lary-measure of wages per employee significantly overstated the relative human-capital intensity in Brazilian motor-vehicle production (2). As concerns the employment share of more qualified employees, Table 25 does not reveal significant differences between transport equipment and total manufacturing (3).

#### γ. Summary

Accounting for all qualifications discussed above, the conclusions from Section α concerning human-capital intensity in Brazilian automotive industries have to be revised. High wages per employee, which according to the Lary-concept were considered as an indicator of human-capital intensity, were largely due to other factors than inter-industry differences in the absorption of highly qualified labour, i.e., the relatively scarce production factor in Brazil. Taking the effects of firm-size and the impact of unionization on wages into account, differences in human-capital intensity between automotive industries and the manufacturing average were considerably reduced, if not completely eroded. Though it seems safe to conclude that most of the Brazilian automotive industries

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(1) For industrial relations in the Brazilian automobile industry, see Humphrey [1982; 1984a; 1984b].

(2) It must be stressed, however, that productive workers accounted for more than four fifth in total employment. This large and rather heterogeneous group could not be disaggregated. To some degree, higher wages in transport equipment may have resulted from higher skill requirements within the group of productive workers.

(3) More qualified employees included: managers, upper and medium-level productive staff, upper-level non-productive staff. Employment shares amounted to 8.4 (1975) and 7.5 per cent (1980) in transport equipment, and 8.8 (1975) and 7.3 per cent (1980) in total manufacturing.

had not become standardized to the extent hypothesized by the product-cycle theory, Brazil may have become a favourable location for motor-vehicle production in the late 1970s and early 1980s.

Due to data restrictions, the question of factor absorption in the context of given factor endowments in Brazil could not be assessed for the more recent past. As concerns the future competitive position of Brazil's automobile industry (to the extent that it is determined by comparative advantages), the development of production techniques and their adaptation to Brazil's factor endowments plays a crucial role. Presently, "the degree of automation on Brazilian production lines is very limited by modern OECD standards" [Stevens, 1987, p. 30]. Sometimes it is argued that more automation is required for reasons of quality control, implying a larger number of robots for welding and painting for example. Undoubtedly, quality considerations are important if international markets are aimed at. However, further automation in the Brazilian automobile industry would also affect the chances to strengthen comparative advantages. Brazil must not strive for the most recent technology to be applied in automobile production, considering the country's factor endowments and the still prevailing relative scarcity of human capital.

## 2. *The Role of Government Interventions in Brazil*

From the preceding analysis, the automobile industry's position with respect to comparative advantages could not be determined unambiguously. It cannot be ruled out that the favourable export performance in the past was mainly due to economic incentives provided by the Brazilian government, rather than industrial specialization which was in accordance with the country's relative factor endowments. The alternative hypothesis according to which economic policies artificially created the success of Brazilian automobile production in world markets has two dimensions [Nunnenkamp, Fasano-Filho, 1986, pp. 30 ff.]:

- Overall financial and monetary policies in countries such as Brazil frequently result in domestic inflation rates in excess of world-price increases. The *global* competitive position of manufacturing industries

thus depends on whether the exchange rate is flexible enough to correct for divergencies between the national and the international price trend (1). Changes in the exchange rate affect the automotive industries and all other manufacturing industries at the same rate.

- In addition to determining the global world-market position of manufacturing by exchange-rate policies, various policy measures are likely to affect the *relative* competitive position of different industries. Typically, economic incentives like fiscal and financial bonuses and protectionist measures are not evenly distributed, but rather discriminate between industries. Thus, the inter-industry allocation of production factors is affected, and domestic producers will concentrate on activities where the officially granted incentives are particularly high. The resulting pattern of industrial specialization may well be in conflict with the country's locational advantages; i.e., a favourable export performance of industries may be artificially created by policy-induced distortions, rather than based on an efficient use of factors of production according to the country's relative factor endowments. At the prevailing exchange rate, high-cost producing firms may compete in international markets successfully because of firm or industry-specific export subsidies.

The impact of economic policies on the export performance of the Brazilian motor-vehicle industry is analysed in the following. Section B.IV.2.a focuses on exchange-rate policies. Subsequently, it is discussed if and to what extent industry-specific incentives favoured the motor-vehicle industry.

#### a. Automobile Exports and Exchange-Rate Policies

The basic equation estimated in order to assess the exchange-rate impact on the export performance of the Brazilian automobile industry runs as follows:

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(1) In the case of domestic inflation exceeding inflation abroad, a nominal depreciation of the domestic currency to the amount of the inflation differential is required to keep the real exchange rate and thus international price competitiveness constant.

$$X = \text{Const.} + a_1 \text{REXR} + a_2 \text{CU} + a_3 \text{PR}$$

where:

X = export-performance indicator; for the alternative definitions, see the text below;

Const. = constant term;

REXR = real exchange rate of the Cruzeiro vis-à-vis Brazil's major partners in trade of automotive items (1980 = 100; logarithmic form) (1);

CU = degree of capacity utilization in the Brazilian automobile industry (2);

PR = number of motor vehicles produced in Brazil (1000; logarithmic form) (3).

This equation presents the Brazilian supply of automobile exports as a function of the real exchange rate. Additionally, the degree of capacity utilization and total production volume were considered as explaining variables (4). As concerns the signs of the regression parameters, it was to be expected that:

- $a_1$  is positive; since in the case of real depreciations (appreciations) of the Cruzeiro, resulting in higher (lower) index values of REXR, the price competitiveness of Brazilian exports improved (decreased);
- $a_2$  is negative; since the recession/boom variable CU captures the fact that, in periods of slackening domestic demand, Brazilian producers may have tried to sell more abroad, in order to reduce idle capacity;
- $a_3$  is positive; since the higher was overall output, the higher was the potential of exports.

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(1) For the reference countries considered and the calculation procedures, see notes to Tables 26 and 27. For the regressions considering specific export markets of Brazil (Table 27), separate exchange-rate indices were calculated vis-à-vis major trading partners located in the specific regions.

(2) The difference between trend figures on the volume of domestic sales (of the indicated segment of the Brazilian motor-vehicle industry) and actual volumes of domestic sales was considered as a proxy of capacity utilization; trend figures were based on logarithmic trend estimates for 1970-1980.

(3) In Table 26, number of vehicles produced in the indicated segment of the Brazilian motor-vehicle industry.

(4) As is common use, the small-country assumption was applied; i.e., it was assumed that Brazil faced a perfectly elastic demand curve for automobile exports.

Table 26 - The Impact of the Real Exchange Rate and the Degree of Capacity Utilization on Brazilian Exports of Road-Motor Vehicles 1970-1985 - Regression Results (a)

Exported item(b)	Const.	REXR(c)	CU(d)	PR(e)	R <sup>2</sup> N	F D.W.	RHO(f)
Total road-motor vehicles	-6.47 (-0.96)	0.07 (0.06)	-1.13** (-2.28)	1.56 (1.42)	0.18 15	1.64 2.55	0.60 (7)
Passenger cars	-18.65** (-2.35)	0.37 (0.32)	-2.56** (-3.04)	3.35* (2.13)	0.48 15	4.41 2.74	0.52 (5)
Cars for mixed use(g)	-2.02 (-0.17)	-2.03 (-0.69)	-0.72 (-1.41)	2.52*** (3.43)	0.40 15	3.41 1.47	0.58 (3)
Pick-ups(h)	-23.39*** (-7.47)	0.96 (1.46)	-2.82*** (-6.79)	4.57*** (10.24)	0.90 15	34.08 2.56	0.51 (4)
Light and medium trucks	-10.15 (-1.95)	0.02 (0.02)	-1.07** (-2.40)	2.82*** (4.93)	0.68 15	8.93 2.36	0.39 (4)
Heavy trucks	-7.73 (-0.88)	0.17 (0.09)	-1.76** (-2.54)	3.02*** (3.72)	0.44 15	3.87 1.83	0.61 (5)
Total trucks	-10.53 (-2.01)	0.15 (0.12)	-1.01** (-2.36)	2.74*** (4.93)	0.67 15	8.42 2.32	0.41 (4)
Buses	-8.03 (-0.65)	0.34 (0.12)	-0.76 (-1.53)	2.80*** (5.91)	0.75 15	12.51 2.23	0.22 (2)
Tractors	-8.83 (-0.78)	-0.75 (-0.33)	-2.28** (-2.51)	3.09* (2.25)	0.20 15	1.75 1.53	0.62 (6)

(a) Due to serious auto-correlation of the error term, the Cochrane-Orcutt iterative method was applied as estimation technique; t-statistics in parentheses beneath the regression coefficients; \*\*\* significant at 1 per cent level of confidence; \*\* 5 per cent; \* 10 per cent (two-tailed t-test). - (b) Dependent variable: number of motor vehicles (1000) of the category indicated exported by Brazil (logarithmic form). - (c) REXR: real exchange rate (logarithmic form) of Brazil vis-à-vis its major trading partners as regards Brazilian exports of road-motor vehicles (France, West Germany, Italy, Netherlands, United Kingdom, United States, Argentina, Chile, Colombia, Ecuador, Mexico, Peru, Uruguay, Venezuela, Algeria, Egypt, Morocco, Nigeria, South Africa, and Tunisia; these countries accounted for nearly 70 per cent up to 87 per cent of total Brazilian road-motor-vehicle exports in 1974, 1978, and 1982). Calculation as follows: nominal exchange-rate indices (1980=100) of Brazil vis-à-vis each country of the above list were multiplied by trade weights; for the 1970-1975 period, trade weights of 1974 were applied; for 1976-1980: 1978; and for 1981-1985: 1982. Nominal exchange-rate indices were multiplied by the index of relative wholesale prices (1980=100) between the trading partners listed and Brazil (consumer prices where wholesale prices were not available). Thus, a real depreciation (appreciation) of the Cruzeiro vis-à-vis the world is indicated by index figures above (below) 100, taking 1980 as the reference period. - (d) CU: degree of capacity utilization in the indicated sub-branches of the Brazilian motor-vehicle industry that can be attributed to domestic sales; approximated by the difference between  $\ln$  DSVTR and  $\ln$  DSVACT, where DSVTR: trend figures for the volume of domestic sales of the respective sub-branch (based on logarithmic trend estimates for the 1970-1980 period); DSVACT: actual volume of domestic sales. - (e) PR: number of motor vehicles (1000) of the category indicated produced in Brazil (logarithmic form). - (f) Final value of RHO; in parentheses: number of iterations. - (g) Automóveis de uso misto. - (h) Camioneta de uso misto, utilitários, camioneta de carga.

Source: ANFAVEA, unpubl. data on Brazilian exports and production of motor vehicles; IMF [various issues]; UN [a]; own calculations.

In Table 26, time-series regressions are presented for the 1970-1985 period. As dependent variable X, reflecting Brazilian export performance in world markets, the number of motor vehicles sold abroad was considered. Separate regressions were run for various types of motor vehicles. All in all, the regressions revealed the same pattern. As hy-

Table 27 - The Impact of Real Exchange Rates and the Degree of Capacity Utilization on Brazil's Market Share in Total Road-Motor-Vehicle Imports of Selected Regions 1970-1984 - Regression Results (a)

Importing region (b)	Period (c)	Const.	REXR (d)	CU (e)	PR (f)	R <sup>2</sup> N	F D.W.
World	1970-84	-3.72* (-2.06)	-0.28 (-0.57)	-0.72*** (-6.35)	0.79*** (5.78)	0.87 15	31.32 1.26
	1970-80	-6.40*** (-6.51)	0.44 (1.60)	-0.67*** (-3.61)	0.73*** (9.76)	0.95 11	62.19 1.87
Industrialized countries	1970-84	-0.72 (-0.80)	-0.24 (-0.90)	-0.40*** (-10.43)	0.28*** (4.25)	0.92 15	53.18 2.80
	1970-80	-2.86*** (-7.94)	0.49*** (4.18)	-0.25*** (-5.78)	0.12*** (4.07)	0.97 11	117.67 2.90
United States	1970-84	-1.52 (-1.49)	-0.21 (-0.80)	-0.27*** (-4.02)	0.39*** (6.73)	0.84 15	26.15 0.80
	1970-80	-2.63** (-2.58)	-0.02 (-0.10)	-0.63*** (-6.19)	0.44*** (11.40)	0.96 11	72.38 1.77
Europe (g)	1970-84	-0.10 (-0.09)	-0.77 (-1.57)	-0.67*** (-7.95)	0.53** (2.61)	0.88 15	33.98 2.30
	1970-80	-1.49** (-3.02)	0.27 (1.07)	-0.23 (-1.83)	0.05 (0.49)	0.64 11	6.84 1.51
Developing countries	1970-84	-15.59*** (-3.11)	-0.09 (-0.07)	-1.68*** (-3.69)	2.60*** (6.29)	0.85 15	27.21 2.06
	1970-80	-20.85*** (-9.03)	1.16* (1.91)	-1.85*** (-3.79)	2.57*** (14.27)	0.97 11	107.17 3.29
ALADI	1970-84	-36.27 (-1.49)	-2.01 (-0.35)	-7.12*** (-3.98)	7.44*** (4.27)	0.74 15	14.23 2.04
	1970-80	-64.51*** (-4.29)	5.90 (1.67)	-2.27 (-0.78)	6.46*** (6.35)	0.85 11	19.27 2.65
Africa	1970-84	-16.91*** (-4.26)	-2.01 (-1.09)	-1.92 (-1.59)	3.97** (3.09)	0.60 15	8.08 1.34
	1970-80	-21.68*** (-5.82)	-4.34 (-0.83)	-8.17 (-1.40)	6.15 (1.74)	0.79 11	13.50 2.46

(a) In parentheses: t-statistics; \*\*\* significant at 1 per cent level of confidence; \*\* 5 per cent; \* 10 per cent (two-tailed t-test). - (b) Dependent variable: Brazil's market share in total road-motor-vehicle imports (SITC 732) of the respective region. - (c) For the economic rationale of running the regressions for the 1970-1980 period (in addition to 1970-1984), see the text. - (d) REXR: real exchange rate between Brazil and the respective region (logarithmic form). Calculation as follows: nominal exchange-rate indices (1980=100) of Brazil vis-à-vis the most important trading partners in the respective region (world: France, West Germany, Italy, Netherlands, United Kingdom, United States, Argentina, Chile, Colombia, Ecuador, Mexico, Peru, Uruguay, Venezuela, Algeria, Egypt, Morocco, Nigeria, South Africa, and Tunisia; these countries accounted for nearly 70 per cent up to 87 per cent of total Brazilian road-motor-vehicle exports in 1974, 1978 and 1982; other regions: countries from the above list located in the respective region) were multiplied by trade weights of the countries listed; for the 1970-1975 period, trade weights of 1974 were applied; for 1976-1980: 1978; and for 1981-1984: 1982. Nominal exchange-rate indices were multiplied by indices of relative wholesale prices (1980=100) between the respective region and Brazil (consumer prices where wholesale prices were not available). Thus, a real depreciation (appreciation) of the Cruzeiro vis-à-vis the region considered is indicated by index figures above (below) 100, taking 1980 as the reference period. - (e) CU: degree of capacity utilization in Brazilian motor-vehicle production that can be attributed to domestic sales; approximated by the difference between ln DSVTR and ln DSVACT, where DSVTR: trend figures for the volume of domestic sales of the road-motor-vehicle industry of Brazil (based on logarithmic trend estimates for the 1970-1980 period); DSVACT: actual volume of domestic sales. - (f) PR: total number of road-motor vehicles (1000) produced in Brazil (logarithmic form). - (g) Brazil's market share in EC (10) plus EFTA.

Source: UN [a; b; d]; IMF [various issues]; ANFAVEA, unpubl. data on Brazilian motor-vehicle production; own calculations.

pothesized, exports were positively related to the production volume of the specific type of motor vehicles. Expectations were met as concerns CU as well: in most regressions, the recession/boom variable proved to be significantly negative at the 5 per cent level or better. Contrary to what was hypothesized, however, the real-exchange-rate variable remained insignificant for all types of motor vehicles.

By and large, the latter result was also found when the performance of Brazilian automobile exports in different export markets was analysed. In Table 27, time-series regressions for Brazilian exports of all types of motor vehicles to the country's most important overseas markets are reported. Here, the dependent variable X was defined as Brazil's market share in total road-motor-vehicle imports (SITC 732) of the respective region (1). The real-exchange-rate variable proved to be totally insignificant in explaining Brazil's market shares when the 1970-1984 period was analysed. The evidence was somewhat "better", considering the hypothesized pattern, when the calculations were restricted to 1970-1980. With two exceptions (United States, Africa), the parameters revealed the expected positive signs at least; for the aggregates of all industrialized economies and all developing countries, statistical significance was guaranteed.

The differences between the 1970-1984 and 1970-1980 periods were likely to be due to economic turbulences, that could be supposed to have obscured the impact of exchange-rate variations on the Brazilian performance in exporting motor vehicles. In the early 1980s, demand factors gained crucial importance. Both domestic-market conditions in Brazil and the demand in other debt-ridden developing countries deteriorated drastically. The adjustment problems arising from these unfavourable demand developments caused economic performance to decline, although Brazil devalued the Cruzeiro considerably in February 1983 (2). On the

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- (1) Again CU and PR showed the expected signs and were highly significant in most cases.
  - (2) Brazil's share in world trade of road-motor vehicles declined from 1.2 per cent in 1981 to 0.7 per cent in 1983; in ALADI-markets, 6.5 per cent of automobile imports originated from Brazil in 1983, as against 10.5 per cent in 1981 (Africa: 1.1 and 2.6 per cent respectively).



other hand, Brazilian automobile companies had to comply with export commitments previously agreed upon in BEFIEX-programs. The pressure to fulfill the commitments of the first round of BEFIEX-programs culminated in the early 1980s. This may have induced the companies to increase exports even at times of an overvalued Cruzeiro; this situation prevailed particularly prior to the 1983-devaluation.

From the lack of statistical significance it cannot be concluded that the real exchange rate was irrelevant with respect to Brazil's performance in exporting motor vehicles. As shown elsewhere [Nunnenkamp, Fasano-Filho, 1986, pp. 32 ff.], Brazilian authorities followed exchange-rate policies during much of the period considered in our estimations that managed to reduce real-exchange-rate instability and thus uncertainty for exporters. According to Table A13, the exchange-rate variable experienced very small deviations from its mean, compared with both the remaining explaining variables and the dependent variable. The Brazilian exchange-rate policies of the past can be viewed as a necessary condition to expand exports. Recently, however, they became rather volatile (1). This has created considerable uncertainty for exporters as concerns the price competitiveness of overseas sales. With the Cruzado-Plan of February 1986, the hitherto applied system of mini-devaluations was abolished, and the exchange rate of the newly introduced Cruzado was fixed against the US \$ for an undetermined period [for a critical evaluation of the Cruzado-Plan, see Fischer, 1986]. Since the attempt to eradicate inflation failed, exports were discouraged by an increasing overvaluation of the Cruzado (2). Public authorities would thus be well-advised to return to the fairly flexible exchange-rate policy of the 1970s. As a prerequisite to increase exports further, a) overvaluation of the national currency should be avoided and b) real-exchange-rate fluctuations should be kept to the minimum.

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(1) In the case of the Cruzeiro/US \$-relation, somewhat larger fluctuations were already revealed in Table A13; compared with 1970-1980, the standard deviation doubled when exchange-rate variations for the extended period of 1970-1984 were calculated.

(2) Overvaluation was indicated by the huge agio on the official exchange rate to be paid for US \$ in the parallel market; the agio amounted to more than 100 per cent in October 1986 [for details, see Fasano-Filho et al., 1987, pp. 76 ff.].

## b. Export Incentives for Automotive Exports

According to the World Bank [1983, p. 119], the rapid increase in the percentage of automobile production exported in the 1970s "was mainly the result of government incentives granted through the BEFIEEX program" (1). By other observers it was argued, however, that export incentives only compensated for export-retarding effects of import-substituting policies. The latter discriminated potential exporters in two respects: a) import restrictions that favoured automotive input suppliers may have raised input prices beyond world-market levels and thus affected the competitive position of automobile companies in world markets negatively; b) import-substituting policies gave rise to overvaluation of the Cruzeiro, compared with the exchange rate that would have prevailed under free-trade conditions. In order to evaluate whether export incentives compensated for export discriminations rather than effectively subsidizing overseas sales, we start with a short overview on the major instruments stimulating exports and their relevance for automotive industries. Subsequently, the question of relative incentives to domestic and overseas sales of the Brazilian motor-vehicle industry is raised and net effective incentive rates of automotive industries are assessed.

The Brazilian system of fiscal and financial incentives for manufactured exports was established during the years of economic liberalization in the mid-1960s and re-inforced later on. Export incentives were handled in a rather discretionary way and were subject to frequent changes. The system was devised to support specific sub-sectors such as the automobile industry, which were considered as key industries at different points in time. In the early 1980s, two programs for the financing of manufactured exports were in operation. Under the FINEX-program (Fund for Export Financing), the foreign-trade department of the Central Bank (CACEX) financed manufactured exports at subsidized terms in the pre-shipment and post-shipment stages. The other main

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(1) According to a questionnaire on the automobile companies' motives to engage in and to export from Brazil, the availability of export incentives appeared to be the second-important factor (the large domestic market allowing for economies of scale proved most important); see Crissiuma [1986, pp. 116 f.].

credit program directed to manufactured export financing was the so-called Resolution 674. This program aimed at supplying working capital to the firms producing manufactured exports.

Fiscal incentives figured prominently in the early 1980s [for details, see e.g. Carvalho, 1984]. They could be classified in two main groups: a) exemptions of indirect taxes and import duties reduced or eliminated export-retarding effects of tax policies and import restrictions; b) additional measures compensated for remaining disincentives to exports, in particular an overvaluation of the Cruzeiro, or provided genuine subsidies. Among the compensatory measures, the duty-drawback system was most important. Especially export-tax credits (*crédito prêmio*) and the reduction of corporate income taxes could be supposed to include a subsidy element.

For the automobile industry, the BEFLEX-program proved to be most important. Introduced in 1972, BEFLEX provided a combination of export incentives, granted on a firm-specific basis in return for commitments to reach agreed export targets over a period of generally 10 years. "The typical incentive package offered contains a 70-90 per cent duty and tax reduction on imports of machinery and equipment and a reduction of 50 per cent on raw material and intermediate products' imports, with complete exemptions of import duties and taxes granted in special cases. Major advantages of the BEFLEX incentive system are the permission to use the imports for both export and domestic market production, the waiver of the 'law of similars' (1), and, in some cases, a long-term guarantee against changes in the incentive system" [World Bank, 1983, pp. 54 f.]. The latter guarantee proved most valuable after 1979 when the "*crédito prêmio*" was abolished, but maintained for the automotive enterprises with a BEFLEX-agreement. The "*crédito prêmio*" represented the most important subsidy to exports. Until 1979, the export-tax-credit scheme was related to payments of sales taxes, and its rates were generally identical to the various tax rates for specific products. With

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(1) The waiver of restrictions to import items which were also produced domestically provided access to equipment at world-market prices and quality.

its re-implementation as a general incentive scheme in 1981, the "crédito prêmio" was set at a uniform rate for all products and it could be used immediately for payment of all tax obligations. The uniform rate amounted to 15 per cent of fob-export values; it was scheduled for reduction in several steps up to 1983, but the phasing-out was substantially revised later on.

Principally, the incentive system provided by BEFIEEX could be used by all enterprises (1). Actually, however, automotive industries were the main beneficiaries. In the 1972-1984 period, they accounted for 47 out of 294 firm-specific programs. The export commitments of this sector amounted to 38 per cent of total BEFIEEX-commitments of US \$ 85 billion. The share of imports obtained within BEFIEEX-programs by automotive industries in total BEFIEEX-imports was even larger; it reached 42 per cent for imports of machines and equipment, and 56 per cent for imports of materials and parts [for details, see CDI, 1984, Table 142](2). This concentration might have been partly due to the fact that other industries were not as prepared as the automotive industries to make use of the incentives offered by the government. Apart from this, however, the administrative complexity of the incentive system discriminated smaller firms that did not have the resources to be fully informed of the complexities of the system, to process the applications and to find their way through the bureaucratic mechanism. Another factor which handicapped smaller local firms related to the export commitments required in order to apply for BEFIEEX-programs. In contrast to foreign subsidiaries with their strong international links to parent companies and other subsidiaries, considerably higher risks were involved for smaller local firms to guarantee a minimum level of exports over a rather long period

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(1) A similar export-promotion system was operated in parallel to BEFIEEX. It applied to small enterprises for which export agreements were made for only up to five years, and export targets in relation to import volume were lower than in BEFIEEX-agreements.

(2) For the 1972-1983 period, more specific data for automobile companies and autoparts producers were available [CDI, 1983, Table IV.6]: The former accounted for 34 per cent of overall export commitments, 41 per cent of overall imports of machines and equipment, and 52 per cent of overall imports of materials and parts within BEFIEEX-programs. Autoparts industries added further 5 per cent in all respects.

[Tauile, 1987, p. 168]. According to Gadelha, Lobão [1982], BEFIEX-programs were best suited to foreign-based multinationals, which could ensure export sales to their countries of origin.

The favourable treatment of the transport-equipment sector with respect to export incentives is reflected in Table A14 (1). As concerns fiscal incentives, some adjustments have to be made since the actual value of incentives to exporters often differed from their legal value [for details, see World Bank, 1983, pp. 61 f.]. In the case of the "crédito prêmio", the impact of delays in cashing the certificates and the incidence of corporate income taxes reduced its value to about 65 per cent of its nominal amount. Similarly, the nominal amounts of tariff reductions under the BEFIEX and drawback schemes only coincided with their value to the exporters under very special circumstances. Taking these adjustments into account, Table A14 reveals that more than 47 per cent of total export incentives granted to all manufacturing industries went to transport-equipment industries in 1980; whereas transport equipment accounted for less than 20 per cent of total manufactured exports of the same year.

The concentration of export incentives on this sector was less pronounced in 1979, when about one third of overall incentive payments were absorbed by transport equipment [World Bank, 1983, p. 61]. The extremely high concentration in 1980 was mainly due to the abolition of the "crédito prêmio" as a general incentive system in December 1979, whereas it was maintained for automotive enterprises with BEFIEX-agreements. Consequently, the re-introduction of export-tax credits in 1981 can be assumed to have reduced again the concentration of export incentives on transport equipment after 1980. But even without "crédito prêmio", this sector received by far more than a proportionate share of export incentives; in 1980, this adjusted share (38 per cent) was twice as high as the sector's participation in total manufactured exports [World Bank, 1983, p. 213]. Moreover, transport equipment accounted for

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(1) More disaggregated and more recent information was not available on a comprehensive basis; for recent changes in major export incentives, see pp. 121 ff. below.

nearly four fifths of BEFIEEX-incentives in 1980, as opposed to about two fifths of overall export commitments agreed to in the 1972-1984 period.

The export-incentive rate enjoyed by transport-equipment industries, i.e., export incentives relative to the sector's export sales, amounted to 22.7 per cent, which was 2.4 times the average rate for all manufacturing industries (Table 28; for the major elements, see Table A14). Only electrical equipment achieved a similarly high rate (17.5 per cent). For all remaining industries, the export-incentive rate was at best half as high as for transport equipment. The privileged status of the latter industry was only due to fiscal incentives. The inter-sectoral dispersion in financial export promotion remained relatively modest. In contrast to fiscal measures, the financial incentive rate for transport equipment did not exceed the average rate for total manufacturing. Therefore, the positive difference in incentive rates between transport equipment and the manufacturing average was reduced, when looking at total export incentives (34.1 versus 20.8 per cent). But it could be maintained that this particular industry enjoyed an extremely favourable treatment; it ranked second among the 21 industries listed in Table 28.

This provides first evidence in support of the aforementioned hypothesis, according to which the favourable export performance of automotive industries in the 1970s was helped considerably by government support; though it should be kept in mind that we have not yet considered the net effects of export promotion and export discriminations arising from import restrictions. Since the early 1980s, export incentives have been reduced by the Brazilian government. As in 1979, when the "crédito prêmio" was abolished with the maxi-devaluation of the Cruzeiro, the revisions of the incentive systems were at least partly related to exchange-rate adjustments. In particular the maxi-devaluation of 30 per cent against the US \$ in February 1983 reduced considerably the level of export subsidies required to compensate for the overvaluation of the Cruzeiro. But the reduction of incentives went apparently beyond the adjustment for exchange-rate effects (1); i.e., the subsidy element

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(1) This is also evident from the fact that export incentives were not raised when the overvaluation of the Cruzeiro (after February 28, 1986: Cruzado) increased again in the mid-1980s.

Table 28 - Incentive Rates to Exports and Domestic Sales (a) of Brazilian Manufacturing Industries, 1980 (per cent)

	Fiscal export incentives (b)		Financial export incentives	Total export incentives (c)	Implicit nominal protection (d)	Anti-export bias (e)		Net effective protection (f)
	before adjustment	adjusted				gross	net	
Non-metallic minerals	4.5	4.0	10.1	14.1	-17.7	-31.8	-27.3	-31.1
Metallurgy	8.3	6.8	10.1	16.9	10.8	-6.1	-5.3	15.0
Machinery	15.9	11.2	18.0	29.2	48.3	19.1	16.4	51.7
Electrical equipment	24.7	17.5	18.0	35.5	71.4	35.9	30.8	81.6
Transport equipment	34.3	22.7	11.4	34.1	-5.8	-39.9	-34.2	-22.5
Wood products	9.1	7.8	11.4	19.2	-4.3	-23.5	-20.1	0.9
Furniture	3.5	3.2	11.4	14.6	26.1	11.5	9.9	30.8
Paper	8.4	7.5	7.8	15.3	-16.1	-31.4	-26.9	-30.2
Rubber	10.2	7.7	9.8	17.5	-15.4	-32.9	-28.2	-32.6
Leather products	7.6	5.9	17.4	23.3	15.6	-7.7	-6.5	-2.4
Chemicals	4.5	3.5	10.1	13.6	55.1	41.5	35.5	59.7
Pharmaceuticals	11.6	8.5	10.1	18.6	97.4	78.8	67.6	85.3
Perfumes	3.6	3.5	10.1	13.6	35.1	21.5	18.4	64.2
Plastics	14.5	10.5	10.1	20.6	28.9	8.3	7.1	9.9
Textiles	9.6	8.1	21.5	29.6	25.2	-4.4	-3.8	17.1
Clothing, footwear	10.0	8.2	22.1	30.3	30.6	0.3	0.3	25.7
Processed food	4.2	3.7	10.1	13.8	-8.2	-22.0	-18.9	8.1
Beverages	0.4	3.3	10.1	13.4	-5.3	-18.7	-16.1	-15.3
Tobacco	0.0	0.2	10.1	10.3	1.3	-9.0	-7.7	-9.4
Printing	0.1	0.1	10.1	10.2	24.1	13.9	11.9	13.0
Miscellaneous	4.9	4.0	10.1	14.1	91.8	77.7	66.6	132.8
Total manufacturing	12.7	9.3	11.5	20.8	22.8	2.0	1.7	23.1

(a) In per cent of exports and domestic sales respectively. For the calculation methods applied, see the text. - (b) For the adjustments made, see the text. - (c) Sum of financial incentives and adjusted fiscal incentives. - (d) Based on comparisons between domestic prices in Brazil and foreign prices of the same or similar goods. Additionally production subsidies were considered. - (e) Implicit nominal protection minus total export incentives; i.e., positive (negative) signs indicate an anti-export bias (a pro-export bias). Gross: calculated at the official exchange rate; net: adjusted for overvaluation of the Cruzeiro by applying a shadow-exchange rate. - (f) Adjusted for overvaluation of the Cruzeiro by applying a shadow-exchange rate.

Source: World Bank [1983, Tables 36, 37, 38 and 6.7].

declined. Possibly, this was partly because the Brazilian government realized that industries such as automobile production could no longer be considered infant industries, which required official support in the early stages of their development so that they could finally compete in world

markets successfully. More importantly, Brazil came under mounting pressures, especially from the United States, to cut export subsidies. Otherwise the United States threatened to bring further anti-dumping actions against Brazil and to increasingly levy countervailing duties on imports from this country.

For the automobile companies, the reduction of the genuine subsidy element inherent in BEFIEX-agreements represented the most important change in export-incentive systems in recent years. According to the World Bank [1983, p. 123], export subsidies granted to the automobile industry amounted to 26 per cent in 1980. Subsequently, genuine subsidies within BEFIEX-agreements were reduced to 15 per cent of overseas sales. Moreover, it was announced that the BEFIEX-system would not be extended beyond 1989. It is open to question whether the Brazilian government is prepared to implement alternative measures which guarantee similarly high levels of export promotion thereafter. Automobile producers are presently faced with considerable uncertainties as concerns the future course of the authorities to stimulate automotive exports.

Whereas the changes in the BEFIEX-system hit automotive industries in the first place (and thus reduced the inter-industrial differences in incentive rates), all manufacturing industries were affected by other recent changes in export-incentive schemes at roughly the same rate.

- A substantial change in the provision of subsidized financing to industry and exports took place in 1981 [Guimarães, da Costa, 1987]. During 1980, pre-fixation of monetary correction resulted in negative real interest rates for most types of credit. Subsequently, monetary correction equal to the rate of consumer-price increases was applied, which pushed real interest rates into positive values. Though still lower than current market rates, the subsidy element of preferential credits for exports further declined in early 1984, in response to Resolution 882. Consequently, financial export incentives were of only minor importance in 1985, and CACEX encountered a very small number of applications for that type of incentive. For automotive industries,



the incentive rate (1) ranged from 2 per cent (motors and autoparts) to 3 per cent (electrical equipment for motor vehicles) (2).

- With its re-introduction in April 1981, the "crédito prêmio" was set at a flat 15 per cent rate of fob-exports. As in 1979, the contracted rates remained untouched again for some exports under the BEFIEX-program. The "crédito prêmio" was originally scheduled to be phased out gradually up to mid-1983. In 1983, the United States and Brazil agreed upon a flat rate of 11 per cent which was to be abolished up to 1985 [Carvalho, 1984, p. 48].

The interventions of the United States with respect to Brazilian export-tax credits clearly showed that the authorities of Brazil were not free to decide on their own on export-promotion policies. The United States also announced that they would impose countervailing duties on some Brazilian exports that benefited from the "crédito prêmio" (shoes, cotton textiles and leather products). Although automotive products were not yet affected by retaliatory measures of the United States, the protectionist policy of the latter country created considerable uncertainty for automotive exporters as well. Moreover, import restrictions by the United States did not take into account the export discriminations resulting from import-substituting policies of Brazil, i.e., the net effects of export incentives; they were rather directed against high export incentives as such, irrespective of whether these incentives provided genuine export subsidies or only compensated for the overvaluation of the Cruzeiro and higher input prices resulting from import restrictions. It is thus most important to assess the net effects of Brazilian export incentives in the following.

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- (1) Including incentives of Resolutions 882/883 and 626 as well as "crédito prêmio"; although the latter should not be included in financial incentives, the arising distortion is likely to be minimal, since "crédito prêmio" was abolished in early 1985.
  - (2) No comparable information was available for total manufacturing. However, similarly high incentive rates for the iron and steel sector pointed to low inter-industry differences.

c. Relative Incentives to Domestic and Export Sales of Automobiles: A Comparison of Nominal Incentive Rates

Ceteris paribus, export incentives make producers more inclined to sell their output in overseas markets. It is typical for developing countries, however, that governments support inward-oriented producers as well. Moreover, specific industries can normally make use of both, export subsidies and protection of domestic markets against imports. Whether enterprises prefer selling their products in domestic or overseas markets depends on the relative strength of the two incentive systems. Formally, this can be illustrated as follows:

$$pe_i > pw_i < pd_i$$

where:  $pw_i$  = international price of product  $i$ ;

$pe_i$  = price received by Brazilian producers for exports of product  $i$ , including export subsidies;

$pd_i$  = domestic price of product  $i$  in Brazil.

Due to the aforementioned export incentives, Brazilian exporters of automotive items received more than international prices for their overseas sales. But domestic prices for automotive items could be expected to exceed world-market levels as well, since imports were largely banned by tariff and non-tariff barriers. The willingness of automotive industries to export thus depended on whether  $pe_i \gtrless pd_i$ ; they could be supposed to prefer overseas (domestic) sales, if  $pe_i > pd_i$  ( $pe_i < pd_i$ ). In this nominal perspective (which has to be supplemented by a tentative assessment of effective incentive rates later on), nominal export incentives resulted in a pro-export bias (an anti-export bias) when they were higher (lower) than nominal import protection.

Nominal incentive rates to exports and domestic sales were given in Table 28. The calculation of the latter was based on direct price comparisons (as of late 1980 and early 1981) between domestic prices in Brazil and foreign prices of the same or very similar goods. This procedure yields *implicit tariff rates*. Additionally, production subsidies were considered to obtain the total level of *implicit nominal protection*. Price

comparisons at the product level had to be aggregated at the industry level, since product-specific information on export incentives was not available.

Table 28 shows an implicit nominal protection rate of -5.8 per cent for transport-equipment industries. Contrary to our expectations, domestic prices in Brazil were lower than international prices for this industry, although extremely high tariffs were levied on imports of transport equipment. The dramatically high redundancy shown in the legal tariffs indicated that import tariffs were not relevant as far as the competitive position of transport-equipment industries in Brazil is concerned, although they were an effective means of eliminating foreign competition. This result applied to automotive industries in particular (Table 29). Notwithstanding legal tariff protection of 84 per cent (commercial vehicles), 113 per cent (motors and autoparts) and 126 per cent (passenger cars), implicit tariff protection for these items ranged from -16 per cent to -46 per cent. Accounting for production subsidies, the overall implicit protection remained significantly negative, and even more so than in total transport equipment.

Tariff redundancy was mainly to be attributed to domestic price controls for automotive items in Brazil. Due to official price regulation, automobile producers could not raise their prices beyond international prices to the extent indicated by the legal tariffs. This was especially so in 1980, when price increases had to be approved by the government before they became effective [Saes 1986, p. 46]. Prices were completely liberalized from December 1980 to October 1982. Subsequently, various forms of price relementation were in operation (except August 1984 to January 1985). Consequently, implicit protection might have increased (i.e., rates became less negative or even positive) in 1981/82 due to the elimination of price controls, but was eroded again with the return to price regulation later on. Actually, negative rates of implicit protection were calculated for some automotive items in 1985 as well [Guimarães, da Costa, 1987]. This applied to passenger cars and motors, whereas rates were positive for commercial vehicles and mechanical autoparts.

Table 29 - Legal and Implicit Tariffs and Implicit Protection of Automotive Products in Brazil (a), 1980/81 (per cent)

	Automobiles	Trucks and buses	Motors and autoparts	Tractors
Nominal legal tariff	126.3	83.6	112.5	41.5
Average implicit tariff	-23.2	-46.2	-15.5	-47.8
Implicit nominal protection	n.a. (b)	-39.3	-9.1	-32.9
Effective protection	-23.5	-58.7	-11.0	-40.0

(a) Based on a sample of selected items. - (b) In the summary of Tyler's results presented by the World Bank [1983, p. 218], a figure of 15.3 per cent was given; probably, it should be -15.3 per cent.

Source: Tyler [1981].

Negative implicit import protection and high nominal export incentives resulted in a *pro-export bias* of nearly 40 per cent in transport-equipment industries in 1980 (Table 28). This figure has to be adjusted, since the incentive rates for exports and domestic sales were calculated at the official exchange rate. Trade-policy interventions affected also the level of the exchange rate and thus resulted in changes in the net effect of nominal incentives. Both import restrictions and export subsidies gave rise to overvaluation of the Cruzeiro. Applying the shadow-exchange rate that would have prevailed if the policy distortions did not exist, the net bias towards domestic or overseas sales could be calculated (1). After this adjustment, the net *pro-export bias* in transport-equipment industries amounted to about 34 per cent; whereas a modest *anti-export bias* of less than 2 per cent was calculated for the average of all manufacturing industries. Relative incentives to exports and domestic sales favoured exports most strongly in transport-equipment industries. Only in four other industries, the net *pro-export bias* also exceeded 20 per cent (non-metallic minerals, wood products, paper, rubber). The bias for transport-equipment industries in 1980 seemed sufficiently strong to render it rather unlikely that the sign has changed in the following years, i.e., that the *pro-export bias* has turned into an *anti-export*

(1) According to World-Bank estimates [1983, pp. 137 ff.], the shadow-exchange rate for 1980 was 16.7 per cent above the official exchange rate.

bias. Compared with the early 1980s, export incentives were reduced indeed; but the 30 per cent devaluation of the Cruzeiro in early 1983 limited the negative impact of weaker export incentives on the net export bias.

#### d. Effective Incentives Granted to Automotive Industries

In order to capture the effects of Brazilian trade policies on the relative profitability of exports and domestic sales fully, it is most important to calculate *effective* incentive rates for the automotive industries. The preceding paragraphs focussed on differences between international and domestic prices of automotive products. The total impact of trade and other economic policies on Brazilian producers, however, depends not only on the prices of the goods which were produced by them, but also on the prices which they had to pay for automotive inputs, i.e., on the change of value added induced by policy interventions. This impact is measured by the concept of effective protection which can be illustrated formally as follows:

$$EP = \frac{VA - VA^*}{VA^*} \cdot 100$$

where: EP = effective rate of protection;

VA = domestic value added in Brazilian production;

VA\* = value added computed at international prices.

For an industry  $i$ , EP increases (decreases) when the nominal protection of its production (its inputs  $j$ ) increases. This is evident from the following formula:

$$EP_i = \frac{1 - \sum_j a_{ij}}{\frac{1}{1+t_i} - \sum_j \frac{a_{ij}}{1+t_j}} - 1$$

where:  $t$  = nominal protection;

$a_{ij}$  = technical input coefficients of industry  $i$ .

Estimates of effective protection of Brazil's manufacturing industries were presented in various empirical studies [for an overview, see Carvalho, 1984]. Frequently, effective protection was calculated by applying legal import tariffs as given by the official tariff code. Due to the extremely high tariff redundancy, this procedure is inadequate in the case of transport-equipment industries (1). Moreover, non-tariff import barriers are ignored. This conflicts with the recent thrust of Brazilian trade policies: due to the intensified recourse to non-tariff import barriers, tariffs can no longer be assumed to be the most important protectionist instrument [Guimarães, de Costa, 1987].

In order to adequately assess effective protection of Brazilian transport-equipment industries, the calculations must be based on international price comparisons. Implicit protection accounts for both tariff and non-tariff measures. After adjusting for production subsidies (2), the World-Bank study arrived at an implicit effective protection rate of -9.6 per cent for Brazil's transport-equipment industries in 1980 (3). Effective protection of this industry was also found to be negative (-6.1 per cent) in 1985 [H.C. Braga, 1986, Table 2] (total manufacturing: 39 per cent). The 1980-figure decreased further to -22.5 per cent, when calculated at the shadow-exchange rate of the Cruzeiro, i.e., accounting for the overvaluation of the domestic currency (see also Table 28 on p. 122). Net effective protection rates of 1980 are also available at a more disaggregated level [World Bank, 1983, pp. 222 f.]. For the major motor-vehicle industries, the estimates were even lower than for the average of total transport equipment (4):

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- (1) This bias is reduced when actual tariff rates (i.e., import duties effectively paid as a percentage of cif-import values) are applied. In this case, provisions for the exemption or reduction of import duties are taken into account.
  - (2) The relevant prices for the inputs used are those effectively paid by the producers. The calculation of implicit effective protection thus does not take into account the production subsidies granted to input-supplying industries.
  - (3) For total manufacturing, effective protection amounted to 43.6 per cent.
  - (4) Based on legal tariff rates prevailing in the 1978-1980 period, studies by Braga and Guimarães [1982] and Kume et al. [summarized by Guimarães, da Costa, 1987] revealed effective protection rates of 108-242 per cent for passenger cars, 58-79 per cent for commercial vehicles, and 131-230 per cent for autoparts.

- passenger cars: -35.6 per cent;
- trucks and buses: -65.2 per cent;
- motors and autoparts: -25.1 per cent;
- tractors: -49.5 per cent.

The calculations based on international price comparisons are sensitive to revisions in the administration of domestic price controls. As in the case of nominal protection, effective protection of transport-equipment industries was likely to increase during periods of liberalized prices. However, apart from the two periods December 1980-October 1982 and August 1984-January 1985, motor-vehicle prices in Brazil were subject to various forms of official regulation during the 1980s. All in all, it thus seems appropriate to refer to the aforementioned calculations when assessing the effective protection of this industry.

Attempts were also made by Pastore et al. and Tyler to estimate effective export incentives in Brazil [for an overview, see World Bank, 1983, pp. 86 f.]; but they were subject to considerable limitations (1). Consequently, the effective incentives to exports must be gauged in a very tentative way. As was argued in the World-Bank study, the comparison of net effective protection, net nominal protection and net nominal export incentives provides an indication of the net effective incentives to exports. This is because the incentives provided through special access to imported inputs were already taken into account in the quantification of nominal export incentives. Only the differences between the internal prices of the domestically produced inputs and international prices were not considered. But the protection of domestically produced inputs does not distinguish between production for internal or overseas markets. Thus, for example, high protection of input-supplying industries j,

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(1) The study by Pastore et al. used data for 1975 and did not include the effects of the BEFIEX-scheme. The protection of inputs was calculated by applying legal tariffs, which involved substantial redundancies. Both shortcomings introduced a strong downward bias in the estimation of effective export incentives, especially in the case of transport equipment where BEFIEX-incentives were of overriding importance. Tyler's estimations for 1980/81 also excluded BEFIEX and drawback-schemes. The quantification of financial incentives was based on the legal rates rather than the actual amounts of financing.

which results in lower effective protection of an industry  $i$  that is dependent on inputs of  $j$ , compared with  $i$ 's nominal protection, has the same effect on effective export incentives of  $i$ ; i.e., effective export-incentive rates are lower than nominal export-incentive rates of  $i$  to roughly the same extent as to be observed with respect to its import protection.

For Brazil's transport-equipment sector, the following exchange-rate adjusted (i.e., net) incentive rates were calculated for the year 1980 [World Bank, 1983, p. 88]:

- nominal export incentives: 14.9 per cent;
- nominal protection of domestic sales: -19.3 per cent;
- effective protection of domestic sales: -22.5 per cent.

According to the aforementioned reasoning, net effective incentives to exports of transport equipment were very likely to remain above 10 per cent. This is because effective protection was only 3.2 percentage points below the nominal incentive rate granted to domestic sales. There is no reason to assume that the difference between effective and nominal rates was significantly greater in the case of overseas sales. It can thus be concluded that, at the beginning of the 1980s, export incentives granted to Brazil's transport-equipment industries more than compensated for the export-retarding effects of the overvaluation of the Cruzeiro and higher input prices which were due to import protection of input-supplying industries.

As far as major sub-branches of Brazil's motor-vehicle industry are concerned, this result has to be qualified somewhat. This is due to the fact that the differences between effective and nominal incentive rates to domestic sales were higher than for total transport equipment (see Table 29). In particular for commercial vehicles, effective protection was considerably lower than nominal protection (about 20 percentage points); the differences amounted to 7-8 percentage points for passenger cars (1)

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(1) Based on nominal protection of -15.3 per cent for passenger cars; see footnote (b) in Table 29.



and tractors, whereas they remained very small (2 percentage points) for motors and autoparts. Consequently, effective incentives to exports of finished vehicles must be supposed to be significantly below nominal incentive rates as well. This refers to trucks and buses in the first place. Yet, effective export incentives may remain positive. Data on nominal export incentives were not available for the various sub-branches of Brazil's transport-equipment sector; but it can safely be assumed that the incentive rates for automotive industries exceeded the rate which was calculated for total transport equipment. It was mainly the automotive industries that benefited from the BEFIEX-incentives. Considering that nominal export incentives were higher in automotive industries than in total transport equipment, the aforementioned conclusion can be upheld, at least as far as passenger cars and autoparts are concerned.

The conclusion that export incentives provided genuine subsidies, rather than merely compensating for policy-induced export discriminations, is confirmed when the nominal incentive rate to exports of transport equipment (before exchange-rate adjustment: 34.1 per cent; see Table 28) is compared with the implicit tariffs of important input items (1). The latter incentive rates provide a measure of the differences between the relevant input prices (i.e., prices that were effectively paid by the Brazilian producers of transport equipment) and international prices (2). On an average of all items listed in Table A15, implicit tariff calculations revealed that the input prices effectively paid by Brazilian producers of transport equipment exceeded international prices by only 13 per cent;

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(1) The comparison has to be made without taking the overvaluation of the Cruzeiro into account, since exchange-rate adjusted information on implicit tariff protection was not available for specific input items. However, the resulting distortion is likely to remain marginal; both the "real" value of export incentives granted to transport equipment and the "real" value of implicit tariffs of input items are overstated to roughly the same extent.

(2) Table A15 indicates that tariff redundancy was typical for almost all of the most important input items. It would thus be strongly misleading to assess the extent of export incentives which was required to compensate for export-discriminating effects on the basis of legal tariff rates.

this was considerably below the export-incentive rate of 34 per cent (1). Moreover, the margin between domestic and international prices is reduced further if weights were attached to the various inputs that reflect their relative importance in motor-vehicle production. Detailed information was not available in this respect. However, iron and steel products continued to be of major importance (2). Except castings, all iron and steel products showed negative implicit tariff rates. For other inputs such as glass, non-ferrous metals, tires and autoparts, domestic prices were also lower than international prices. Compensatory export incentives were mainly required for higher prices of machinery and equipment.

All in all, the preceding analysis lends support to the hypothesis that Brazil's favourable performance in exporting automotive items was helped considerably by policy interventions of the Brazilian government, which more than compensated for export-retarding effects of import-substituting measures. Due to the lack of more recent data, the analysis was largely concentrated on the early 1980s. Nevertheless, two conjectures can be made as far as the future prospects of automotive exports are concerned: a) Export incentives remain necessary to the extent that they guarantee a balanced incentive structure to domestic and overseas sales; this includes compensation for an overvaluation of the domestic currency; b) if the Brazilian government is not prepared to introduce alternative measures to promote exports, when the BEFIEEX-scheme expires in 1989, the growth of automotive exports is likely to be affected negatively. However, on the basis of information presently available, no definite conclusion can be reached in the latter respect. The fact that automobile exports continued in the most recent past, despite some reductions in export incentives, may indicate that genuine subsidies, to the extent observed in the past, are no longer necessary to guarantee a favourable export performance of Brazil's automotive industries.

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(1) Even if input protection and export-incentive rates were of the same level, i.e. 34 per cent, the transport-equipment industries would benefit from an effective incentive rate of 34 per cent; this is easily derived from the formula on p. 128.

(2) See e.g. U.S. Department of Transportation [1981, p. 28]; Black [1982a, p. 9]; Transnationals Information Exchange [1984, p. 29].

## V. Prospects of Automobile Production in Brazil

The domestic market for automobiles in Brazil "is booming and promises to become the third largest in the world by the year 2000. The industry should begin a new cycle of investments to introduce new models and raise capacity in line with optimistic expectations. ... But Brazil's unstable economic situation could make a nonsense of any investment planning" [Stevens, 1987, p. 1]. Such statements reflect the high degree of uncertainty as concerns the prospects of automobile production in Brazil. Besides the erratic economic policies pursued in Brazil, other factors add to the difficulties of automobile companies operating in this country to decide on the future course of production and investment.

- In the past, future growth in automobile demand was frequently overstated for developing countries with relatively low degrees of motorization [Berg, 1982, pp. 69 ff.]. Forecasts proved to be over-optimistic, especially if they were based on unrealistic assumptions on the speed to which NICs such as Brazil could approach the degree of motorization typical for developed economies.
- Future developments in world demand for automobiles are highly uncertain as well. Besides the margin of error which is due to the general problems of economic forecasting, new competitors in world markets face additional uncertainties. It is open to question to what extent the traditional automobile producing countries are prepared to allow for even more competition in their internal markets when countries such as Brazil and South Korea add to the Japanese challenge.
- Automobile production is subject to considerable technological change. Presently, the economic consequences of more flexible automation are hard to predict. It cannot be ruled out that the revision of firm-strategies will substantially affect the locational advantages of Brazil and other NICs.
- Finally, it is difficult to decide to which extent Brazil's position in worldwide automobile production will be challenged by imitators in the Third World, which attempt to establish a domestic motor-vehicle industry as well. In the Far East, the Korean success may invite countries such as Taiwan, Thailand and Malaysia to assign a greater role to

automotive industries. The consequences for Brazil may be twofold: a) intensified competition in world markets may negatively affect Brazilian exports, and b) automobile multinationals may reconsider their "strategic positioning" [Cohen, 1982] with respect to low-cost sourcing.

In the following, these issues are discussed without attempting to make own forecasts on future automobile demand. Firstly, the potential of the internal market in Brazil is shortly assessed, mainly by referring to various forecasts available from published and unpublished sources (1). Secondly, the international environment the Brazilian producers are operating in is portrayed with respect to demand developments and possible consequences arising from technological change. Thirdly, internally created bottlenecks to future growth of automobile production in Brazil are identified. The evaluation of economic policies summarizes the findings presented in earlier chapters of this study, insofar as they are supposed to determine the locational advantages of Brazil in automobile production in the future as well.

### *1. Domestic Demand Prospects for Automobiles in Brazil*

Two factors are of utmost importance in assessing the long-term prospects of automobile demand in the domestic market of Brazil: a) the principal focus of the country's transportation system and b) the degree of motorization already achieved (2). Both factors point to a fairly great potential in automobile demand in the long run. The transportation of people in Brazil was largely concentrated on road transportation in the

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(1) The latter were largely made available by automobile firms operating in Brazil, whose kind cooperation is highly appreciated. Since they involve confidential data, firm-specific information and the sources of the data are not disclosed in the following.

(2) It goes without saying that a detailed analysis of future developments in domestic automobile demand - which is not attempted in this study - requires to consider various other factors as well; for example: the expected prices of automobiles, operating costs, the average income level of potential buyers of automobiles, inter-regional and inter-personal income distribution, availability of public transport facilities, average life time of vehicles (replacement ratio), etc. [for the determinants of automobile demand, see OECD, 1983, pp. 14 ff.; Tanner, 1983].

past, and it is highly unlikely that this will change before long (1). The dominance of collective bus transport in the 1970s indicated the potential of substitution between different means of road transportation; with rising per-capita incomes, the proportion of the Brazilian population using private cars is likely to increase significantly. Though the country was relatively well-advanced in terms of the passenger-car fleet per capita of the population (2), the number of persons per car considerably exceeded the corresponding figures for major industrialized countries and also for economies such as Spain, Yugoslavia and Argentina in 1985 (Table A16).

Due to the multitude and complexity of factors determining automobile demand, any attempt to incorporate such variables in an economic model is a highly speculative exercise [OECD, 1983, p. 21]. The approach adopted by the OECD-Secretariat in its well-known study on the long-term outlook for the automobile industries of various countries basically assumed that past interrelationships between the many variables, which ultimately determine the number of passenger cars per capita of population (3), hold true in the future [for details, see *ibid.*, pp. 28 ff.]. Vehicle densities for each market were thus projected forward by means of a growth function. This market-penetration model subsumed all the various demand determinants within the projections of vehicle densities.

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(1) Darbera and Prud'homme [1983] estimated that, in 1976, less than 4 per cent of total transportation of people was due to subways and railroads (no information was given for airplanes); cars, including taxis, accounted for 18 per cent, buses for more than 78 per cent.

(2) In Table A16, all countries with higher degrees of motorization (measured by the number of persons per car) than Brazil were characterized by higher per-capita incomes; on the other hand, countries such as Malaysia, Mexico and South Korea showed lower degrees of motorization than Brazil, despite higher per-capita incomes. The fairly advanced degree of motorization in Brazil is also indicated by the following simple cross-country regression, which considered the data of 94 countries for 1985:

$$\ln \text{PERCAR} = 12.54 - 1.226 \ln \text{GNPPC} \quad (R^2 = 0.85; F = 515.8)$$

where: PERCAR = number of persons per car in circulation;  
GNPPC = per-capita income.

According to this "normal pattern", Brazil (per-capita income: 1640 US \$ in 1985) would be expected to show 32 persons per car, which is considerably above the actual figure of 14.1 persons per car.

(3) The OECD-study did not present estimates for commercial vehicles.

The latter were then multiplied by the likely population to give estimates of the future car parc. Annual changes in the car parc are equivalent to new demand. Replacement demand was calculated by applying assumed vehicle-scrapping rates to the car-parc estimates.

Applying this procedure to Brazil (1), the OECD arrived at an average annual growth rate in excess of 5 per cent in domestic automobile demand for 1985-2000. The Brazilian passenger-car market was thus supposed to perform very strongly (2). First-time consumers were expected to play a prominent role, as a result of the growth phase of the market and population growth. The number of persons per car would be reduced to 7.3 in 2000 (3). The OECD-projections for Brazil are summarized in Table 30.

Although the OECD-Secretariat considered its region-wise estimates to be on the conservative side, compared to earlier projections [see the overview and the literature given in OECD, 1983, p. 26], the extremely favourable development of the Brazilian automobile market is likely to

Table 30 - OECD-Estimates of Car Parc and Automobile Demand in Brazil, 1990-2000 (1000)

End of year	Car parc	Demand		
		new	replacement	total
1990	16689	1082	624	1706
1995	22700	1273	964	2223
2000	29635	1432	1410	2833

Source: OECD [1983, p. 45].

- (1) Scrapping rates in Brazil of about 3 per cent in 1976-1977 were supposed to progressively increase to 5 per cent by the year 2000. Average annual population growth was given as 2.7 per cent in 1985-1990; 2.6 per cent in 1990-1995; and 2.4 per cent in 1995-2000.
- (2) Similarly high growth rates were only estimated for Asian developing countries, Mexico and Turkey. Brazil was expected to experience the largest increase in absolute market size between 1985 and 2000.
- (3) According to Table A16, this ratio amounted to 14.1 in 1985. Stevens [1987, p. 14] presented a figure of 11.0 for 1985 which, however, seems to be based on the total motor-vehicle parc in Brazil, rather than the number of passenger cars.

be considerably overstated. Projections presented by Caporale [1980; for a summary, see Caporale, Gross, 1983] (see also Table A17) pointed to considerably lower degrees of motorization and automobile demand in 1990 and 1995. As concerns passenger cars (1), the estimated car parc of 13.6 and 17.3 million vehicles (1990 and 1995 respectively) is about 20 per cent below the OECD-estimates. Domestic demand was projected at only 60 per cent of the corresponding OECD-figures.

The projections on vehicle densities presented in the OECD-study involve considerable conceptual problems. It is rather unrealistic to assume that the interrelationships between the various variables determining automobile demand remain stable over several decades. This applies particularly to NICs such as Brazil (2). Future growth developments are biased on the optimistic side, if "forecasts" merely project forward high growth rates of the past, which were easily achieved in the early phases of industrial development. In the case of Brazil, it is highly unlikely that the path of booming automobile production of the 1960s and 1970s can be perpetuated throughout the 1980s and 1990s. The OECD-projections on the growth of automobile demand in Brazil and the estimated car parc of nearly 30 million vehicles by the year 2000 require real GDP growth in the order of 5-6 per cent per annum.

Even before the OECD-projections were published, the Brazilian automobile industry suffered from a dramatic economic set-back. In 1981, total motor-vehicle production declined by more than 30 per cent, as compared to the previous year. Overall economic growth in Brazil (in real terms), that amounted to more than 7 per cent in 1980, turned out to be negative in subsequent years and recovered only in 1984. Therefore, earlier projections were in need of substantial revision. The structural break of the early 1980s affected the level of automobile demand and the vehicle parc which could reasonably be achieved in the future. Moreover, the unfavourable development of automobile production

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(1) For commercial vehicles, see Table A17, where information on production and exports is available as well.

(2) The OECD itself pointed out that projections for developing countries are most likely to deviate from actual performance; total demand comes mainly from new purchases, which are "more susceptible to the vagaries of economic conditions" [OECD, 1983, p. 24].

in the recent past (1) suggested that the expected growth in automobile demand had to be reconsidered.

Actually, recent forecasts by major automobile producers and automotive producer organizations even reduced the relatively conservative projections presented by Caporale [1980]. According to one source, domestic sales of passenger cars were supposed to reach 740000 vehicles in 1990 and 900000 vehicles in 1995 (Caporale [1980]: 1.0 and 1.4 million respectively) (2). Compared to the OECD-projection of 5-6 per cent average annual growth in domestic demand for passenger cars in 1985-2000, a remarkably flatter growth path was expected after the economic shock of the early 1980s, as indicated by the following forecasts:

- domestic sales of passenger cars, 1987-1995: 3-3.5 per cent;
- domestic sales of trucks, 1987-1995: about 3 per cent (3);
- domestic sales of buses, 1987-1992: less than 4 per cent.

Considerably higher growth rates were given for Brazilian vehicle production in the 1985-1990 period by the industrial organization of autopart suppliers SINDIPEÇAS (4). But favourable expectations were largely restricted to the mid-1980s. Subsequently (1987-1990), the production of commercial vehicles was expected to increase only modestly (trucks: 2.8 per cent; buses: 1.6 per cent). Interestingly enough, however, production growth for passenger cars in 1987-1990 was predicted to exceed growth in domestic sales. Although forecasts from different sources are involved, this may point to an increasingly important role of overseas markets in expanding the production of passenger cars in the future.

Sometimes it was stressed that even the reduced growth expectations were based on rather optimistic assumptions, particularly with respect to

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(1) In 1985, the volume of total vehicle production in Brazil remained still below its peak of 1980 [ANFAVEA, b, p. 67].

(2) Domestic sales of light and heavy trucks were estimated to amount to 200000 vehicles in 1990 and 230000 vehicles in 1995.

(3) By one firm, however, domestic sales of trucks were expected to grow by 7 per cent annually in 1987-1992; an even higher figure (9 per cent) was given for exports of trucks.

(4) Passenger cars (including jeeps and pick-ups): 5.4 per cent; trucks: 6.3 per cent; buses: 5.5 per cent.



overall economic growth in Brazil. Nevertheless it seems safe to assume that the domestic automobile market will expand at a higher rate than OECD-markets (1). At least in relative terms, the long-run outlook for automobile demand in Brazil is favourable. The experience of the early 1980s showed, however, that the trend towards higher motorization may be sharply interrupted. Structural breaks to the surprise of producers and consumers are most likely if the government adheres to stop-and-go policies and ad-hoc interventions into automotive markets, as was recently the case in Brazil. Misguided economic policies may thus seriously retard the process of satisfying the large potential of internal automobile demand by substantially increased production in the future (for a detailed analysis of policy-induced bottlenecks, see Section B.V.3).

## *2. The International Environment for Brazilian Automobile Firms in the Future*

### *a. Prospects of World Demand for Automobiles*

Whereas future growth in automobile demand was frequently overstated for developing economies due to unrealistic assumptions on the speed of approaching developed countries' standards, demand projections were typically biased to the conservative side for maturing markets [Berg, 1982, p. 69; OECD, 1983, p. 21]. For the latter, many observers assumed that saturation was nearly reached. Actually, it is rather unlikely that the degree of motorization will continue to increase significantly in developed countries (for the currently prevailing car density, see Table A16); it would be misleading, however, to base demand forecasts on the change in the stock of total car registrations only. In contrast to developing economies, automobile demand in industrialized countries is mainly feeded by replacement of old cars rather than first-time buyers.

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(1) The latter were assumed to grow at considerably less than 2 per cent on average (for further information, see the following section).

Assuming that vehicle-scraping rates in a number of OECD-markets were below their expected long-term level in the early 1980s, the OECD-Secretariat expected world-passenger-car demand to rise by 1.5-2 per cent per annum during the 1985-2000 period; earlier forecasts and the projection of Altshuler et al. [1984, p. 115] arrived at somewhat higher growth rates (see Table 31 for an overview of alternative projections) [see also Altshuler et al., 1984, p. 116] (1). The OECD-figure was slightly below the average annual increase in world-passenger-car demand calculated for the 1970s and early 1980s (2). Demand was supposed to expand only modestly in industrialized economies (all OECD-countries: 0.5 per cent to slightly above 1 per cent).

- With one exception, the projections presented in Table 31 pointed to very low growth rates for the United States. A major European automobile producer expected demand in this market to stagnate up to 1995. It should be noted, however, that the United States revealed slow growth in automobile demand in the past as well (1970-1985: about 1 per cent).
- The outlook seems somewhat better for Western Europe. Growth projections figured around 1 per cent per annum, which was considerably less than in the 1970s (about 3 per cent), but roughly in line with the early 1980s (below 1.5 per cent) (3).

As concerns future demand of commercial vehicles in industrialized countries, Altshuler et al. [1984, p. 118] presented growth estimates of slightly above 1.5 per cent per annum up to the year 2000. The expansion of world demand was considered to figure around 2.5 per cent in the case of commercial vehicles.

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- (1) For an overview of passenger-car demand forecasts for 1990, see additionally O'Brien, Lobo Aleu [1984, p. 20]; Fujimoto [1983, pp. 7 ff.]; Sinclair [1982]; U.S. Department of Transportation [1981, pp. 4 ff.].
  - (2) For both periods, 1970-1980 and 1979-1985, the OECD-Secretariat arrived at average annual growth rates of 2.4 per cent. For the early 1980s, calculations were based on estimates of world-passenger-car demand in 1985 [OECD, 1983, pp. 22 f.]. A significantly higher growth rate (4.5 per cent) was given by Caporale, Gross [1983, Table 1] for the 1967-1977 period.
  - (3) Past growth rates calculated from data given in OECD [1983, pp. 22 f.]; for the early 1980s, based on estimates of automobile demand in 1985.

Table 31 - Alternative Projections (a) of Passenger-Car Demand in Various Regions, 1985-2000 (per cent) (b)

Region	Source (date of compilation)	1985-1990	1987-1995	1990-2000
United States	Arthur Anderson & Co. (1980)	2.2	n.a.	n.a.
	U.S. Department of Transportation (1980)	-0.7	n.a.	n.a.
	OECD (1981)	0.4	n.a.	0.6
	Major European producer (1986/87)	n.a.	0.1	n.a.
Western Europe	IFO-Interfutures (1977)	0.5	n.a.	n.a.
	VDA-Interfutures (1977)	1.0	n.a.	0.6
	OECD (1981)	1.2	n.a.	1.3
	Major European producer (1986/87)	n.a.	0.7	n.a.
Japan	RIIM (1981)	1.8	n.a.	n.a.
	IFO-Interfutures (1977)	-2.3	n.a.	n.a.
	OECD (1981)	-0.5	n.a.	0.9
Total OECD	IFO-Interfutures (1977)	1.2	n.a.	n.a.
	OECD (1981)	0.5	n.a.	1.1
	Eurofinance (1980)	0.7	n.a.	n.a.
	Altshuler et al. (1984)	1.5(c)	n.a.	1.3
Eastern Europe	IFO-Interfutures (1977)	6.1	n.a.	n.a.
	OECD (1981)	4.4	n.a.	4.1
	Altshuler et al. (1984)	1.6(c)	n.a.	4.1
Africa	IFO-Interfutures (1977)	5.9	n.a.	n.a.
	OECD (1981)	4.6	n.a.	3.4
Latin America	IFO-Interfutures (1977)	7.6	n.a.	n.a.
	OECD (1981)	5.7	n.a.	5.0
	Major European producer (1986/87)	n.a.	3.6	n.a.
Asia(d)	OECD (1981)	1.5	n.a.	2.2
Total developing countries	Altshuler et al. (1984)	3.2(c)	n.a.	8.3
	IFO-Interfutures (1977)	2.5	n.a.	n.a.
Total world	Eurofinance (1980)	2.5	n.a.	n.a.
	OECD (1981)	1.5	n.a.	2.0
	Altshuler et al. (1984)	1.8(c)	n.a.	2.8

(a) IFO: Ifo-Institut für Wirtschaftsforschung, München; VDA: Verband der Automobilindustrie, Frankfurt; RIIM: Research Institute of Industrial Materials, Japan. - (b) Average annual growth rates, based on projections of the number of passenger cars demanded at the beginning and the end of the indicated periods. - (c) 1979-1990. - (d) Including Japan, Australia and New Zealand.

Source: OECD [1983, p. 26]; Altshuler et al. [1984, pp. 112 ff.]; unpubl. information provided by a major European producer; own calculations.

Reduced growth of future automobile demand in major industrialized regions renders difficult Brazil's attempt to strengthen its position in developed markets. This applies especially to the recent drive to enter the US-market for finished vehicles. It is much easier to gain additional market shares in a strongly expanding market which allows even those producers losing market shares to sell more than in the past. New competitors such as Brazil will face stiff opposition from traditional suppliers if the position of the latter is threatened not only in relative terms, but also in terms of absolute automobile sales. In such a situation, domestic producers in the United States and Western Europe may increasingly ask for import protection and other forms of official support; their demand is likely to be met by the governments.

In the early 1980s, import protection became a major element of government policies towards the automobile industry in the United States [VDA, b, p. 16]. From an analysis of the domestic automobile industry, the U.S. Department of Transportation [1981] concluded: "Under even the best assumptions, the transition of the industry will probably eliminate a large number of jobs and impact heavily on a handful of cities. The federal government should not stand by idle and watch; assistance for workers and communities must be forthcoming" (p. 5 of the attached letter of the Secretary of Transportation to the President). A "new socio-economic compact" between industry, labour and government was proposed. For its part, the US-government should negotiate import-restraint agreements with major overseas competitors and help the domestic industry to obtain the capital it requires in order to compete. Import restrictions were mainly directed against Japanese competitors (1). However, the recent export boom of Korean automobile producers, which was heavily concentrated on Northern American markets [Becker, 1987], raised concern with respect to new automobile competitors as well. South Korea's HYUNDAI had already to commit itself to limit its annual exports to Canada to 100000 units [Automobil Revue, Bern, September 1,

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(1) In 1981, a "voluntary" export-restraint agreement became effective with Japan, which committed itself to limit the number of passenger-car exports to the United States to 1.7 (1981) - 2.3 million units (1986); for an economic assessment of the agreement, see Dunn, Altshuler [1981].

1986]. This is likely to induce intensified attempts by Korean producers to penetrate the US-market; this, in turn, can be expected to trigger similarly restrictive measures by the US-government (1). After official interventions by the United States, Taiwan withdrew a government decree, according to which specified shares of automotive production had to be devoted to exports [VDA, d, p. 3].

Although Brazil was not yet affected directly, increased protectionism in the United States threatens future growth in automotive exports of this country. It creates considerable uncertainty for exporters. The current trend in US-trade policies towards bilateralism, discrimination and selective measures directed against the most successful competitors seriously impedes the medium-term planning of production and investment by Brazilian automobile companies. Selectivity is most harmful to NICs such as Brazil, since they do not have the economic power to successfully prevent discriminations by the threat of retaliatory measures. US-policies involve considerable risks for exporters of autoparts as well (2); this is most important in the Brazilian case, since parts and components continue to figure prominently in Brazil's automotive exports to the United States.

In an attempt to circumvent US-protectionism and its negative impact on export performance, Japanese automobile companies intensified their efforts to penetrate European markets in the past. South Korea is supposed to follow this avenue in the near future [Becker, 1987]. Obviously, European automobile markets are of crucial importance for Brazil as well. Strong links to their parent companies suggest that the subsidiaries of European multinationals operating in Brazil will try to raise their exports to Western Europe via intra-firm trade. The Japanese example showed, however, that EC-governments did not tolerate the re-orientation of exports from the United States to Western European countries.

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- (1) Recently, South Korea was urged by the United States to appreciate the Won against the US \$, in order to alleviate US-trade deficits.
  - (2) Autoparts were of major importance in the context of the so-called MOSS-negotiations (market-oriented sector selective) between the United States and Japan [VDA, d, p. 3]; US-autopart suppliers urged for officially imposed local-content requirements of about 50-60 per cent.

Protectionist pressures gained impetus in Europe as well [Dunn, 1983, p. 13; see also Altshuler et al., 1984, pp. 228 ff.]. France followed the most restrictive course against automobile imports from Japan [VDA, b, p. 40]. West Germany adhered to free trade in automobiles in the past (1); but the liberal treatment of automobile imports may be subject to revision in the coming years (2).

Any attempt to harmonize the treatment of automobile imports by European governments within the EC is highly likely to result in intensified protectionism. According to historical experience in other sectors, the rules of more restrictive EC-partners will be adopted, rather than the liberal rules of strongly world-market oriented countries such as West Germany. The approach favoured by the EC-Commission was presented in an official report on the outlook of the European automobile industry [Kommission, 1981, pp. 9 and 51 ff.]. Coordinated trade policies vis-à-vis automobile imports aimed at increased import administration; negotiations between major governments were considered as necessary to re-structure worldwide automobile production in an "orderly" way. Although the EC-Commission was mainly concerned about Japan (3), it was stressed that NICs in which automobile production played a significant role should be taken into account as well. Considering the distribution of economic power between automobile producing countries in such negotiations, it cannot be ruled out that the "big three", i.e., Western Europe, Japan and the United States, come to terms with each other at the expense of new competitors such as Brazil. In other words, the EC contributes to the export pessimism of developing countries and creates

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- (1) In 1986, the German association of automobile companies (Verband der Automobilindustrie) implicitly argued against protectionism; VDA [d, p. II] concluded that import restrictions in the United States and in some European countries considerably retarded the adjustment of these countries to the Japanese challenge.
  - (2) In this context, it is interesting to note that the head of VOLKSWAGEN, Carl H. Hahn, participated in the group of automobile managers that recently urged the EC-Commission to protect European markets more effectively against automobile imports from Japan [Frankfurter Allgemeine Zeitung, July 25, 1987, p. 9, "Klagen über Japans Autoimporte"].
  - (3) In June 1986, Japan agreed to limit the growth of automobile exports to the EC to 10 per cent; this figure had been considered as tolerable by EC-officials in the preceding consultations [VDA, b, p. 46].

further uncertainties for Brazil and other automobile producing countries in the Third World. The reluctance of industrialized economies to guarantee open markets for automotive imports from countries such as Brazil adds to the difficulties of the latter to overcome persistent economic tensions and foreign-debt problems.

Brazil may be forced to return to its traditional third-world export markets when protectionism in Northern America and Western Europe prevents it from reaping the full benefits of an economically efficient division of labour between industrialized and newly industrializing economies in the production of automotive items. However, many third-world countries are plagued by serious economic problems and over-indebtedness; this applies particularly to Latin America and Africa, i.e., Brazil's major export markets in the Third World. Since it is rather unlikely that economic problems will be solved within short, many developing countries will continue to control the expansion of imports, in order to alleviate balance-of-payments disequilibria. This limits the growth of Brazilian exports of automobiles to these countries.

The forecasts on passenger-car demand for various third-world regions presented in Table 31 largely support the view that high growth in automobile demand, as experienced in the past, will slow down in the future (1). This is most evident for Africa (2), where, in the late 1970s and early 1980s, average annual growth in automobile demand amounted to about 8 per cent (3); according to OECD-projections, growth rates will be roughly halved in the 1985-2000 period. The same organization expected an only modest decline in the growth of automobile demand for

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(1) The major exception was presented by Altshuler et al. [1984, p. 104], who expected passenger-car demand of all developing countries to expand at a rate of more than 8 per cent after 1990. However, the authors qualified this very optimistic forecast by stressing the great uncertainty whether the current debt crisis of developing countries will be resolved in such a way as to permit them to resume rapid economic growth in the future.

(2) As concerns Asia, comparable data on the development of automobile demand in the past was not available.

(3) Based on estimates of automobile demand in 1985; see OECD [1983, p. 22].

Latin America after 1990 (1979-1985: about 5.5 per cent) (1). But the OECD-Secretariat completed its projections before the severe debt problems of Latin American economies erupted in 1982-1983 (2). A more recent forecast by a major European producer arrived at lower growth rates. In addition to the rate of 3.6 per cent for passenger cars given in Table 31, the same company expected Latin American demand for commercial vehicles to expand at about 4 per cent per annum in 1987-1995 (3).

Though considerably reduced, growth in automobile demand of developing countries is likely to remain well above that of industrialized economies. But Brazil needs both developed and developing markets to sustain the expansion of automotive exports, thereby alleviating its foreign-debt problems; and it needs open markets for both finished vehicles and auto-parts (4). It is most important for the Brazilian automobile industry that:

- debt-ridden developing countries succeed to adjust to the changed international economic environment without sacrificing medium-term growth of their economies;
- industrialized countries commit themselves to free trade in automotive items (as well as in other goods).

In both respects, prospects look not very bright. Dunn [1983, p. 14] concluded that the EC will not permit a drastic shrinkage in European automobile production (5); "what leverage toward liberalism exists

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- (1) Compared to actual growth in the 1967-1977 period [given as slightly above 9 per cent per annum by Caporale, Gross, 1983, Table 1], the decline was considerable, however.
  - (2) The same applies to Sinclair [1982], who presented demand forecasts for various third-world countries up to 1990.
  - (3) For all developing countries, the demand for commercial vehicles was supposed to grow at an average annual rate of 4.6 per cent in 1990-2000 [Altshuler et al., 1984, p. 118]; 1979-1990: 5.3 per cent.
  - (4) Dunn [1983, p. 14] argued that international trade in automotive items will increasingly be concentrated on autoparts and components, since import restrictions were mainly expressed in terms of finished vehicles.
  - (5) As Dunn [1983, p. 18] reported, one European automobile executive remarked recently: "Free trade, like alcohol, is stimulating in small doses; in large quantities it is poison".



depends largely on what decisions the U.S. takes". As concerns the latter country, Dunn [1983, p. 15] found reason for some optimism, since US-automobile manufacturers did not press for protectionist measures beyond the export-restraint agreement with Japan: "The United States will almost surely continue to be the most liberal region in terms of permitting imports of automotive products. Both in terms of the absolute level of imports and in terms of market share the U.S. will continue to provide the largest relatively open market in the world". Recent experience and current trends in US-trade policies justify a more sceptical view, however [see also Altshuler et al., 1984, pp. 233 ff.]. Public activities to manage international trade are increasingly kept on a sector-specific and bilateral basis, which threatens not only Japanese competitors but also new competitors such as Brazil. Moreover, it is open to question whether the administration will successfully stem the protectionist tide which may arise from the extremely restrictive trade bills discussed in US-Congress.

#### b. Technological Change, Firm Strategies and Motor-Vehicle Production in Brazil

As pointed out in Section B.IV.1.a, world-automobile production is considered by many observers to be subject to another major transformation, characterized by the catchword "flexible manufacturing systems"; O'Brien and Lobo Aleu [1984, p. 155] even concluded that "the industry is in the midst of a technological revolution which is again giving it the pioneer role which it had in the 1920s". Current technological changes affect both the product design and the production process (1). As regards the former, the increasing use of electronic-control systems figures prominently. The main technological developments in the manufacturing process refer to flexible automation of assembly lines, i.e., the use of more specialized transfer-line equipment as well as robotic or computer-controlled welding, painting and testing equipment.

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(1) See e.g. UN Centre on Transnational Corporations [1983, pp. 22 ff.]; Jones [1981, pp. 14 f.].

The key technological dimensions [O'Brien, Lobo Aleu, 1984, pp. 52 ff.] involve:

- Robotization: All automobile multinationals have already introduced robots, especially in areas such as arc and spot-welding, spray-painting and finishing. Companies consider the remarkably improved manufacturing flexibility as the major advantage, rather than direct labour savings. The automobile industry is supposed to be the most important sector for the employment of robots. For Japan, it was estimated that 90 per cent of spot-welding, 60 per cent of material handling and engine production, and nearly 50 per cent of assembly operations will be undertaken by robots by the year 2000 [Iguchi et al., 1983].
- Computer-aided design and manufacturing systems (CAD/CAM): These systems have only recently begun to be incorporated in motor-vehicle production. The former, CAD, is of importance for design and engineering work; "it allows computer storage of multiple designs, modifications to them without major redrawing and the use of the same computers to handle all of the calculation questions which arise in designing machine tools" [O'Brien, Lobo Aleu, 1984, p. 56]. CAM-systems involve the use of computers in the logistics of control of groups of machines, in automatic inspection and in systems for partly unmanned production.
- Electronics: It is widely agreed that electronic items will represent about 20 per cent of the value of a car by the year 1990. The indirect role of electronics in motor-vehicle production is evident from the preceding paragraphs.
- New materials: The major target for changing the material composition of motor vehicles is steel, in order to reduce their body weight and thus improve on fuel economy. Lighter steel qualities have been introduced; as steel substitutes aluminium and plastics will be of increasing importance.

The availability of new technologies will considerably help automobile companies in developed economies to overcome a major dilemma, i.e., the conflict between the need to increase productivity and yet retain production flexibility. In contrast to what was often predicted only recently, world-automobile markets are not demanding the same types of

vehicles [Altshuler et al., 1984, p. 183]. Therefore, the application of special-purpose machines, which promised to reap the full benefits from economies of scale, proved to be of limited value; they rendered it difficult to adapt to the heterogeneous and varying consumer demands. With the new production hardware, productivity gains can be achieved without ever increasing the production runs. Actually, flexible automation is supposed to dramatically reduce the minimum-efficient scale of production [see also Jones, Womack, 1985, pp. 401 f.].

Though the diffusion of flexible automation has proceeded since the late 1970s, recent country studies indicated that it has been much slower than anticipated. "In the automobile industry many areas of production remain unaffected by the diversification of demand and product mix and automobile manufacturers try to maximize opportunities for fixed automation, sometimes as a result of 'commonization' of components for different models" [Watanabe, 1987b, pp. 191 f.]. Particularly among smaller firms, conventional general-purpose machines and special-purpose machines were found to be of greater popularity.

As concerns the prospects of automotive industries in NICs such as Brazil, the question arises whether new technologies will render existing assembly-line technologies in these countries uneconomical. Even if the diffusion of flexible automation proceeds more slowly than anticipated, this may provide only short relief for automobile producing countries in the Third World. The new technologies threaten to considerably retard the relocation of automotive industries to low-wage locations (1). In which way can and should Brazil and other new competitors in automobile markets adjust to the changed technological environment? What are their strategic options? Currently it is hardly possible to reach definite conclusions in this respect; in the following, a rather preliminary assessment of the major issues involved is presented.

Assuming that the technological changes are setting "fresh standards throughout the industry" [O'Brien, Lobo Aleu, 1984, p. 63], some ob-

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(1) Altshuler et al. [1984, p. 249]; see also UN Centre on Transnational Corporations [1983, p. 149].

servers argue that countries such as Brazil cannot avoid at least part of the organizational and production changes. According to this reasoning, new competitors are forced to conform to the norms set by the industrialized countries. In these lines, Jones and Womack [1985, pp. 405 f.] identified three traps which third-world countries seeking a future in automobile production should try to avoid:

- buying into obsolete patterns of social organization of production that cause efficiency disadvantages against Japanese standards;
- applying obsolete production technologies, i.e., labour-intensive modes of production and dedicated automation;
- producing "third-world automobiles" that can only be sold at bargain prices in developed markets.

Undoubtedly, new competitors such as Brazil have to conform to the quality standards required abroad if they aim at penetrating automotive markets in industrialized countries. This is why Brazilian producers have introduced welding, painting and other robots, as well as numerical-control (NC) machines in their tool rooms to some extent, though considerably less so than in advanced economies [Tauile, 1987]. In the Brazilian autoparts industry, NC-machine tools were most commonly used recently; whereas only a few programmable controllers and CAD-systems, and no robots were in operation.

In contrast to the reasoning of Jones and Womack and others, however, major warnings are in order as concerns an extended application of flexible automation of the latest design in countries such as Brazil. Firstly, government policies in third-world countries often render technological innovation extremely expensive. Brazil provides a case in point. The government is strongly devoted to domestic production of microelectronic equipment. Since the mid-1970s, local production facilities for the production of NC-machines were developed with priority. Recently, the "Lei da Informática" defined electronics as an area reserved for Brazilian-owned companies [Stevens, 1987, p. 33]; imports of machines are illegal if they contain some form of electronic control. But the domestic production of electronics is seldom fully competitive. The volume of production is still rather low. Consequently, "NC-machine tools pro-

duced in Brazil cost two to three times the price of their counterparts in the world market" [Tauile, 1987, p. 164]. Automobile executives considered the high price of the equipment as a major obstacle to the diffusion of NC-machines in Brazil.

Secondly and more importantly, the introduction of new technologies in automobile production may seriously conflict with Brazil's locational advantages, if new technologies draw extensively on the relatively poor endowment with highly skilled labour. It is common view that flexible automation and related process innovations increase the overall-capital intensity of automobile production [see e.g. UN Centre on Transnational Corporations, 1983, p. 23]. From this alone, however, the competitiveness of automobile production in third-world countries cannot be ruled out. It would be most important to reveal the impact of new technologies on human-capital intensity, as human skills stand for the relatively scarce production factor in developing countries. Here, comprehensive empirical evidence is not yet available. As regards NC-machines, it was argued elsewhere that skilled operators are not necessarily needed; flexible automation may thus be successfully adopted in Brazil's automobile manufacturing [Fujimoto, 1983, p. 16]. From interviews held by Tauile [1987, Tables 4 and 9] with automotive executives in Brazil, it was even concluded that skill saving and the scarcity of skilled labour were among the major motives to introduce microelectronic equipment at Brazilian assembly plants. However, labour savings in the production process are at least partly offset by increased programming and maintenance work, which can safely be assumed to be rather human-capital intensive. The lack of adequate manpower and the shortage of maintenance personnel was found in several studies to be a major bottleneck in applying microelectronic production technology in industrialized countries, even though these economies are relatively well equipped with human skills [Watanabe, 1987b, p. 192; see additionally Northcott et al., 1985]. These findings suggest that comprehensive implementation of the latest technique in the automobile industries of countries such as Brazil will strongly conflict with their locational advantages.

But what are the alternatives for countries such as Brazil which seek a future in automotive industries, given that full implementation of flexible

automation results in a stalemate? They may follow different avenues. On one route, politics rather than economics will rule. It can hardly be doubted that, besides economic factors, political pressures by trade unions etc. in the traditional automobile producing countries hindered a more pronounced shift of automotive industries to third-world countries in the past [UN Centre on Transnational Corporations, 1983, p. 149] (1). Political bargaining on future automotive investments in different locations, on local-content requirements and on trade-balancing is likely to continue and to gain even in importance, considering the deep-rooted economic problems and persistent disequilibria in the balance of payments of many countries.

Developing countries have a say in this political bargaining. Countries such as Brazil largely banned automobile imports in the past and thus induced foreign companies to establish production facilities in third-world markets which they did not want to give up (2). In the future, "the leverage LDC governments have in negotiating with the assemblers will depend on the size and growth prospects of their domestic markets" [Altshuler et al., 1984, p. 193]. Countries offering bright growth prospects in their internal automobile markets may require domestic manufacture at high local content or with positive contributions to the reduction of trade deficits, in return for market access by the automobile multinationals. Assembly of automobiles is likely to gravitate to the final markets for cars. In the long run, regions with the fastest growth of demand tend to attract the greatest amount of assembly investment [UN Centre on Transnational Corporations, 1983, p. 148].

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- (1) Import protection of industrialized countries may even induce some relocation of automobile production from the Third World back to developed economies in the future. The Korean Development Bank advised the Korean automobile companies to establish production facilities in Northern America, in order to circumvent the threat of losing export markets [VDA, b, p. 35]. Actually, HYUNDAI is presently constructing facilities for passenger-car assembly in Canada.
  - (2) Empirical analyses on the motives of direct investments of automobile companies in developing countries revealed the dominant role of overcoming import restrictions [see e.g. Vacano, 1979].

To get a share of world-automobile production by political bargaining and the threat of market closure is one thing; to sustain or strengthen the performance in exporting automotive products is quite another, considering the technological innovations taking place. Actually, policy-enforced relocation is rather likely to impede the competitive position in world markets if local-content requirements prevent the automobile producers from buying automotive inputs at international standards in terms of price and quality (1). Brazil was in a relatively favourable position, not only because export subsidies reduced the export-discriminating effects arising from import restrictions, but also because a fairly diverse and technologically advanced domestic supplier industry had developed already. The well developed industrial structure can be assumed to be a major asset in attracting further investments by foreign automobile companies. Apparently, Brazil continued to figure prominently as far as direct investments of automobile multinationals in the Third World are concerned. In 1983, the UN Centre on Transnational Corporations [1983, p. 149] expected Brazil and Mexico to receive the great bulk of foreign automotive investments in the Third World.

However, despite Brazil's outstanding role within the Third World in the 1970s and early 1980s, the long-term prospects of automobile production in this country and its position in world-automotive markets depend on the pattern of specialization followed in this industry, given the changed technological environment. From the preceding analysis, we can draw some general guidelines. It is rather unlikely that countries such as Brazil can compete in world markets successfully with automotive goods in the production of which flexible automation will figure prominently in the future. As mentioned before, technological change can safely be assumed to impact to different degrees on the various areas of automotive production. Some areas are supposed to remain largely unaffected by the assumed trend towards robotization, CAD/CAM-systems and other forms of electronics. Standardization is not rendered obsolete by recent

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(1) Altshuler et al. [1984, p. 193] considered it "only logical" that multinational assemblers in Mexico, for example, seemed intent on meeting rather than exceeding their trade-balance requirements, since there was little economic advantage to Mexican production in world markets.

technological innovations, but likely to remain crucially important, especially in the production of various autoparts and components.

Standardization involves the application of special-purpose machines, rather than general-purpose or NC-machines. The former require large production volumes to be cost-efficient (more than  $Q_2$  in Figure 1). Principally, special-purpose machines are best-suited for NICs, considering the relative factor endowments of countries such as Brazil. Human-skill requirements are considerably lower than for other types of machining operations (1). General-purpose machines have to be operated by highly skilled employees, which are typically extremely scarce in third-world countries. NC-machines require human-capital-intensive programming and maintenance work. Special-purpose machines, however, can be operated by semi-skilled workers. Additionally, they are relatively stable in the quality of their output, since production control is embodied in the machine hardware, rather than dependent on human skills.

What remains then to be done by automobile companies is to identify automotive goods that are well-suited for standardization. Although one may think of autoparts and components in the first place, standardization may extend to finished vehicles as well. As concerns the former, three broad categories were considered by Jones and Womack [1985, pp. 404 f.]:

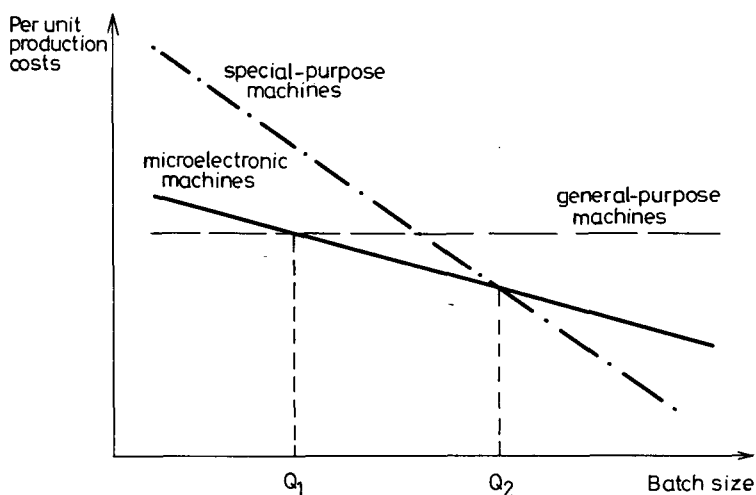
- minor mechanicals (such as starter motors, wiring harnesses, etc.) which are best-suited to standardization and low-wage sourcing;
- major mechanical components (such as motors, transmissions, etc.) which require inputs of skilled labour to different degrees, so that some may conform to and some may conflict with Brazil's locational advantages;
- "finished" parts (such as bodies, etc.) for some of which Section B.IV.1.b revealed relatively low human-capital intensity in Brazilian production; for these items shipping costs are frequently excessive, however, so that massive exports seem rather unlikely.

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(1) See also Fujimoto [1983, pp. 14 ff.], who expressed a somewhat different view with respect to NC-machines, however.



Figure 1 - Cost-Efficient Production Volumes by Type of Machines



Source: Watanabe [1987a, p. 17]; Fujimoto [1983, p. 16A].

Within the heterogeneous set of finished vehicles, the impact of technological change is likely to differ as well. Probably, flexible automation will apply to the production of passenger cars in the medium-size and upper-size segments of the market in particular. Here consumer demands are most diverse and subject to frequent change, so that flexibility in production is of overriding importance. The need to quickly adjust to changes in consumer demand may be relatively modest in the production of certain commercial vehicles, utility cars, and passenger cars belonging to the small or mini-size segments of the market (1). Thus, further standardization may be also achieved in specific areas of production of finished vehicles. In the production of such vehicles, it seems possible to overcome "the dilemma ... to find a product suited to local needs that also has export potential" [Jones, Womack, 1985, p. 405]. Here Brazilian automobile producers may find various niches in the fairly differentiated OECD-markets.

(1) For the latter, HYUNDAI's Pony and VWB's Fox provide cases in point.

### *3. Policy-Induced Bottlenecks to Future Growth of Automobile Production in Brazil*

Undoubtedly, the future prospects of automobile production in Brazil depend to a large degree on overseas demand developments, import policies of major trading partners, and technological trends, which are beyond the control of the Brazilian government. However, the strategic positioning of automobile multinationals is not determined exclusively by factors that cannot be influenced by Brazil. In the analysis of the preceding sections, various areas were identified where internal policies had an important impact on the automobile industry's performance. Economic policies can thus be supposed to have an impact on the future prospects of Brazil's automobile industry as well. Automobile multinationals will continue to consider NICs such as Brazil both as largely untapped markets for automotive sales and as potentially profitable locations for automotive production. Brazil's economic policies can provide an environment that stimulates further activities of automotive enterprises in this country, but can also "make a nonsense of any investment planning" [Stevens, 1987, p. 1]. Before addressing the most important policy areas specifically, some general prerequisites to a favourable development of automobile production in the future should be stressed.

The long-term decisions of entrepreneurs to strengthen or to reduce their engagement depend primarily on the overall investment climate in the country in question and the stability of its economic policies, rather than temporary profit-increasing measures of the government. This holds especially true for industries where foreign-based multinationals play a major role, as is the case in Brazil's automobile industry. It is typical for developing countries that foreign enterprises face even more political and economic risks than domestic producers. Multinationals are often made responsible for various economic problems prevailing in the Third World and are accused of exploiting the economic resources of the host country and, particularly, its labour force. Many governments pay tribute to rather hostile public feelings towards foreign enterprises; they threaten with outright expropriation, limit the transfer of profits, impose restrictions for economic activities of multinationals, or turn round abruptly from privileged to discriminatory treatment of foreign enterprises.

Under such conditions, multinationals can be assumed to disinvest, e.g. via transfer pricing, rather than adding further to their direct investments in the host country.

The Brazilian government decided at an early stage of its industrial development to establish an automobile industry based on foreign multinationals. The future of automobile production in this country thus depends on the companies' perceptions of the long-term outlook as regards the attitudes of the public and the Brazilian authorities towards them. Especially for capital-intensive industries such as automobile production whose productive facilities must be amortized over long periods, the threat of politically induced changes in profit expectations can seriously impede further investments [Johnston, 1981, p. 6; see also Kronish, 1984, p. 16]. In order to sustain the country's attractiveness for foreign capital, the government must aim at reducing political and economic risks for automotive producers (and other firms as well). This requires efforts to guarantee political stability as far as possible and economic conditions that create a favourable investment climate in the long run. Uncertainties arising from ad-hoc policy interventions should be kept to the minimum; binding rules rather than discretionary measures are required. Economic policies must be devised in a way that predictability is assured, so that production and investment decisions can be made on a sound and stable basis. Furthermore, incentive schemes must be simplified, since the currently prevailing administrative complexity renders discriminatory actions by the bureaucracy very likely.

Especially in the field of foreign-trade interventions, Brazilian policies are characterized by institutional complexity, contradictions between specific measures, and an uneven dispersion of incentive schemes at the industry and firm-level (1). This involves considerable costs, both private and social, and implies that Brazil cannot fully exploit the

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(1) On the administrative complexity in devising and executing foreign-trade policies, see Guimarães, da Costa [1987]; Carvalho [1984]. Considerable uncertainties for producers are due to the fact that various councils and institutions are involved in the decision process. Since they belong to different ministries and reflect different priorities, the outcome is subject to the vagaries of changes in the power structures within the government.

potential benefits from a stronger integration into the world markets. The complicated pattern of decision making results in the waste of economic resources which are absorbed by unproductive activities. Various large bureaucracies draw extensively on the country's relatively poor endowment with human capital. To cope with administrative complexities, enterprises must devote a significant part of their efforts to lobbying and rent-seeking rather than productive purposes. Less ad-hoc policy interventions as well as more transparent and simplified decision-making processes would thus encourage the productive employment of scarce resources; such a re-allocation, in turn, would help to sustain high export growth and improve overall economic development.

Another area of concern refers to the interrelations between import protection, export incentives and the exchange rate [see also World Bank, 1983, pp. 87 ff.]. Although the Brazilian government succeeded to compensate for export discriminations arising from import-substituting policies in the case of the automotive industries, this result was only achieved at considerable costs for the economy and for the industry. High levels of nominal export incentives, required to guarantee a balanced incentive structure towards domestic and overseas sales, involve significant fiscal costs which must be financed in some way (1). "When public sector deficits are the result, financing is not avoided but simply disguised as the inflation tax which results from higher aggregate expenditure. Thus, the budgetary and inflationary pressures resulting from the fiscal and financial incentives generate costs, which are borne by other sectors of the economy, and distortions in the allocation of resources" [ibid., p. 88].

The compensation for other policy distortions, which is granted to exporters, is only a second-best solution. The strategy best-suited to encourage exports and foster economic growth requires to reduce the need for compensation. This would also alleviate protectionist pressures in major export markets; this refers especially to the United States where

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(1) Since import protection is increasingly done by non-tariff barriers rather than import duties, the system of protection does not generate the revenues needed to finance export incentives.

the threat of retaliatory actions and countervailing duties is frequently directed against high export incentives as such, irrespective of whether compensatory incentives or genuine subsidies are granted by the exporting country. The focus of the first-best solution must be on the liberalization of imports and on exchange-rate policies that prevent the domestic currency from being overvalued. For countries such as Brazil where domestic inflation is typically by far higher than international inflation, it is most important to allow for nominal devaluations to the extent of the differences in inflation. Real exchange-rate fluctuations must be kept to the minimum in order to reduce uncertainties for exporters; this can safely be assumed to be a prerequisite to sustaining high export growth. Import liberalization assures that domestic producers get their inputs at international standards in terms of price and quality. The structure of relative prices becomes less distorted, which stimulates economic development in line with the country's locational advantages. A liberalization program may start with increasing the competitive pressure for so far highly protected products in order to narrow the inter-industry differences in import protection, before import protection is reduced across the board in a second step.

In both respects, i.e., exchange-rate policies and import policies, the recent course of the Brazilian government may seriously hinder further growth in exports of automotive and other goods. As was pointed out in Section B.IV.2.a, the management of the exchange rate became rather volatile in recent years. In order to assure a favourable performance in international markets, the public authorities would be well-advised to return to the exchange-rate regime of the 1970s which succeeded to reduce the fluctuations in the real exchange rate. High and persistent import protection renders it dispensable to cut production costs, which would help to penetrate world markets more deeply. The strongly uneven dispersion of incentives among industries gives rise to misallocation of resources. The "Lei da Informática" provides a case in point: since the domestic production of electronic items in Brazil implies significantly higher costs than international production, the chances of industries which are dependent on electronic inputs to compete successfully in world markets deteriorate. The export performance of Brazil's automotive

industries is likely to be affected negatively in the first place (1). Cost disadvantages of motor-vehicle production in Brazil vis-à-vis its major competitors decreased considerably since the early 1970s. However, this favourable trend may be reversed, if local-content requirements are strictly enforced in the future. This refers especially to the treatment of imports of machinery and equipment; but Brazil's future prospects in exporting automotive goods also depend on whether the government is prepared to allow for more competition in other areas. As was shown in Section B.III.2, the protection of national suppliers of transport services and the obligation for producers to ship their exports under the Brazilian flag eroded labour-cost advantages in automotive production substantially. Artificially raised freight rates place the Brazilian automobile companies at a disadvantage in world markets, in particular relative to exports from other NICs such as Mexico, South Korea and Taiwan.

Restrictive import policies may even harm those industries that are supposed to be privileged. Brazil's automobile industry provides an interesting case in point. Since imports of nearly all types of automobiles are banned, the companies operating in Brazil and serving various segments of the internal market are forced to produce the whole range of cars domestically. This gives rise to model proliferation which, in turn, causes scale efficiency to deteriorate at the model level. In other words, the protection of domestic car production in Brazil prevents the intra-firm specialization of multinationals in production and trade and renders it impossible to reap the full benefits from economies of scale. Import restrictions which are intended to favour domestic producers of automotive items may turn out to be a major bottleneck to further standardization. Since the locational advantages of economies such as Brazil vis-à-vis industrialized countries are supposed to be concentrated on the

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(1) The examples given by Stevens [1987, p. 33] include the following: electronic engine controls, necessary to meet American and European emission standards, were sometimes not available in Brazil, but had to be fitted in the country of destination; FORD's plans to boost Escort-exports suffered from insufficient supplies of electronic fuel injection; and MERCEDES-BENZ had to wait for nine months for electronic imports although a project to use electronic production equipment had been approved by the authorities.

cost-efficient production of standardized products, the policy-induced limits to firm-specialization may seriously impede the integration of Brazilian automobile plants into worldwide automotive production. International sourcing requires that automotive items can easily flow at world-market prices to Brazil as well.

Apart from the export-retarding effects arising from misdirected import policies, Brazil's trade policies are in conflict with industrial-policy measures [Guimarães, da Costa, 1987]. This applies to domestic price regulation in particular. Price controls for automotive items give rise to substantial tariff redundancy, i.e., the price-increasing effects of high import protection are rendered obsolete by other government interventions in product markets. Officially imposed price stops, as experienced within the "Plano Cruzado" of 1986 for example, may seriously impair the profitability of automobile production and thus result in significant production cuts. Consequently, it becomes more difficult to realize economies of scale. Higher per-unit costs, in turn, reduce the chances to penetrate world markets successfully. Additionally, the extraordinarily high sales taxes which are levied on automobiles in Brazil indirectly hinder the growth of automotive exports. This is because the tax-induced decline in domestic demand causes higher per-unit costs. Moreover, if the government continues to adhere to ad-hoc interventions in automotive product markets, as was the case in recent years, this would add to the uncertainties of Brazilian producers and thus their reluctance to strengthen their engagement in this country.

Stability and predictability is not only required in product-market policies, but also in factor-market policies. Accounting for the labour incorporated in automotive inputs, the labour share in total production costs of motor vehicles continues to be significant (see Section B.III.2.b). Brazil's advantages in unit-labour costs of automobile production are still fairly strong against the advanced economies. But its position is increasingly challenged by a small group of other NICs such as South Korea and Taiwan. Moreover, the future attractiveness of Brazil for foreign capital may be impaired by high and volatile financial costs, insufficient improvements in productivity, and government promotion of technologies which are in conflict with the country's locational

advantages. Since most automotive productions require substantial inputs of capital, high capital costs in Brazil (see Section B.III.2.d) are likely to erode labour-cost advantages to a significant extent. Discretionary fiscal and monetary policies result in heavily fluctuating inflation and real interest rates, which render longer-term investment decisions extremely difficult.

As a consequence of the producers' reluctance to invest, the increase in labour productivity in Brazil's automotive industries may be too low to sustain the country's favourable position in unit-labour costs against industrialized economies in the future. Hence, it is most important that the Brazilian government removes policy-induced bottlenecks to productivity increasing investments in automotive industries. In order to create a favourable investment climate, ad-hoc interventions in factor markets must be abolished and fiscal and monetary policies, presently characterized by stop-and-go attitudes, must be devoted to long-term growth objectives. The government should fight the causes of excessive inflation, rather than artificially suppressing it by temporary price stops. As was shown elsewhere [Fischer, 1986], a reduction in public-sector deficits by cutting unproductive government expenditures is crucially important in this respect.

Such a re-orientation in economic policies would also create conditions under which it is most likely that the technological choices of automotive producers are in line with Brazil's locational advantages. Quality considerations may render some automation necessary; but a comprehensive application of most recent technologies, which draw extensively on the country's relatively poor endowment with human capital, can be supposed to have negative effects on the long-term outlook of automobile production in Brazil. Therefore, the government should not promote an extensive use of flexible automation in Brazil's automotive industries. The policy best-suited to prevent technological mis-specialization requires that distortions in product and factor markets are minimized, so that market prices correctly signal the relative scarcities of production factors. Where electronic equipment is necessary it should be available at competitive terms. The approach presently followed by the Brazilian government, namely to reserve the production of electronic inputs for



national companies, represents the most unfavourable alternative. It absorbs considerable amounts of human capital, which are no longer available for other productions, and puts Brazilian automobile producers at a disadvantage in international markets since national production of electronics involves higher costs.

## C. The Competitive Edge of the Brazilian Steel Industry

### I. Introduction

A persistent crisis of the steel industry in Western Europe and the United States as well as continuing efforts by developing countries to establish their own steel industries have been the major features of the international steel scene during the last 15 years. The changing regional pattern of world steel production was strongly influenced by changing demand conditions. Increased competition from alternative materials has affected the steel industry all over the world. In the industrialized countries steel demand was further dampened by low rates of overall economic growth and a growing proportion of services in gross output. In fact, there has been an absolute decline of steel consumption in industrialized countries since the mid-1970s while steel consumption has increased markedly in developing countries due to rapid economic growth. However, a stagnation or reduction of domestic demand does not necessarily imply a worsening of supply conditions. Apart from unfavourable (domestic) demand conditions the steel crises in the industrialized countries must, therefore, also result from unfavourable or deteriorating supply conditions. Worsening supply conditions have been explained early on by a shift of comparative advantage from industrialized to developing countries [Wolter, 1974]. It has been argued that a broader industrial base and a growing maturity of the labour force have provided some NICs with a comparative advantage in steel production.

For an examination of this hypothesis the product cycle model may provide a useful theoretical background. According to this model, highly advanced countries enjoy a comparative advantage in innovative (research and development-intensive) and skill-intensive activities while NICs should specialize in standardized production lines and less developed countries in labour-intensive industries (for a more extensive discussion of this approach, see Chapter A). In addition, a negative vintage effect can be expected for the slowly growing or stagnating steel industries in the advanced countries as compared to the young steel nations with quickly expanding productive capacity, since new technol-

ogy is usually embodied in new equipment. Other factors which may affect the international location of the steel industry include the availability of natural resources, the stringency (or otherwise) of legislation concerning pollution standards, and the extent to which economies of scale may be realised in production.

If comparative advantage in steel production is shifting from industrialized to newly industrializing countries, Brazil should possess locational advantages for steel production. For this reason, the following study focuses on the emergence of an internationally competitive steel industry in Brazil. In 1985, Brazil was the biggest exporter of steel products (1) from the developing world, with a share of over 4 per cent of total world exports compared with only about 0.2 per cent in the mid-1970s (Table 35). Apart from her significance as a steel exporter, three other features underline the relevance of selecting Brazil for this study. Firstly, the Brazilian steel industry has been a major target of import substitution efforts since the mid-1930s, and it constitutes an important source of value added and employment in manufacturing. Secondly, systematic attempts have been made since the mid-1970s to improve the export performance of steel products. Steel products now represent the largest source of export earnings within the manufacturing sector. Thirdly, the majority of Brazilian steel exporters are local companies either state- or privately owned, while foreign companies dominate other sectors like automobiles and chemicals.

Chapter C of this study is organized as follows: Section C.II contains an assessment of the evolution of the Brazilian steel industry and describes its present structure and performance with special emphasis on steel exports. In Section C.III Brazil's international competitiveness is discussed against the background of a quantitative assessment of Brazil's revealed comparative advantage in world steel markets. Further indications of Brazil's competitive position in steel production are provided by an international comparison of the level and structure of production costs, including major competitors from both developing and industri-

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(1) Unless otherwise specified steel products include, throughout this study, ingots, semi-finished products and rolled products.

alizing countries. In Section C.IV three hypotheses are examined in order to identify the major factors behind the growth of Brazilian steel exports. Firstly, factor intensities in steel production are analysed in order to test the product cycle hypothesis. Secondly, the role of technology diffusion and economies of scale is discussed in order to evaluate the technology adoption hypothesis. Thirdly, it is assessed whether exchange rate policies and incentive systems have significantly contributed to the Brazilian steel exports expansion. Finally, prospects of steel production in Brazil are evaluated by assessing domestic and international trends in demand, effects of technological change, the impact of protectionism in industrialized countries and domestic policy-induced bottlenecks for steel production in Brazil.

## **II. Economic Performance of the Brazilian Steel Industry**

### *1. Output, Trade, and Current Structure*

#### a. Origin and Development of Steel Production

Steel production in Brazil started in the early 1920s in the state of Minas Gerais, where the bulk of the country's resources of iron ore are located, and where pig iron production was already well established (1). In the early 1930s, the Getulio Vargas administration began to take an active interest in the development of the steel industry. By that time a large proportion of the country's consumption of light non-flat rolled products was manufactured domestically, especially after the Belgo-Mineira's Monlevade plant started operations in the mid-1930s. However, the heavier varieties of non-flat as well as most flat products, which are of particular importance for the railway, shipbuilding, and construction industries, were still being imported. At the same time the depressed situation of international trade caused Brazilian export revenues and,

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(1) For an historical analysis of the Brazilian steel industry see Baer [1969].

consequently, manufactured imports to decline, while output of domestic manufacturing industries increased. This situation inspired the idea to establish a nationally controlled, large integrated steel mill to ensure a stable supply for the steel-consuming industries in Brazil. At that time, domestic investors were either unable or unwilling to put up the large amounts of capital required for this purpose, though. Therefore the government tried to attract foreign steel companies (mainly from the United States and West Germany); however, negotiations broke down because the issue of national control over production could not be resolved.

Finally, the government itself established the CSN in 1941, which began to operate a large flat products mill at Volta Redonda (State of Rio de Janeiro) in 1948. Active government involvement in the industry continued with the establishment of the COSIPA and USIMINAS plants, also specializing in flat rolled products, in the 1950s and early 1960s [Baer, 1969, pp. 68-83] (1). During the same period a number of private firms entered the non-flat sector of the industry where capital requirements were considerably lower, especially in the case of semi-integrated plants with electric furnaces. Most ventures were financed by domestic investors; one important exception was the local subsidiary of a German company (MANNESMANN), whose product lines included seamless tubes and special steels.

An overview of production, consumption and foreign trade in rolled steel products in Brazil since the mid-1920s is given in Table 32. From a modest beginning, output of rolled steel grew steadily for several decades. The degree of self-sufficiency, as measured by the share of domestically produced rolled steel in domestic consumption, increased along with production; exports, however, remained small except during the 1940s (due to a war-related increase in demand) and the mid-1960s (Table 32). By the second half of the 1960s, Brazil had become the

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(1) Again, the large amount of capital required for the construction of an integrated flat-products mill could not be raised by private domestic investors, while the national control issue restricted foreign participation. Japanese participation in USIMINAS, originally intended to amount to 40 per cent, shrank to about one fifth when cost overruns necessitated the introduction of fresh capital by the BNDE.

Table 32 - Production, Trade, and Apparent Consumption of Rolled Steel Products (a), Brazil, 1925-1985

	Production	Imports	Exports	Apparent consumption (b)	Share of exports in production	Share of imports in apparent consumption
	1000 tons			per cent		
Five-year annual averages						
1925-1929	18	403	-	421	-	95.8
1930-1934	33	205	-	238	-	86.1
1935-1939	75	330	-	405	-	81.5
1940-1944	153	232	12	373	7.9	62.2
1945-1949	302	336	13	625	4.4	53.8
1950-1954	717	383	2 (c)	1099	0.2	34.8
1955-1959	1186	325	4 (d)	1508	0.3	21.5
1960	1712	435	19	2128	1.0	20.4
1961	1932	334	8	2258	0.4	14.8
1962	1999	282	6	2276	0.3	12.4
1963	2140	474	1	2614	0.0	18.1
1964	2213	303	43	2473	1.9	12.2
1965	2164	254	167	2252	7.7	11.3
1966	2795	318	109	3005	3.9	10.6
1967	2748	340	286	2802	10.4	12.1
1968	3399	348	191	3556	5.6	9.8
1969	3781	391	218	3954	5.8	9.9
1970	4091	543	405	4230	9.9	12.8
1971	4661	849	172	5339	3.7	15.9
1972	5276	699	365	5610	6.9	12.5
1973	5870	1424	227	7066	3.9	20.1
1974	6127	3851	137	9842	2.2	39.1
1975	6866	2193	127	8932	1.8	24.6
1976	7362	1059	140	8281	1.9	12.8
1977	8799	805	218	9387	2.5	8.6
1978	9834	565	530	9869	5.4	5.7
1979	11217	367	867	10717	7.7	3.4
1980	12745	435	1006	12174	7.9	3.6
1981	10870	479	1499	9851	13.8	4.9
1982	11194	156	2072	9278	18.5	1.7
1983	12428	79	4854	7652	39.1	1.0
1984	13649	95	4520	9224	33.1	1.0
1985	14593	89	4395	10288	30.1	0.9

(a) Excluding semi-finished products for sale. - (b) Production plus imports minus exports. - (c) No exports in 1953 and 1954. - (d) No exports in 1958 and 1959.

Source: Suma Económica [1985, p. 9: 1925-83 data]; CONSIDER [Anuário Estatístico 1986, Tables 4, 12, and 15: 1984-85 data].

largest steel producer in Latin America, with two thirds of crude steel capacity held by government-controlled firms [Baer, 1969, p. 83]. In line with the import substitution policy pursued until the early 1960s the share of imports in domestic consumption had been reduced to about 10 per cent in 1968, while exports had remained insignificant.

After the mid-1960s, the general policy shift towards a more outward-oriented trade regime led to accelerated overall economic growth (Table A18). As a consequence, domestic demand for steel products increased sharply. The additional demand could not fully be satisfied by domestic production and had to be met through increased imports, especially during the mid-1970s (Table 32). Considerable investment was undertaken to expand the capacity of existing plants and to set up new ones (1). Just when this investment reached maturity, economic recession in the domestic market and abroad led to a precipitous fall in domestic steel consumption by almost 40 per cent between 1980 and 1983 (Table 32).

In response to sluggish domestic demand firms switched to export sales [IBS, a, pp. B 6-9] and exports grew more than four-fold during the same period (2). Therefore, total output returned to its 1980 level in 1983 and continued to expand in subsequent years. Capacity utilization in the steel industry declined from 98 per cent in 1980 to 81 per cent in the following year and also recovered thereafter [ibid., e, p. 8] (3). Nevertheless, annual rates of output growth were markedly lower during the first half of the 1980s than in the late 1970s.

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- (1) Table A18 characterizes the position of the metallurgical sector (comprising the non-ferrous metals as well as the iron and steel industry) within the overall development of the Brazilian economy in the period 1965-1984.
  - (2) Section C.II.2 below analyses in some detail the structure of Brazilian steel exports by product groups and countries of destination, and thus provides some clues as to how Brazil was able to expand its share of world steel exports from practically nil to more than 4 per cent in 1985, in spite of idle capacity and growing protectionism in industrialized importing countries.
  - (3) By comparison, the steel industry in the European Community showed rates of capacity utilization of only about 60 per cent during this period [EUROSTAT, b, p. 57].

Table 33 - Structure of the Brazilian Steel Industry by Ownership, Technology and Product Specialization, 1985 (per cent)

Company (State) (a)	Crude steel				
	integrated coke steelworks	integrated charcoal steelworks	integrated direct reduction steelworks	semi-in- tegrated steelworks	total
	4 firms	8 firms	2 firms	25 firms	
State-controlled (8 firms)	<u>100.0</u>	<u>20.8</u>	<u>100.0</u>	<u>4.8</u>	<u>68.1</u>
SIDERBRAS (b)	100.0		100.0	4.8	64.7
CSN (RJ)	27.1				16.7
COSIPA (SP)	21.0				12.9
CST (ES)	25.4				15.6
USIBA (BA)			61.8		1.4
USIMINAS (MG)	26.5				16.3
ACESITA (MG)		20.8			3.4
Private (31 firms)		<u>79.2</u>		<u>95.2</u>	<u>31.9</u>
Foreign controlled		31.2			5.1
PAINS (MG)		9.4			1.5
MANNESMANN (MG)		21.8			3.6
Domestically controlled		48.0		95.2	26.8
GRUPO GERDAU (c)				44.1	8.8
GRUPO VILLARES (d) (SP)				10.7	2.1
ANHANGUERA (SP)				8.1	1.6
BELGO-MINEIRA (MG)		25.4			4.2
DEDINI (SP)				7.5	1.5
BARRA MANSA (SP)		6.0			1.0
ALIPERTI (SP)		9.2			1.5
MENDES JR. (MG)				9.2	1.8
Total	100.0	100.0	100.0	100.0	100.0
Volume (1000 tons)	12574	3372	463	4041	20450
Share in total of product category	61.4	16.5	2.3	19.8	100.0

(a) For the full name of the states see Figure A5. - (b) Apart from the companies listed, the SIDERBRAS group also includes the following steel-producing firms: AÇOMINAS (MG), PIRATINI (RS), COFAVI (ES), COSIM (SP). The AÇOMINAS plant was still under construction in 1985, and produced no crude steel in that year. COSIM ceased production in 1985. (c) The GERDAU group includes the following steel-producing companies: COSIGUA (RJ),



Table 33 continued

Rolled products						Semi-finished products for sale		
flat		non-flat		seamless tubes	total	slabs	blooms and billets	total
ordinary	special	ordinary	special					
<u>100.0</u>	<u>100.0</u>	<u>15.3</u>	<u>32.6</u>	<u>4.9</u>	<u>64.7</u>	<u>100.0</u>	<u>36.0</u>	<u>82.5</u>
100.0		15.3	14.0	4.9	61.0	100.0	29.2	80.6
30.7		5.0			18.5	0.2	14.4	4.2
30.5					16.7	0.2		0.2
						98.8		71.6
38.8		5.4			1.8			
					21.2	0.8		0.5
	100.0		18.6		3.7		6.8	1.9
		<u>84.7</u>	<u>67.4</u>	<u>95.1</u>	<u>35.3</u>		<u>64.0</u>	<u>17.5</u>
		5.8	13.8	95.1	5.3		4.4	1.2
		5.8			1.9			
			13.8	95.1	3.4		4.4	1.2
		78.9	53.6		30.0		59.6	16.3
		32.1			10.7		33.2	9.1
			25.6		1.7		5.8	1.6
			18.2		1.2		6.0	1.7
		14.6			4.9			
		5.2			1.7			
		3.7			1.2			
		5.5			1.8			
		8.6			2.9			
100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
7979	351	4882	997	385	14593	2698	1027	3725
54.7	2.4	33.5	6.8	2.6	100.0	72.4	27.6	100.0

AÇONORTE (PE), CEARENSE (CE), GUAIRA (PR), HIME (RJ), RIOGRANDENSE (RS).  
- (d) The VILLARES group includes the following steel-producing companies: AÇOS VILARES (SP), VIBASA (SP).

Source: CONSIDER [1986, Tables 6 and 7]; Visão [1986]; IBS [b, 1986, p. 1].

Among the steel-consuming sectors automobile and construction industries account for almost one half of total domestic consumption in Brazil (Table A19). The mechanical engineering and the packing materials and receptacles sectors jointly with re-rolling mills are responsible for another third of total domestic demand. Due to the high export intensity of some of these industries, indirect steel exports in the form of manufactures with a high steel content have been estimated to be in the range of 0.7 to 1.2 million tons of rolled steel in 1983 and 1984, respectively (1). These indirect exports amounted to about one quarter of total direct rolled steel exports (Table 32).

#### b. Firm-Specific Characteristics of the Brazilian Steel Industry

The state-owned or state-controlled sector, which is responsible for more than two thirds of total crude steel production, is dominated by four large integrated coke steelworks (Table 33). Three firms (CSN, COSIPA, USIMINAS) jointly account for almost the total output of ordinary flat rolled products in Brazil. The fourth large firm (CST) specializes in the production of slabs, largely for export. Other companies in the state-controlled sector include two small direct reduction steelworks. ACESITA, which plays an important role in the production of special steels, is the only state-owned firm that does not belong to the SIDERBRAS holding company.

The private sector consists of seven integrated charcoal steelworks along with twenty-four semi-integrated plants with electric furnaces. Together they account for most of the output of non-flat rolled products as well as blooms and billets for sale.

Concerning the regional distribution, the industry is still heavily concentrated in the states of Minas Gerais (where most iron ore deposits are located), São Paulo and Rio de Janeiro (the most important centres of domestic consumption; Figure A5).

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(1) Siderurgia Latinoamericana [1985, p. 3]. For comments on the methodology of calculating such estimates, see IISI [a].

### c. Brazil's Position in the World Steel Market

This section provides an overview of the shifts in the location of world steel production and consumption, as well as the concomitant changes in international trade since the mid-1970s. At a fairly aggregate level, three major trends become evident:

- The share of industrialized countries in world steel production declined from 64.4 per cent in 1973-1975 to 52.1 per cent in 1985 (Table 34). During the same period their shares in world exports and imports of semi-finished and finished steel products also diminished, but industrialized countries maintained a dominating position in world steel markets (Tables 35, 36).
- The centrally planned economies showed a persistent increase of their share in world production, from 31.1 per cent (1973-1975) to 37.4 per cent in 1985, while their export and import shares did not change very much (Tables 34, 35, 36).
- Developing countries more than doubled their share in world production to 10.5 per cent in 1985. Their export share rose even more significantly from 2.3 per cent in 1973-1975 to 11.6 per cent in 1985, while their import share more or less stagnated (Tables 34, 35, 36).
- Apparent consumption of steel products shifted from industrialized countries to developing and centrally planned economies. In 1985, industrialized countries accounted for less than half of world steel consumption (Table 37).

A closer look at the data for individual countries reveals some important differences between countries within the same category:

- Within the group of industrialized countries the United States lost considerable ground in terms of production (from 18.3 to 11.1 per cent). Her already small share in world exports declined even further, and the country became a sizeable net importer. In the EC (10), only Italy maintained its share in world production. Peripheral West European countries, most prominently Spain, could increase their share in world production and roughly doubled their share in world exports. As a result, they became net exporters of steel around 1980.

Table 34 - World Crude Steel Production by Regions and Selected Countries, 1973-1985 (percentage shares of world total)

Region/Country	1973-1975 (a)	1976-1978 (a)	1979-1981 (a)	1982-1984 (a)	1985
EC (10)	<u>21.2</u>	<u>19.1</u>	<u>18.3</u>	<u>16.9</u>	<u>16.8</u>
France	3.6	3.3	3.1	2.7	2.6
West Germany	7.0	5.9	6.1	5.5	5.6
Italy	3.3	3.4	3.5	3.5	3.3
United Kingdom	3.4	3.1	2.2	2.2	2.2
Other Western Europe (b)	4.3	4.2	4.5	5.2	5.3
Spain	1.6	1.6	1.7	1.9	2.0
Other industrialized market economies (c)	<u>38.9</u>	<u>36.5</u>	<u>34.9</u>	<u>30.3</u>	<u>30.0</u>
Canada	1.9	2.0	2.2	1.9	2.0
United States	18.3	17.1	15.4	11.3	11.1
Japan	16.6	15.1	15.0	15.0	14.6
Total industrialized market economies	64.4	59.8	57.7	52.4	52.1
Latin America (market economies)	<u>2.6</u>	<u>3.1</u>	<u>3.8</u>	<u>4.4</u>	<u>4.9</u>
Brazil	1.1	1.6	1.9	2.3	2.8
Mexico	0.7	0.8	1.0	1.1	1.0
Africa	<u>0.2</u>	<u>0.3</u>	<u>0.3</u>	<u>0.4</u>	<u>0.4</u>
Middle East	<u>0.1</u>	<u>0.2</u>	<u>0.3</u>	<u>0.3</u>	<u>0.4</u>
Iran	0.1	0.2	0.2	0.2	0.2
Saudi Arabia	-	-	-	-	0.1
Asia (market economies)	<u>1.6</u>	<u>2.6</u>	<u>3.4</u>	<u>4.5</u>	<u>4.7</u>
India	1.1	1.4	1.4	1.6	1.6
South Korea	0.2	0.6	1.2	1.8	1.9
Taiwan	0.1	0.3	0.4	0.7	0.7
Total developing market economies	4.5	6.2	7.8	9.6	10.5
Eastern Europe	<u>27.2</u>	<u>29.7</u>	<u>28.8</u>	<u>31.1</u>	<u>29.7</u>
Soviet Union	20.0	21.4	20.5	22.5	21.5
Other centrally planned economies (d)	<u>3.9</u>	<u>4.3</u>	<u>5.8</u>	<u>6.9</u>	<u>7.7</u>
China	3.4	3.7	4.9	5.9	6.5
Total centrally planned economies	31.1	34.0	34.5	38.0	37.4
World total	100.0	100.0	100.0	100.0	100.0
Total volume (million tons)	681.3	689.4	723.3	673.1	719.1

(a) Annual average. - (b) Including Austria, Finland, Sweden, Turkey, Yugoslavia. - (c) Including Australia, New Zealand, and South Africa. - (d) Including Cuba and North Korea.

Source: IISI [f, 1983; 1986, Table 2]; own calculations.

- Within the group of centrally planned economies China's performance was remarkable. The country doubled its share in world production from 3.4 to 6.5 per cent, but remained a major net importer.

Table 35 - World Exports of Semi-finished and Finished Steel Products by Regions and Selected Countries, 1973-1985 (percentage shares of world total)

Region/Country	1973-1975 (a)	1976-1978 (a)	1979-1981 (a)	1982-1984 (a)	1985
EC (10)	47.4	42.3	43.1	38.5	38.7
France	7.7	7.5	7.9	6.9	6.8
West Germany	15.5	12.6	13.6	12.0	12.4
Italy	4.1	5.3	5.1	5.0	4.8
United Kingdom	2.9	3.2	2.7	2.7	2.9
Other Western Europe (b)	5.9	7.0	8.4	10.4	12.9
Spain	1.1	2.3	3.2	4.0	4.7
Other industrialized market economies (c)	30.5	32.1	27.7	26.0	24.3
Canada	1.3	1.7	2.3	2.2	2.1
United States	3.3	1.7	2.1	0.8	0.5
Japan	24.0	25.4	20.8	20.8	18.9
Total industrialized market economies	83.7	81.5	79.2	74.9	75.8
Latin America (market economies)	0.7	1.0	1.8	4.8	6.1
Brazil	0.2	0.4	1.1	3.2	4.3
Mexico	0.1	0.2	0.1	0.5	0.3
Africa	-	0.2	0.3	0.3	0.2
Middle East	0.0	0.1	0.4	0.4	0.4
Iran	-	-	-	-	-
Saudi Arabia	-	-	-	-	-
Asia (market economies)	1.5	2.6	4.3	5.7	4.9
India	0.2	0.7	0.0	0.0	0.1
South Korea	0.8	1.1	2.9	3.9	3.4
Taiwan	0.2	0.4	0.8	1.3	1.1
Total developing market economies	2.3	3.9	6.8	11.2	11.6
Eastern Europe	14.0	14.3	13.7	13.6	12.4
Soviet Union	6.1	5.6	5.1	4.2	3.3
Other centrally planned economies (d)	-	0.2	0.3	0.3	0.1
China	-	0.2	0.3	0.3	0.1
Total centrally planned economies	14.0	14.6	14.0	13.9	12.5
World total	100.0	100.0	100.0	100.0	100.0
Total volume (million tons)	119.2	131.3	142.4	146.3	166.4
Share of exports in world output (per cent)	17.6	19.0	19.6	21.7	23.1

(a) Annual average. - (b) Including Austria, Finland, Sweden, Turkey, Yugoslavia. - (c) Including Australia, New Zealand, and South Africa. - (d) Including Cuba and North Korea.

Source: IISI [f, 1983; 1986, Table 7]; own calculations.

Table 36 - World Imports of Semi-finished and Finished Steel Products by Regions and Selected Countries, 1973-1985 (percentage shares of world total)

Region/Country	1973-1975 (a)	1976-1978 (a)	1979-1981 (a)	1982-1984 (a)	1985
EC (10)	<u>30.3</u>	<u>29.1</u>	<u>28.5</u>	<u>26.2</u>	<u>24.6</u>
France	<u>6.9</u>	<u>6.4</u>	<u>6.1</u>	<u>5.5</u>	<u>4.7</u>
West Germany	8.1	8.8	8.5	7.8	7.3
Italy	3.8	3.7	4.3	3.5	3.7
United Kingdom	3.0	2.9	2.8	2.5	2.3
Other Western Europe (b)	<u>10.2</u>	<u>8.9</u>	<u>7.8</u>	<u>7.9</u>	<u>8.2</u>
Spain	<u>1.0</u>	<u>1.1</u>	<u>0.9</u>	<u>0.8</u>	<u>0.9</u>
Other industrialized market economies (c)	<u>15.1</u>	<u>14.9</u>	<u>14.4</u>	<u>16.3</u>	<u>17.2</u>
Canada	<u>1.8</u>	<u>1.1</u>	<u>1.5</u>	<u>1.0</u>	<u>1.5</u>
United States	10.9	12.3	11.0	12.2	13.0
Japan	0.2	0.2	0.9	2.0	1.7
Total industrialized market economies	55.6	53.0	50.6	50.2	49.8
Latin America (market economies)	<u>7.0</u>	<u>4.6</u>	<u>4.7</u>	<u>2.5</u>	<u>1.8</u>
Brazil	<u>2.5</u>	<u>0.7</u>	<u>0.5</u>	<u>0.1</u>	<u>0.1</u>
Mexico	1.5	0.6	1.7	0.5	0.4
Africa	<u>3.9</u>	<u>4.9</u>	<u>6.0</u>	<u>4.8</u>	<u>4.7</u>
Middle East	<u>6.0</u>	<u>7.1</u>	<u>7.9</u>	<u>9.7</u>	<u>7.5</u>
Iran	2.3	2.9	1.4	2.4	1.9
Saudi Arabia	0.7	1.2	2.3	3.2	2.1
Asia (market economies)	<u>8.3</u>	<u>9.2</u>	<u>12.3</u>	<u>13.3</u>	<u>12.1</u>
India	<u>0.9</u>	<u>0.5</u>	<u>1.5</u>	<u>1.4</u>	<u>1.3</u>
South Korea	1.7	1.7	1.6	1.4	1.5
Taiwan	1.1	1.2	1.8	1.0	0.8
Total developing market economies	25.2	25.8	30.9	30.4	26.1
Eastern Europe	<u>15.3</u>	<u>15.8</u>	<u>13.8</u>	<u>13.6</u>	<u>11.8</u>
Soviet Union	<u>5.4</u>	<u>6.5</u>	<u>6.4</u>	<u>6.5</u>	<u>5.6</u>
Other centrally planned economies (d)	<u>3.9</u>	<u>5.4</u>	<u>4.6</u>	<u>5.7</u>	<u>12.2</u>
China	<u>3.4</u>	<u>4.8</u>	<u>3.9</u>	<u>5.1</u>	<u>11.5</u>
Total centrally planned economies	19.6	21.2	18.5	19.3	24.0
World total	100.0	100.0	100.0	100.0	100.0
Total volume (million tons)	116.3	131.6	142.9	146.6	166.7

(a) Annual average. - (b) Including Austria, Finland, Sweden, Turkey, Yugoslavia. - (c) Including Australia, New Zealand, and South Africa. - (d) Including Cuba and North Korea.

Source: See Table 34.

- The developing countries' rising share in world production can be attributed mainly to Brazil, South Korea, India, Mexico and Taiwan,

Table 37 - World Apparent Steel Consumption by Regions and Selected Countries, 1973-1985 (percentage shares of world total)

Region/Country	1973-1975 (a)	1976-1978 (a)	1979-1981 (a)	1982-1984 (a)	1985
EC (10)	<u>17.3</u>	<u>15.9</u>	<u>14.7</u>	<u>13.6</u>	<u>13.0</u>
France	3.4	3.0	2.7	2.4	2.0
West Germany	5.2	5.0	4.8	4.4	4.3
Italy	3.1	3.0	3.3	3.1	3.0
United Kingdom	3.4	3.0	2.3	2.1	2.0
Other Western Europe (b)	<u>5.3</u>	<u>4.7</u>	<u>4.4</u>	<u>4.5</u>	<u>4.0</u>
Spain	1.7	1.3	1.2	1.1	0.9
Other industrialized market economies (c)	<u>35.7</u>	<u>32.6</u>	<u>31.9</u>	<u>28.1</u>	<u>28.2</u>
Canada	2.1	1.9	1.9	1.6	1.8
United States	20.2	19.6	17.6	14.3	14.6
Japan	11.2	9.4	10.5	10.3	10.2
Total industrialized market economies	58.2	53.2	50.9	46.2	45.2
Latin America (market economies)	<u>4.1</u>	<u>3.9</u>	<u>4.5</u>	<u>3.8</u>	<u>3.8</u>
Brazil	1.6	1.6	1.8	1.5	1.7
Mexico	0.8	0.9	1.4	1.1	1.0
Africa	<u>1.0</u>	<u>1.4</u>	<u>1.7</u>	<u>1.5</u>	<u>1.6</u>
Middle East	<u>1.4</u>	<u>1.8</u>	<u>2.1</u>	<u>2.7</u>	<u>2.4</u>
Iran	0.6	0.9	0.5	0.8	0.7
Saudi Arabia	0.2	0.3	0.6	0.9	0.7
Asia (market economies)	<u>2.8</u>	<u>4.2</u>	<u>5.3</u>	<u>6.4</u>	<u>6.6</u>
India	0.9	1.4	1.7	1.9	1.9
South Korea	0.4	0.8	0.9	1.2	1.4
Taiwan	0.3	0.5	0.7	0.6	0.6
Total developing market economies	9.3	11.4	13.5	14.5	14.4
Eastern Europe	<u>27.7</u>	<u>29.9</u>	<u>28.7</u>	<u>30.9</u>	<u>29.4</u>
Soviet Union	20.1	21.5	20.8	23.0	22.1
Other centrally planned economies (d)	<u>4.8</u>	<u>5.5</u>	<u>6.8</u>	<u>8.3</u>	<u>11.0</u>
China	4.2	4.7	5.8	7.2	9.5
Total centrally planned economies	32.5	35.4	35.5	39.3	40.4
World total	100.0	100.0	100.0	100.0	100.0
Total volume (million tons)	676.4	692.5	726.8	675.4	721.4

(a) Annual average. - (b) Including Austria, Finland, Sweden, Turkey, Yugoslavia. - (c) Including Australia, New Zealand, and South Africa. - (d) Including Cuba and North Korea.

Source: See Table 34; own calculations.

which together accounted for more than 80 per cent of the group's total production in 1985. Almost 75 per cent of the developing countries' exports in 1985 were concentrated on Brazil (4.3 per cent of

world exports), South Korea (3.4 per cent), and Taiwan (1.1 per cent). As a whole, the group remained a net importer of steel products. However, the Latin American countries, with Brazil playing an important role, as well as South Korea and Taiwan became net exporters during the early 1980s.

Summarizing it may be stated that moderate growth of world steel consumption between 1973 and 1985 was the net result of a fast increase of consumption in developing countries including China and a decline in the industrialized market economies. The net excess demand was met through expansion of output by some developing country producers (most notably Brazil, South Korea, and Taiwan), and through a moderate growth of production in the peripheral West European countries. At the same time, the remaining industrialized market economies suffered a sharp decline of production along with a fall of consumption (1). In addition the world steel economy became more internationally integrated as is demonstrated by the rising share of exports in world output from about 18 to 23 per cent (Table 35). The remaining sections of this study attempt to assess the extent to which these structural changes are the result of changing comparative advantage in steel production rather than of policy interventions.

## *2. Major Trends in Brazil's Steel Exports*

### *a. Export Performance and Export Propensity*

In the 1976-1985 period Brazil's steel exports achieved unprecedented rates of growth both in terms of volume and export revenue (Table 38). The total export value increased almost sevenfold to 2,2 billion US \$ in 1985. During the same period, imports were reduced to about one fourth of their 1976-1978 value. The successful export performance was accompanied by considerable changes in the composition of exports. The share of the more basic iron products (ferro-alloys and pig iron) in total

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(1) For a more detailed analysis of structural change in the world steel economy from 1965 to 1981 see Kohama, Kajiwara [1986].



Table 38 - Exports and Imports of Iron and Steel Products by Type of Product, Brazil, 1976-1985

	1976- 1978 (a)	1979- 1981 (a)	1982- 1984 (a)	1985	1976- 1978 (a)	1979- 1981 (a)	1982- 1984 (a)	1985
	1000 tons				percentage of total export value			
	exports							
Ingots	29.3	33.6	58.0	48.9	1.1	0.7	0.6	0.4
Semi-finished products	150.2	265.0	596.9	2385.7	6.9	5.7	6.4	18.4
Flat-rolled products	67.1	654.2	2319.1	2318.1	6.1	22.6	37.0	26.5
Ordinary steel	67.1	642.1	2289.3	2289.7	6.1	21.9	36.1	25.9
Special steel	0.1	12.1	29.8	28.4	0.0	0.7	0.9	0.6
Non-flat rolled products	233.6	470.1	1381.6	2077.3	17.2	20.8	22.5	23.7
Seamless tubes	3.6	54.1	79.0	72.9	0.6	5.0	3.1	2.0
Bars	42.4	97.8	265.7	372.6	4.2	6.0	5.7	5.5
Concrete reinforcing bars	145.9	217.0	783.1	1063.3	9.1	6.4	9.9	10.2
Wire-rod	29.1	73.5	223.1	542.1	2.0	2.2	3.2	5.6
Transformed rolled products	26.7	159.5	244.9	252.4	3.9	8.8	6.0	4.8
Drawn products	14.1	32.1	52.6	55.9	1.9	2.6	1.6	1.1
Tube fittings	4.6	13.5	15.9	18.9	1.8	2.3	1.2	1.0
Ferro-alloys	115.8	193.1	287.9	311.3	29.5	20.3	12.3	10.3
Pig iron	884.0	848.4	1655.6	2477.9	29.1	12.3	10.9	12.2
Other	8.5	40.9	21.9	42.0	2.5	3.9	1.4	1.5
Total	.	.	.	.	100.0	100.0	100.0	100.0
Export value (US \$ million fob)	.	.	.	.	320.5	917.5	1622.3	2203.7
	imports							
Ingots	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Semi-finished products	3.5	120.3	63.6	0.1	0.2	5.1	7.7	0.3
Flat-rolled products	650.4	435.9	71.3	58.4	54.5	51.5	31.2	34.3
Ordinary steel	547.7	346.1	47.3	41.9	33.1	29.7	14.9	15.7
Special steel	102.7	89.8	24.0	16.5	21.3	21.8	16.3	18.7
Non-flat rolled products	237.3	143.4	57.8	33.7	28.7	27.9	34.6	30.4
Seamless tubes	45.3	67.1	10.0	9.4	13.9	18.7	21.0	20.0
Bars	9.3	19.9	4.4	1.2	1.7	3.2	3.0	1.9
Concrete reinforcing bars	-	-	-	-	-	-	-	-
Wire-rod	4.0	1.7	0.5	1.6	0.5	0.2	0.2	0.7
Transformed rolled products	30.0	13.1	6.2	6.0	7.3	5.7	7.0	10.7
Drawn products	11.0	6.0	3.0	3.6	2.3	2.1	3.2	6.4
Tube fittings	5.8	1.2	0.9	0.5	2.0	2.1	5.4	2.3
Ferro-alloys	7.2	3.1	0.7	2.0	0.8	1.0	0.4	0.9
Pig iron	-	-	-	-	-	-	-	-
Other	7.3	3.1	2.1	1.1	4.2	4.6	10.5	14.7
Total	.	.	.	.	100.0	100.0	100.0	100.0
Import value (US \$ million fob)	.	.	.	.	504.8	514.8	189.0	138.3

(a) Annual average.

Source: CONSIDER [1986, Tables 12, 13, 15 and 16].

export value declined from almost 60 per cent in the late 1970s to little more than 20 per cent in 1985, in spite of a tripling of export volumes. The shares of steel products rose accordingly, with particularly strong increases in semi-finished and flat rolled products. Concerning the balance of trade in iron and steel products (Table 38), Brazil turned from the position of a net importer of most steel products in the second half of the 1970s into a net exporter in 1985. A slight exception from this general development concerns "special flat-rolled products" for which the trade balance remained negative in value (but not in volume) terms.

Rising steel exports and the attainment of self-sufficiency even in the more sophisticated types of steel products provide some tacit support for the hypothesis that during the last two decades Brazil (and other NICs) have significantly improved their command over the steel-making technology (see Section C.IV.2 below). The increase in their shares in world steel production and exports might then indicate an advantage in production costs compared with the established producers in industrialized countries.

The growing international competitiveness of Brazil's iron and steel industry is also evident in the export to production ratios (Table 39). While total exports of iron and steel products grew strongly as a proportion of production between 1976 and 1985, the change was most pronounced for the various categories of steel products (as opposed to ferro-alloys and pig iron). In the flat rolled sector, the growth of exports relative to production appears to have started earlier than in the non-flat sector (as is demonstrated by an export ratio of 10.8 per cent in 1980 versus 5.0 per cent for the non-flat sector, both starting from a very low base). By 1985, however, non-flat rolled exports had risen sharply to 33.4 per cent of output, while the corresponding figure for flat rolled products was somewhat lower at 27.9 per cent (1). It thus appears that the difference in the firm structure between the flat and

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(1) Exports of semi-finished products for sale rose to two thirds of total sales in 1985, which can be directly associated with the start of operations of the CST plant that specializes in this product category.

Table 39 - Production Volume and Export Ratios for Iron and Steel Products, Brazil, 1976-1985

Product category	Production volume			Share of exports in production			Share in total export value of iron and steel products		
	1976	1980	1985	1976	1980	1985	1976	1980	1985
	1000 tons			per cent					
Ingots	.	.	.	.	.	.	<u>1.3</u>	<u>1.4</u>	<u>0.4</u>
Semi-finished products for sale	380	705	3610	18.6	29.9	66.1	<u>5.1</u>	<u>5.5</u>	<u>18.4</u>
Flat rolled products	3408	6911	8320	1.1	10.8	27.9	<u>4.8</u>	<u>26.4</u>	<u>26.5</u>
Ordinary steel	3359	6781	7928	1.1	10.8	28.9	<u>4.8</u>	<u>25.6</u>	<u>25.9</u>
Uncoated	n.a.	5987	7134	.	11.5	30.0	<u>3.9</u>	<u>23.3</u>	<u>23.1</u>
Plates	n.a.	2402	2659	.	24.0	30.8	<u>2.1</u>	<u>19.0</u>	<u>8.5</u>
Hot-rolled sheets and coils	n.a.	1657	2537	.	3.0	40.0	<u>0.6</u>	<u>1.6</u>	<u>10.3</u>
Cold-rolled sheets and coils	n.a.	1929	1938	.	3.2	15.6	<u>1.3</u>	<u>2.7</u>	<u>4.3</u>
Coated	n.a.	794	794	.	5.5	19.2	<u>0.8</u>	<u>2.3</u>	<u>2.8</u>
Tin plates	n.a.	595	336	.	2.7	16.3	<u>0.4</u>	<u>1.0</u>	<u>1.2</u>
Galvanized sheets	n.a.	182	323	.	14.8	27.7	<u>0.4</u>	<u>1.2</u>	<u>1.4</u>
Others	n.a.	18	136	.	2.3	6.3	-	<u>0.1</u>	<u>0.2</u>
Special steel	46	130	393	0.0	10.3	7.2	<u>0.0</u>	<u>0.8</u>	<u>0.6</u>
Non-flat rolled products	3657	5318	6212	2.8	5.0	33.4	<u>10.5</u>	<u>15.0</u>	<u>23.7</u>
Ordinary steel	2937(a)	2409	2843	3.4	4.7	31.6	<u>8.9</u>	<u>4.9</u>	<u>10.4</u>
Bars	.	793	834	n.a.	8.2	37.1	<u>1.2</u>	<u>2.4</u>	<u>3.9</u>
Wire rod	.	1392	1733	n.a.	0.8	31.1	<u>1.9</u>	<u>0.5</u>	<u>5.5</u>
Seamless tubes	203(b)	224	276	0.5(b)	16.8	18.1	<u>0.3</u>	<u>2.0</u>	<u>1.1</u>
Special steel	518(a)	610	632	0.7	5.4	14.0	<u>1.6</u>	<u>5.6</u>	<u>2.7</u>
Bars	.	393	421	.	5.3	14.9	<u>1.3</u>	<u>3.5</u>	<u>1.6</u>
Wire rod	.	131	102	.	0.8	2.5	<u>0.1</u>	<u>0.2</u>	<u>0.1</u>
Seamless tubes	.	85	109	.	12.6	21.0	<u>0.0</u>	<u>1.9</u>	<u>0.9</u>
Other steel products(c)	. (d)	2300	2736	. (d)	5.1	39.8	.	<u>4.6</u>	<u>10.6</u>
Concrete reinforcing bars	.	1682	2233	.	6.1	47.6	<u>5.2(e)</u>	<u>3.8</u>	<u>10.2</u>
Structural shapes	.	495	390	.	2.6	6.6	<u>0.4(f)</u>	<u>0.7</u>	<u>0.4</u>
Rails and track accessories	.	123	114	.	0.4	0.6	<u>0.1(e)</u>	<u>0.1</u>	<u>0.0</u>
Transformed rolled products	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	<u>5.4</u>	<u>9.5</u>	<u>4.8</u>
Ordinary steel	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	<u>5.2</u>	<u>9.1</u>	<u>4.7</u>
Welded tubes	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	<u>5.1</u>	<u>7.8</u>	<u>4.4</u>
Steel stripes	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	<u>0.1</u>	<u>1.3</u>	<u>0.3</u>
Special steel	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	<u>0.2</u>	<u>0.4</u>	<u>0.1</u>
Drawn products	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	<u>1.2</u>	<u>2.5</u>	<u>1.1</u>
Tube fittings	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	<u>1.4</u>	<u>2.7</u>	<u>1.0</u>
Ferro-alloys	307	539	744	28.3	30.4	41.9	<u>33.2</u>	<u>19.3</u>	<u>10.3</u>
Pig iron	8170	12685	18960	9.5	6.6	13.1	<u>33.8</u>	<u>13.1</u>	<u>12.2</u>
Others	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	<u>3.3</u>	<u>4.5</u>	<u>1.6</u>
Total	.	.	.	.	.	.	100.0	100.0	100.0
Export value (US \$ million)	.	.	.	.	.	.	234.9	913.0	2203.7

(a) Excludes seamless tubes. - (b) Includes seamless tubes of both ordinary and special steel. - (c) Items include both ordinary and special steel products. - (d) In 1976 production of these items is grouped according to steel category. - (e) Included above under ordinary steel. (f) Includes 136 tons (valued at US \$ 132000) of special steel.

Source: CONSIDER [1986, Tables 4, 7, 15 and 16]; IBS [b, 1986, Tables 11 and 12 (1980 and 1985 production data)]; own calculations.

the non-flat sector (the former dominated by three large state-controlled firms, the latter comprising a considerable number of relatively small, mostly private companies) did not have a lasting effect on the relative export propensity of the two sectors.

Within the two sectors export ratios vary considerably among products. While a clear picture does not emerge from the 1980 data, 1985 export ratios tend to be lower for technically more advanced products such as cold-rolled or coated sheets or coils in the flat-rolled sector, and special steel products in both sectors. This observation is consistent with the hypothesis that within a particular industry developing countries become internationally competitive first in technologically less advanced products (Table 39).

#### b. Destination of Exports

Up to the early 1980s Brazil's exports of steel products were directed mostly towards Latin America and the United States, each region accounting for about one third of total exports in volume terms. Europe and Asia (including the Middle East) received only 15.4 per cent and 8.5 per cent of Brazil's steel exports, respectively (Table 40). The relative importance of the Latin American markets diminished to a great extent in more recent years (8.1 per cent in 1985) for all product categories. At the same time, exports to Asia and the Middle East rose substantially to more than half of total exports in 1985 and to about two thirds in the case of rolled products. Within this group China alone accounted for 26.8 per cent of total exports, thus becoming the most important single export market for Brazilian steel products. Japan's role as Brazil's third largest export market in 1985 may be traced to the Japanese involvement in the CST and USIMINAS plants, which specialize in semi-finished and flat rolled products, respectively.

These geographical shifts in the destination of Brazil's steel exports imply that a large share of the export increase since the late 1970s was absorbed by new rather than traditional markets, among which Asian countries, particularly China and Japan, figured prominently. Besides,

Table 40 - Brazil's Exports of Semi-finished and Rolled Steel Products by Destination, 1977-1985 (percentage shares of total export volume)

Region/Country	Semi-finished products			Rolled products						Total		
				flat			non-flat (a)					
	1977	1980	1985	1977	1980	1985	1977	1980	1985	1977	1980	1985
Latin America	<u>100.0</u>	<u>44.5</u>	<u>6.0</u>	<u>100.0</u>	<u>28.5</u>	<u>10.1</u>	n.a.	<u>40.9</u>	<u>8.2</u>	n.a.	<u>34.9</u>	<u>8.1</u>
Argentina	50.1	36.0	-	0.3	9.3	5.2	n.a.	4.8	0.1	n.a.	11.9	1.7
Mexico	-	1.4	-	-	5.4	1.7	n.a.	8.2	0.2	n.a.	5.7	0.6
Uruguay	24.7	1.9	n.a.	73.7	3.8	n.a.	n.a.	5.8	n.a.	n.a.	3.9	0.2
Venezuela	17.3	4.7	n.a.	-	2.5	n.a.	n.a.	0.8	n.a.	n.a.	2.3	0.2
Africa	-	<u>3.2</u>	<u>1.5</u>	-	<u>2.6</u>	<u>1.4</u>	n.a.	<u>15.5</u>	<u>4.5</u>	n.a.	<u>6.8</u>	<u>2.5</u>
Asia and Middle East	-	<u>0.0</u>	<u>26.6</u>	-	<u>3.3</u>	<u>62.0</u>	n.a.	<u>21.2</u>	<u>64.9</u>	n.a.	<u>8.5</u>	<u>50.9</u>
Japan	-	-	<u>10.3</u>	-	<u>0.9</u>	<u>15.9</u>	n.a.	-	-	n.a.	<u>0.5</u>	<u>8.6</u>
China	-	-	5.8	-	-	28.2	n.a.	11.9	46.6	n.a.	3.8	26.8
Iran	-	-	1.7	-	-	4.2	n.a.	-	-	n.a.	-	2.0
Iraq	-	0.0	-	-	0.9	1.4	n.a.	6.2	0.9	n.a.	2.4	4.1
Europe (b)	-	<u>51.6(c)</u>	<u>28.8</u>	-	<u>12.7</u>	<u>4.9</u>	n.a.	<u>2.8</u>	<u>0.7</u>	n.a.	<u>15.4</u>	<u>11.5</u>
West Germany	-	<u>2.0</u>	-	-	<u>1.3</u>	-	n.a.	<u>0.6</u>	<u>0.5</u>	n.a.	<u>1.2</u>	<u>0.1</u>
Italy	-	-	14.9	-	7.4	0.6	n.a.	-	-	n.a.	4.0	5.1
Turkey	-	-	11.3	-	0.5	1.7	n.a.	-	-	n.a.	0.3	4.3
United States	-	<u>0.7</u>	<u>34.5</u>	-	<u>52.9</u>	<u>14.1</u>	n.a.	<u>18.6</u>	<u>15.7</u>	n.a.	<u>34.1</u>	<u>21.5</u>
Others	-	-	<u>2.6</u>	-	-	<u>7.5</u>	n.a.	<u>1.0</u>	<u>6.0</u>	n.a.	<u>0.3</u>	<u>5.5</u>
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Export volume (1000 tons)	64	211	2316	15	744	2318	227	444	2383	306	1398	7086

(a) Including transformed rolled products, but not drawn products. - (b) Including Turkey, Soviet Union. -  
(c) Including deliveries of 104400 tons of semi-finished products to Greece.

Source: IBS [b, various issues]; CONSIDER [1986, Table 17]; own calculations.

Brazil managed to increase its exports to Europe and the United States (in absolute terms) in spite of declining steel consumption and considerable idle capacity in the steel industries of these countries (1). For both regions semi-finished products have played an important role, while steel exports to developing countries were dominated by rolled products.

### c. Export Performance at the Firm Level

Further insights into the structure of Brazilian steel exports may be gained from an analysis of export to production ratios at the firm level (Table A20) (2). During the 1980s state-controlled enterprises (with the exception of ACESITA) tended to expand their export ratios earlier than most private firms.

Much of this development pattern is likely to be accounted for by differences in the product mix as well as the structure of specialization of some enterprises (for example, the CST plant producing slabs mainly for export). Empirical estimates of the impact of differences in factor absorption on the export performance of individual firms revealed that export ratios tended to be higher for larger firms and for firms with higher unit labour costs [Herken-Krauer, 1987a, pp. 90-106] (3). It would be premature, however, to attribute a higher propensity to export to differences in technology or economies of scale. Only a more detailed analysis of the product structure of firms, conditions in the internal and external markets for individual steel products and incentives provided to steel production could explain export performance at the firm level. In the absence of such an analysis (which would go beyond the scope of this study) it can only be concluded that larger firms - which simultane-

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(1) The impact of protectionist measures in industrialized countries on Brazil's steel exports will be discussed in Section C.V.2.c.

(2) This information is available for 17 large steel enterprises in Brazil. Steel exports through trading companies are not covered adequately by these data.

(3) The latter (somewhat paradoxical) result seems to be a consequence of multicollinearity between some of the explanatory variables; in particular, unit labour costs appear to have picked up much of the effect of both the physical and human capital variables.

ously tend to operate with more capital-intensive technology - also tend to show a higher propensity to export.

### **III. An Assessment of Brazil's Position in World Steel Markets and an International Comparison of Production Costs**

#### *1. Quantitative Assessment of Brazil's Revealed Comparative Advantage in World Steel Markets*

##### a. RCA values for Iron and Steel

One frequently applied method of obtaining information on the relative competitive position of different industries in international markets is the concept of revealed comparative advantage (RCA). RCA values relate the excess of an industry's exports over its imports (net exports) to the industry's sum of exports and imports (1). The concept provides a measure according to which different industries (or branches within one and the same industry) may be ranked with respect to their international competitive position. It has to be kept in mind, however, that the RCA concept attempts to evaluate the international competitiveness of an industry by referring to its actual foreign trade performance. In cases of serious distortions in foreign trade or in product and factor markets, favourable RCA values may result from these distortions rather than from a genuine comparative advantage which the country possesses in the production of the respective goods.

Earlier calculations of RCA values for 47 branches of Brazil's industrial sector and selected years during the 1965-1982 period have shown that Brazil's competitive position in world iron and steel markets (SITC 67) improved considerably in the early 1980s (Fasano-Filho et al., 1987, pp.

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(1) A normalization term is sometimes added to this coefficient to account for the effect of the overall surplus or deficit in the balance of trade [see, for example, Fasano-Filho et al., 1987, p. 27].

28 ff.]. If comparative advantage in iron and steel production does shift from industrialized countries to NICs, an improving international competitiveness of countries such as Brazil would have to be accompanied by a declining international competitiveness of iron and steel exports from industrialized countries. This proposition can be evaluated on the basis of RCA values provided in Table 41 (1).

The evidence may be summarized as follows:

- For all industrialized countries covered in Table 41 the foreign trade position of the iron and steel industry deteriorated significantly in 1974-1984. The loss of competitiveness was more pronounced in markets of developing countries than in markets of other industrialized countries, and occurred primarily in traditional (SITC 673, 674) rather than sophisticated products (SITC 678).
- RCA values of NICs improved greatly in the same period of time. In the case of Brazil this is true for trade both with industrialized and developing countries. All NICs covered in Table 41 have a much stronger competitive edge in markets of developing countries than in those of industrialized countries. The indices by product category yield a mixed result. In Brazil, export success was largely built on an expansion of net exports of traditional exports.

These findings are supported by other evidence [UNIDO, c, p. 214] which shows that only the most advanced developing countries have been able to improve their balance of trade in iron and steel products significantly (which is what RCA values really indicate). The indices for industrialized countries are in line with the above relocation hypothesis. Yet, they may still overestimate comparative advantage in steel production of industrialized countries. The reason lies in the shortcomings of the RCA concept applied here.

As has briefly been mentioned above RCA values indicate the international competitiveness of an industry in world markets as it is revealed

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(1) The following formula was used for the calculation of RCA values for product category i:

$$RCA_{ij} = (X_{ij} - M_{ij}) / (X_{ij} + M_{ij}) \cdot 100$$

where X = exports; M = imports; j = country.



Table 41 - RCA Indices for Selected Iron and Steel Products, Brazil and Selected Countries, 1974-1984

Country	Exports to	Year	Total (SITC 67)	Shapes (SITC 673)	Plates and sheets (SITC 674)	Tubes and pipes (SITC 678)
Brazil	world	1974	-83.29	-76.07	-97.98	-82.26
		1982	51.70	76.84	56.25	22.59
	industrialized countries	1974	-90.52	-83.17	-99.88	-94.86
		1982	33.63	53.12	35.85	-0.55
	developing countries	1974	-13.30	-37.35	-58.87	48.73
		1982	89.85	100.0	97.56	84.32
South Korea	world	1974	-1.50	-7.93	48.21	55.62
		1984	21.88	22.77	29.13	60.14
	industrialized countries	1974	-13.08	-12.73	33.64	52.39
		1984	7.95	-36.16	18.65	53.93
	developing countries	1974	97.65	100.00	100.00	100.00
		1984	73.42	91.92	98.55	97.82
Spain	world	1974	-32.58	28.25	-68.10	-4.89
		1983	51.82	86.78	36.24	45.38
	industrialized countries	1974	-51.29	-5.95	-73.94	-29.70
		1983	17.43	66.71	9.97	-3.30
	developing countries	1974	82.79	87.93	72.42	100.00
		1983	93.47	99.87	100.00	99.29
West Germany	world	1974	48.63	46.63	48.24	74.95
		1984	25.40	-8.62	26.77	59.32
	industrialized countries	1974	34.28	31.23	32.24	62.48
		1984	14.32	-12.07	12.52	39.51
	developing countries	1974	92.68	100.00	96.17	98.09
		1984	67.07	52.00	85.05	97.03
United States	world	1974	-35.73	-62.46	-53.28	6.30
		1984	-79.65	-88.05	-88.95	-65.33
	industrialized countries	1974	-60.87	-73.94	-74.99	-40.87
		1984	-85.42	-90.59	-93.02	-75.52
	developing countries	1974	43.69	10.45	39.84	64.06
		1984	-57.83	-74.24	-68.35	-43.03
Japan	world	1974	92.83	99.07	99.55	97.44
		1984	75.75	96.85	82.71	97.55
	industrialized countries	1974	88.20	97.92	98.85	95.76
		1984	75.70	97.34	94.05	95.02
	developing countries	1974	97.02	99.46	99.95	97.95
		1984	68.01	94.67	74.51	97.23

Source: Herken-Krauer [1987a, Tables A1-A6]; own compilations.

in trade flows, but not necessarily the comparative advantage a country has in that particular industry on the basis of its resource endowment. Usually one would assume that a change of comparative advantage goes hand in hand with a respective change of international competitiveness. This causal relationship can, however, be interrupted by government interventions which limit import expansion or subsidize output growth. In such cases, RCA values will indicate a sustained or even improved international competitiveness although the industry has lost its comparative advantage. The relevance of protectionist measures for the performance of iron and steel industries in industrialized countries will be analysed in Section C.V.2.c.

#### b. Price Competitiveness

The measures of Brazil's RCA in steel production presented in the preceding section reflect the combined impact of price and various non-price parameters on the country's competitive position in world markets. Since the product price can be assumed to be the most important single element within the bundle of factors influencing export performance, the prices of Brazilian steel products in the world market will now be compared to those of the country's competitors. However, as most countries' steel markets have been affected by protection, discrimination and government price regulation, the role of prices in determining actual market shares is more limited than it may first appear. A further problem arises from the difficulty of defining standard products due to possible differences in metal content and refinement, type of production process, size and thickness requirements, etc.; such differences imply substantial deviations in actual prices. International comparisons also involve the problem of choosing the correct exchange rate. Finally, with a growing proportion of barter and state-to-state trade the role of quoted prices as indicators of relative efficiency or competitive position has been reduced even further (1). Given these caveats the following assessment of

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(1) No evidence has been found to suggest that quoted steel prices in international trade were severely distorted through underinvoicing of exports/overinvoicing of imports.

Brazil's price competitiveness in selected steel products has to be taken with a grain of salt.

In 1977, the Brazilian Steel Institute undertook a major comparison of internal prices of steel products in Brazil, the United States, and selected European countries [IBS, d]. The results of this study confirm the expected lower price for Brazilian products in comparison to those in industrialized countries. Price differences are most pronounced for low value added products, especially plates and sheets, even using the official exchange rate which was considerably overvalued at that time (Table 42). Applying an exchange rate corrected for the overvaluation bias reinforces the price differentials. The relative small price differentials for products with higher value added may, however, simply reflect different technical specifications and not efficiency differentials.

Another conclusion that emerges from this study is that in all cases quoted export prices were lower than the prevailing domestic prices. When compared with the standard international market prices, i.e. quotes in the steel exchange of Brussels, all domestic prices were higher. This reflects the impact of protectionism which allows companies to charge a higher price domestically than abroad. It is plausible to assume that domestic prices were on average high enough to cover at least some part of the fixed costs of production in addition to all variable costs, whereas the minimum price at which steel was offered in the international market rather reflected marginal costs.

It should be noted that domestic steel prices in Brazil were subject to domestic price controls that tended to hold down prices of steel relative to the general price level (for a more detailed analysis see Section C.IV.4.a). A comparison of unit values of US steel imports from a variety of producer countries confirms, none the less, that Brazilian suppliers possess a price advantage over their competitors from other countries (Table A21). Unit values of imports from Brazil are below average unit values for most years and most product categories. This finding does not depend on whether cif prices or customs values, which do not include transport costs, are used in the calculation.

Table 42 - International Comparison of Internal Prices of Rolled Steel Products, 31.12.1976 (US \$ per ton)

Product	Brasil		United States	France	West Germany	United Kingdom
	US \$ official	US \$ "teórico" (a)				
Plates	248	201	352	352	364	284
Hot rolled sheets	225	182	310	290	349	290
Cold rolled sheets, commercial quality	297	241	382	360	388	330
Concrete reinforcing bars	243	197	256	249	310	279
Structural shapes, light	277	225	278	315	370	324
Wire rod	234	190	330	303	308	315
Structural shapes, heavy	259	210	321	307	343	311
Carbon steel, foundry	403	327	380	471	524	375
Crane steel, foundry	419	340	456	531	567	440

(a) Purchasing power parity exchange rate, base July 1961, calculated on the basis of wholesale price index.

Source: IBS [d].

## 2. Level and Structure of Production Costs: An International Comparison

This section surveys international comparisons of steel production costs as an indicator of the competitive position of the Brazilian steel industry. In particular, it will be examined whether certain advantages Brazil may have on account of the relative abundance of labour and the local availability of raw materials (iron ore) are reflected in a relatively low share of these cost categories in total production costs. It needs to be born in mind, however, that the available estimates of steel production costs can only be regarded as rough approximations. Firstly, the data themselves are in some cases only estimates because reliable information on quantities and prices of many inputs used in the steelmaking process is not available. This information gap is especially large for the steel industries in the Third World. Secondly, there are at least three different methods of cost calculation which can be classified as the "finished-steel" approach, the "stage-by-stage" approach, and costs estimates de-

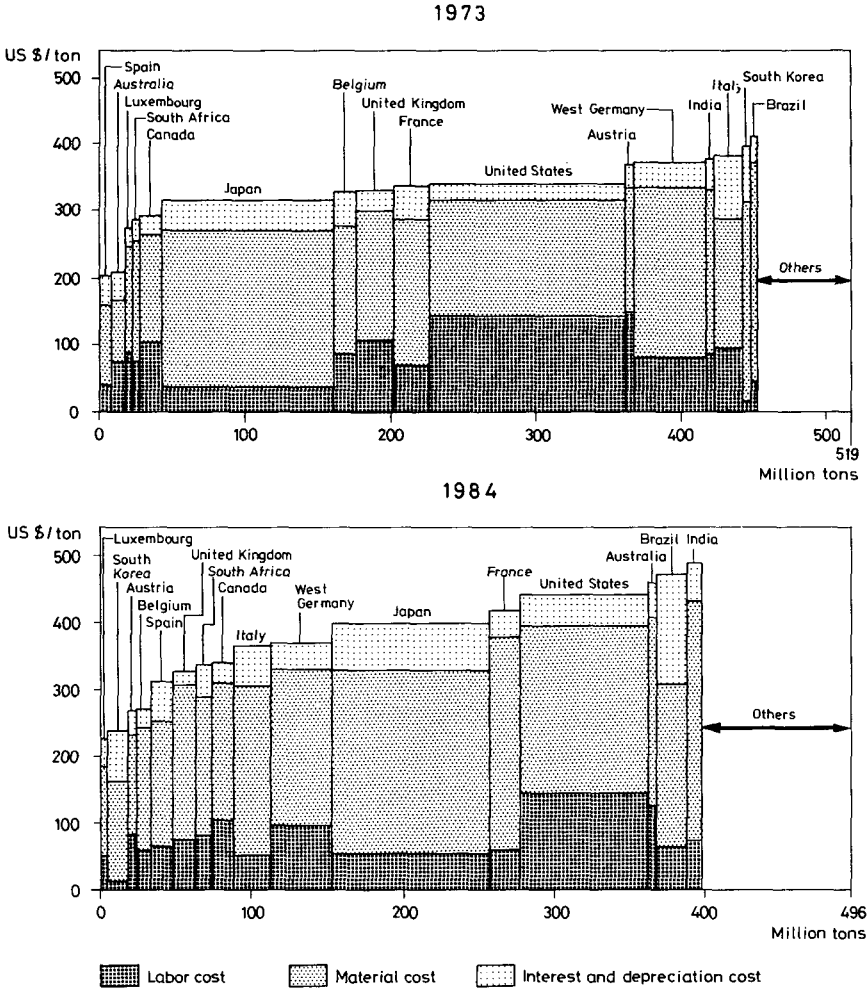
rived from financial reports of steel companies (1). Thirdly, if comparisons are based on US \$ values, the cost figures for industries outside the United States fluctuate with exchange rates. A weakening of the US \$, for example, would reduce the foreign producers' cost advantage in as much as inputs are not purchased at dollar-denominated prices in the world market. Fourthly, there are substantial differences in the product composition among industries which are, of course, also reflected in cost structures. Fifthly, unit costs are computed with respect to the tonnage shipped in a given period, implying that these costs fluctuate with the rate of capacity utilization. Thus a recovery of the market and a rise in utilization rates would result in lower unit costs.

#### a. Overview of International Cost Comparisons

International and intertemporal comparisons of production costs in the steel industry are extremely sketchy. One comprehensive cross-country and intertemporal comparison was recently provided by the World Bank [1987, p. 31]. Figure 2 shows the volume of steel production (on the horizontal axis) and the average costs (1) per ton (on the vertical axis) of sixteen important producers. These two variables allow a comparison of a country's competitive position and market share in 1973 and in 1984. The bold line in the graph can be interpreted as an approximate long-term cost curve for the world steel industry.

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- (1) The first two methods are essentially geared to providing an estimate of production costs from the perspective of factor prices and factor utilization. The "finished-steel" approach starts from the actual volume of production of finished products, calculating the cost of raw materials and labour, and estimating the cost of other inputs, particularly capital. The "stage-by-stage" approach starts from the volume of production of melted iron and crude steel, determining its labour and raw material costs, to proceed then to the estimate for finished steel products by applying yield coefficients to crude steel, and finally adding estimates of capital costs. Both methods are not only highly dependent on the use of some technical coefficients applied in the calculation, but also require highly disaggregated data. For a critical discussion of these methods see Mueller, Kawahito [1978, Chapter II].
  - (2) Production costs have been estimated on the basis of information from an average of 65 per cent of each country's steel producers. For Brazil, India, and Spain, such data have only been available for between 13 and 30 per cent of the firms [World Bank, 1987, p. 31].

Figure 2 - Unit Costs in the World Steel Industry, 1973 and 1984



Source: World Bank [1987, p. 31].

Figure 2 reveals that in terms of total unit costs Brazil's very unfavourable position as a high-cost producer did not change much between 1973 and 1984. However, while above-average material costs were mostly responsible for high total costs in 1973, it was capital charges that played a crucial role in 1984. In terms of material and labour costs Brazil's position was more favourable than that of other steel producers.

South Korea, another small and high-cost producer in 1973, was able to substantially improve its performance in terms of total unit costs, largely as a result of very low labour costs. Conversely, the United States had to cope with high labour costs in both years and experienced a deterioration in its ranking relative to the production costs of its competitors as well as a marked decline of production.

Further information on relative production costs can be obtained from a comparison of the production costs of steel plates and sheets between a Brazilian firm - USIMINAS (1) - and Japanese plants of the same scale [Taniura, 1986, pp. 176-177]. These plants are comparable due to a similar technical level in terms of output per worker, the coke rate, the fuel rate, the continuous casting rate, and the yield of the different finished products per ton of crude steel (2). Accordingly, the quantities of inputs per unit of output can be considered to be about the same and cost comparisons can be based on differences in input prices.

The results of the study which covers the early 1980s can be summarized as follows: Due to domestic iron ore resources the price of iron ore in Brazil was only 70 per cent of the respective price in Japan. On the other hand, both Brazil and Japan have to import coal from abroad, but the price of imported coal was 20 to 30 per cent higher in Brazil than in Japan. The combined costs of these main raw materials were therefore roughly the same for both countries per ton of flat rolled products. The cost of labour in Brazil was only about half that in Japan (3). Assuming that the costs of auxiliary raw materials and other expenses were similar for both countries, the direct production cost per ton of flat steel products was lower in Brazil to the extent to which the cost of labour was lower than in Japan.

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- (1) USIMINAS is one of the integrated iron and steel plants that were constructed after 1955 for the purpose of supplying flat steel products during the early days of Brazil's heavy industrialization drive. The NIPPON STEEL CORPORATION was in charge of the basic design of the USIMINAS production facilities, and has continued to provide technical assistance since the beginning of its operations.
  - (2) Only in terms of production per unit of time USIMINAS is reported to lag slightly behind the Japanese plants owing to differences in machinery and equipment.
  - (3) Wages, benefits, recruitment, and training expenses included.

As for capital costs, both depreciation and interest costs were higher for USIMINAS than for Japanese firms. There are several reasons for higher capital costs in Brazil. Firstly, the cost of physical capital per unit of output was higher in Brazil than in Japan due to the dependence on imports of machinery and equipment. Secondly, Brazil suffered from a high degree of dependence on foreign-exchange financing (varying between 23 to 26 per cent during the three phases of the expansion of the plant). The interest burden in terms of domestic currency increased with the decline the exchange rate of the Cruzeiro, which in turn was the result of high rates of domestic inflation. In the early 1980s, USIMINAS financing costs amounted to 25 per cent of total sales compared to about 7 per cent for the Japanese companies. Therefore, the total cost per unit of output in Brazil exceeded that in Japan by the amount to which Brazil's disadvantage in capital costs exceeded its advantage in labour costs (1).

Other international comparisons of production costs [ASP, 1986, p. 35; Adams, Mueller, forthcoming, p. 107] broadly confirm the picture that has emerged so far. The costs of labour and iron ore are usually found to be lower in Brazil than in many other producing countries, whereas capital costs are higher. Other cost categories in Brazil do not differ substantially from the average. In terms of total costs, Brazil's position in the international "field" of steel producers usually appears slightly more favourable than in the World Bank report.

## b. Major Cost Elements in International Perspective

### α. Unit Labour Costs

As has been demonstrated in the preceding section, labour costs play an important role in determining the competitive position of the Brazilian

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(1) Brazilian consumers of flat rolled products indicated that domestic prices were 20 to 30 per cent higher than international prices; however, as has been pointed out above, domestic prices exceed international prices in most countries, partly because international prices do not always provide compensation for the full cost of production.



steel industry. One of very few comprehensive international comparisons of unit labour costs for individual manufacturing industries is the study by Picht [1987] which covers selected Brazilian industries (including iron and steel) along with their major competitors in developing and industrialized countries (1). Concerning the Brazilian iron and steel industry the following results emerge from this study:

- A comparison of absolute unit labour costs for 1979 [ibid., Table 1] reveals that Brazil had clear advantages not only with respect to the United States (with unit labour costs amounting to only 35 per cent of the US level) but also with respect to South Korea (where unit labour costs amounted to 40 per cent of the US level). Labour costs were higher than in Taiwan (22 per cent of the US level) where, however, wage supplements were not included.
- Trends in unit labour costs over the 1974-1984 period show a rise of unit labour costs in the Brazilian steel industry, while cost reductions were achieved in South Korea, Mexico, and Taiwan (Table 43). Even the German and the Japanese iron and steel industries managed to reduce their unit labour costs relative to the United States. This finding does not only apply to the iron and steel industry but also to total manufacturing where Brazil seems to have lost unit labour cost advantages, while Hong Kong, South Korea, and Japan have improved, or at least maintained their position relative to the United States.

In order to explain this development one needs to look separately at the dynamics of labour costs per unit of time worked and labour productivity (2). In the iron and steel industry, hourly labour costs increased substantially in South Korea and Taiwan (Table A22). Cost increases were relatively modest in West Germany and Japan, while hourly labour

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(1) The study also contains a systematic discussion of the conceptual and methodological problems arising in international comparisons of labour costs [Picht, 1987, pp. 2 ff.].

(2) The US figures have, again, been chosen as a common benchmark. They have been calculated both at industry specific Purchasing Power Parities (PPPs) and average annual exchange rates. The first method seems more appropriate because it generates information about the labour cost burden as it pertains to a domestic producer [Picht, 1987, pp. 6 ff.].

Table 43 - Unit Labour Cost Trends in the Iron and Steel Industry and in Total Manufacturing, Brazil and Selected Countries, 1975-1984 (a) (Base year 1975 = 1.00)

Industry/Country	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Iron and steel industry										
Brazil	1.00	1.12	1.06	1.06	1.24	1.00	1.29	0.94	1.71	1.35
South Korea	1.00	1.15	1.46	1.77	1.46	1.00	0.92	0.62	n.a.	n.a.
Mexico	1.00	1.13	1.03	1.00	0.94	0.81	0.97	0.53	0.47	n.a.
Taiwan	1.00	1.00	0.75	0.75	0.67	0.67	1.08	0.67	n.a.	n.a.
West Germany	1.00	0.98	1.02	1.04	1.00	0.94	1.00	0.66	0.70	n.a.
Japan	1.00	1.21	1.23	0.97	0.95	0.69	0.79	0.54	0.77	n.a.
Spain(b)	n.a.	n.a.	1.00	1.05	1.05	0.85	1.00	0.58	n.a.	n.a.
Total manufacturing										
Brazil	1.00	1.06	1.06	1.12	1.06	1.00	1.71	1.82	1.35	n.a.
Hong Kong	1.00	1.13	1.07	1.13	0.93	0.93	0.93	0.93	n.a.	n.a.
South Korea	1.00	0.69	0.81	0.81	0.81	0.75	0.69	0.75	n.a.	n.a.
Taiwan	1.00	0.87	1.00	1.00	1.00	1.27	1.13	1.20	0.93	1.00
West Germany	1.00	1.01	0.99	1.00	0.95	0.99	1.03	1.03	1.00	1.00
Japan	1.00	1.00	0.98	0.94	0.88	0.88	0.88	0.86	0.86	0.84
Spain	1.00	1.07	1.05	1.07	1.20	1.20	1.20	n.a.	n.a.	n.a.
(a) Hourly labour cost (relative to the United States) for production workers computed at industry specific Purchasing Power Parities (PPPs), and corrected for productivity trend differential. (ratio). - (b) Base year 1977 = 1.00.										

Source: Picht [1987, Table 2].

costs declined in Mexico (1). In essence, Brazil's hourly labour cost advantages were reduced in relation to industrialized countries in the 1975-1985 period, and, hence, there was a significant upward pressure on Brazil's unit labour cost.

Concerning productivity as the other constituent element of unit labour costs (Table A23) Brazil gained substantially in the iron and steel sector, but only to a lesser extent in total manufacturing. In the iron and steel sector South Korea ranked first, followed by Taiwan. Although Brazil's performance in this industry is impressive, productivity increases realized in the industrialized countries in the sample are of similar magnitudes. Putting hourly labour costs and productivity trends together, the reduction in Brazil's unit labour cost advantage relative to its major competitors in the steel industry can be traced to relatively large rises in hourly labour costs that were not compensated for by productivity increases. The remaining countries in the sample have been able to improve, or at least maintain their position because the productivity increases were large enough to match increased wage bills.

In Brazil, increases of hourly wages that were apparently out of line with productivity growth are related to a wide range of labour market interventions (2). Such interventions have made it difficult for firms to employ labour in line with its expected productivity (e.g. unskilled labour was crowded out of the formal labour market). Furthermore, there has been a shortage of skilled labour since the mid-1970s [Spinanger, 1988, Chapter V] which may have negatively effected the iron and steel industry, while other policy measures (e.g. export incentives or regional incentives for the North-East) made it more attractive to employ physical or human-capital-intensive methods of production. All these policies have contributed to the deterioration of Brazil's international competitive position, in particular vis-à-vis her Asian rivals like South Korea and Taiwan, where labour markets have remained relatively free of

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(1) This overall picture would have been different if data calculated at average annual exchange rates are used. However, these calculations are economically less meaningful than those discussed in the main text.

(2) For an analysis of the Brazilian labour market, see Spinanger [1988].

policies either directly or indirectly increasing the price of labour relative to that of other factors of production.

### β. Raw Materials and Energy

Brazil is well-endowed with iron ore, the basic raw material input in steel production. With about 12 per cent of total world production (118 million tons in 1985) (1), Brazil is the largest producer of iron ore in the Western World (2). Although the ratio of exports to total production declined from 80 per cent in the late 1970s to 75 per cent in the mid-1980s (Table A24) Brazil is still the world's most important exporter of iron ore.

Brazilian reserves of iron ore are estimated to be in the order of 27 billion tons of gross weight, including measured, indicated, and inferred reserves. About 90 per cent of these reserves are concentrated in the states of Minas Gerais and Pará. Most of the production of iron ore comes from the so-called "quadrilatero ferrifero" in Minas Gerais, where the ferrous content of the ore is estimated at between 40 and 66 per cent. A sizeable number of independent pig iron producers and integrated steel plants are also located in this area (see Figure A5). The reserves in the state of Pará where production is only now beginning [Suma Económica, 1985, p. 80] consist of ore with a ferrous content of more than 66 per cent. The price of iron ore available to Brazilian consumers lies well below the world market price.

The supply of scrap, which is of particular importance for semi-integrated steelworks with electric arc furnaces, comes from three sources: scrap generated within the iron and steel sector ("internally" generated scrap), scrap generated in the steel-consuming industries ("processing" scrap), and scrap from obsolete products (see also Table A24). The supply of internally generated scrap is likely to be reduced over time as steel production technology improves and the proportion of crude steel suitable for rolling in total production of crude steel is increased. From

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(1) For the following statistics see CACEX [1985, pp. 4-9] and ECLA [1984, pp. 188-231].

(2) The Soviet Union had a share of about 29 per cent in 1983/84.

1975 to 1983 internally generated scrap as a proportion of total crude steel production declined from 21.6 to 18.3 per cent [Suma Económica, 1985, p. 94]. The supply of "processing" scrap depends on the cyclical behaviour of the steel-consuming industries in the short run, while in the long run more careful use of materials is likely to reduce the supply of scrap from this source. From 1973 to 1983 the supply of processing scrap as a proportion of the consumption of rolled products declined from 17.6 to 16.0 per cent [ibid., p. 95]. Reduced supplies of internally generated and processing scrap may be made up for partly by more extensive recycling of metal from obsolete goods; however, quality requirements may then have to be relaxed and costs may rise. The evolution of the relative price of scrap from 1975 to 1985 (Table 44) displays considerable fluctuations while apparently maintaining a relatively stable long-term level.

The key constraint in the availability of basic raw materials for the Brazilian steel industry concerns coking coal. Brazil's reserves of coal are estimated at about 11.7 billion tons [ECLA, 1984, pp. 232-241], 90 per cent of which are concentrated in the South of the country, particularly in the state of Rio Grande do Sul. Because of its high ash content most of the coal has to be processed further to obtain coking coal (1). In addition, the coking coal produced in Brazil generally has to be combined with imported coking coal in the proportion of 1:4 to achieve satisfactory quality. Substantial transport costs add to the high extraction and reprocessing costs, because the main pig iron producers are located in the centre of the country. In spite of various attempts to improve the processing of domestic coal, the surge in pig iron and steel production since the mid-1970s made the industry even more dependent on imported coal; the share of domestic coal in total consumption by the steel industry declined from 21.0 per cent in 1976 to 12.5 per cent in 1985. Coal imports come mainly from the United States and Poland, but also from Canada and Australia [Câmara de Comércio, 1985, p. 10]. In 1985, coal met more than 60 per cent of the total energy needs of the Brazilian iron and steel industry (Table 45). There has been a signif-

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(1) From one ton of raw coal extracted in the state of Santa Catarina, only 64 kg of coking coal with an ash content of 16 per cent is obtained [Câmara de Comércio, 1985, p. 8].

Table 44 - Index of Nominal Prices of Selected Raw Materials Relevant for Steel Production, Deflated by Wholesale Price Index, Brazil, 1975-1985 (1980 = 100)

Input Item	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Charcoal (m <sup>3</sup> )	n.a.	n.a.	n.a.	73.0	89.7	100.0	71.6	74.8	118.5	70.6	70.9
Coal (ton)	n.a.	n.a.	n.a.	n.a.	31.8	100.0	110.9	372.6	433.4	334.5	330.8
Coking coal (ton) (a)	157.7	123.9	115.0	104.8	103.7	100.0	90.8	99.6	101.4	88.7	88.6
Fuel oil (ton)	262.7	50.9	58.0	52.1	60.5	100.0	128.7	116.0	123.3	122.7	111.1
Electricity (wh)	180.2	159.1	139.8	111.6	121.7	100.0	131.9	122.4	102.0	92.6	105.6
Natural gas (Nm <sup>3</sup> )	n.a.	n.a.	72.1	55.9	58.5	100.0	102.3	60.4	62.8	53.1	90.3
Iron ore (ton)	147.7	159.7	144.7	117.0	157.9	100.0	98.7	116.0	99.3	95.8	95.0
Manganese ore (ton)	89.2	86.2	85.0	81.4	78.3	100.0	86.8	84.8	69.4	63.6	62.7
Scrap metal (ton)	117.1	84.3	67.7	75.6	95.7	100.0	79.2	74.2	70.7	93.5	107.8

(a) Imported; fob US \$/t, converted into Cr \$ at the annual average exchange rate.

Source: Unpublished data provided by SIDERBRAS; Conjuntura Económica [various issues]; own calculations.

icant increase in the relative price of national coal between 1980 and 1983, while it has remained relatively stable in more recent years (Table 44).

The lack of suitable coal has forced the Brazilian iron and steel industry since its incipient stages to substitute charcoal for coke in blast furnaces. A vast natural reservoir of timber has been complemented by state-sponsored efforts of reforestation (1). Many of the integrated steel producers and the independent producers of pig iron now have their own extensions of forest land, and their own installations for the conversion of timber into charcoal.

The production of charcoal increased markedly during the first half of the 1980's due to rising exports of pig iron (see Table A25). In 1985,

(1) In 1985, about 83 per cent of the total charcoal supply was of native as opposed to reforestation origin (1976: 91 per cent [IBS, b, 1986, Table 40]).

Table 45 - Energy Consumption in the Brazilian Iron and Steel Industry by Sources, 1978 and 1985 (per cent)

Energy inputs	1978	1985
Charcoal	15.1	16.5
Coal	52.6	62.5
Fuel Oil	18.3	5.0
Electric Power	9.2	9.6
Other	4.8	6.4
Total	100.0	100.0
Consumption (10 <sup>6</sup> Gcal)	62.7	104.3

Source: IBS [b, 1985, Table 51].

charcoal covered 16.5 per cent of the iron and steel industry's energy needs (see Table 45) (1). The domestic price of charcoal varies considerably by origin and also due to seasonal factors (see Table 44). In the long run the price is likely to increase steadily because of the exhaustion of natural stocks and higher transportation costs. The latter arise from the expansion of the urban and agricultural frontier that increases the physical distance between the producing and consuming units.

With regard to alloys and fluxes, Brazil is well endowed with manganese ore (estimated reserves: 95 million tons [Suma Económica, 1985, pp. 102-106], limestone, and dolomite.

The oil price increases in 1973/74 and 1978/79 had a sizeable impact on the costs of fuel-oil intensive production technologies; the same applies with respect to natural gas, though this is relevant mainly for the direct reduction technology of which there are only two small plants in Brazil. As can be seen from Table 45, the major transformation in the energy consumption pattern of the Brazilian steel industry between 1978 and 1985 was the large-scale replacement of fuel-oil by coal. The share of oil in total energy consumption was reduced from 18 to 5 per cent. Semi-integrated firms using electric arc furnaces benefited from the downward

(1) This figure apparently excludes the independent producers of pig iron.

trend in the relative price of electricity that occurred between the mid-1970s and mid-1980s (Table 44). The reduced relative price of electricity is likely to be at least partly the result of the vast extension of the supply of hydroelectricity during that period. Overall, however, the share of electricity in the total energy consumption of the iron and steel industry is below 10 per cent, and did not change markedly between 1978 and 1985 (Table 45). This small share suggests that electricity prices, however distorted they may be, do not have a significant effect on the international competitiveness of the Brazilian iron and steel industry.

#### γ. Capital Costs

The evidence presented in Section C.III.2.a indicates clearly that the Brazilian steel industry suffers from very high capital costs per ton of steel produced. By definition, relatively high capital costs per unit of output may be the result of either a disproportionately large capital stock (or, conversely, low capital productivity) or high interest rates. In the case of Brazil, both factors are likely to have played a significant role. Table 46 shows that financial costs and depreciation charges were both well above the average, but financial (i.e. mainly interest) costs clearly represented the major burden (1).

Capital productivity may have been below the level achieved in industrialized countries because the less developed industrial infrastructure requires extensive repair facilities at the plant sites. Stocks of raw materials and spare parts may also have to be larger in developing countries such as Brazil because supply lines are less reliable than in other producer countries (2). High costs of physical capital may, of course,

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- (1) Some of the difference in financial expenses between Brazil on the one hand and West Germany, Japan, and the United States on the other may of course result from different accounting methods. However, this does not fundamentally alter the picture as is demonstrated by Figure 2.
  - (2) According to "guesstimates" by Mueller [1985, pp. 244-245] recent plant construction and infrastructure problems have caused the burden of capital costs to be considerable higher for most steel firms in the developing world than for producers in advanced countries. Capital costs may vary from US \$ 90 per ton shipped for the integrated producers of South Korea and Taiwan to US \$ 120 for those



Table 46 - Cost Structure in the Steel Industry (a), Brazil and Selected Industrialized Countries, June 1985 (US \$ per ton)

Country	Total costs	Labour costs	Coal	Iron	Energy
Brazil (b)	431	76	67	17	13
West Germany	339	81	73	50	34
Japan	370	68	60	52	43
United States	507	132	59	85	76
	Ferro alloy and fluxes	Depre- ciation	Miscel- laneous	Subtotal	Financial expenses
Brazil (b)	17	44	37	271	160
West Germany	21	18	50	327	12
Japan	22	31	66	342	28
United States	22	30	88	492	15

(a) At 90 per cent capacity utilization. - (b) SIDERBRAS.

Source: ASP [1986, p. 35].

also result from the protection of the domestic mechanical engineering industry. Although duty exemptions on imported machinery were often granted to firms setting up new steel plants in Brazil, it seems at least doubtful whether this has been sufficient to put Brazilian companies on an equal footing with their foreign competitors.

Financial costs in Brazil exceed those of its competitors by a far wider margin than depreciation charges. Therefore it seems likely that high interest rates have contributed to high overall capital costs. However, an adequate assessment of the costs of raising capital in Brazil is difficult due to high inflation rates and frequent government interference in credit markets. In addition, the largest steel companies in Brazil like in nearly all developing as well as most European countries are government-controlled. They have benefited from public loans, often at a reduced rate of interest, and infusion of equity capital to cover accumulated losses. An international comparison is further complicated by the sub-

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of Brazil, and to US \$ 150 or US \$ 160 for newly constructed plants in Mexico and Venezuela. For several plants now under construction in Brazil, Pakistan, and Nigeria capital costs will be far higher, possibly reaching US \$ 300 per ton for simple carbon steel products.

sidization of capital for struggling private steel producers especially in Western Europe.

Overall, it seems likely that interest rates on capital raised domestically have been relatively high because of the risk premium on the real interest rate that results from the very high and rapidly rising inflation in Brazil (1). At the same time, interest rates on capital raised in the international markets, which has been used extensively to finance the expansion of capacity since the first half of the mid-1970s [see Taniura, 1986, p. 177], have remained at an elevated level for much of the period under consideration because of the US budget deficit. An interest rate premium to cover the "country" risk (i.e. the risk of a general default by Brazil on its foreign debt) has added to financial costs of foreign loans.

The relatively high cost of physical capital to the Brazilian steel industry leads to an important conclusion with respect to Brazil's success in exploiting comparative advantages in the production of standardized goods. According to the product cycle hypothesis, physical capital (in contrast to human capital and labour) is freely transferable internationally so that its relative scarcity in a given country does not constitute a barrier to the production of standardized (i.e. physical but not human capital-intensive) goods. The availability of physical capital as such has not constituted a barrier to the expansion of the Brazilian steel industry. However, policy-induced distortions of capital markets and misguided macro-economic policies have all contributed to high capital costs and thereby weakened the industry's competitive position in the world market.

### c. Transport Costs, Embarkation Costs and Sea Freights

Transport costs, embarkation costs and sea freights play an important role in the determination of the final price for steel products and con-

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(1) Longo [1987] provides a detailed analysis of capital market conditions in Brazil.

stitute a major source of complaints of the Brazilian steel industry. Most of the transport of raw materials and finished products within Brazil is done by railway. The average freight in 1986 for iron ore transported from the "quadrilátero ferrífero" of Minas Gerais to the COSIPA plant (US \$ 8 per ton) represented nearly 50 per cent of the average price of iron ore [Zuccoli et al., 1986, pp. 593-596]. In the case of the direct reduction plant of PIRATINI in the South of the country, the average freight costs of iron ore from the port of Tubarão represents about 40 per cent of the average price of iron ore, and about 20 per cent of the final cost of production of sponge iron [Alcântara Oliveira et al., 1986, p. 308]. Similar ratios prevail for the transport of charcoal to the pig iron producing plant by ship or truck. On the basis of an average of US \$ 0.01/m<sup>3</sup> per km, and depending on the distance, freight costs represent between 16.6 and 25.5 per cent of the cost of charcoal [Pfeifer, 1986, pp. 807-810].

Brazilian steel exports compete on the basis of their cif-prices, which include transport costs in addition to production costs. The overall costs of embarkation for steel products are much higher in Brazilian ports than in those of the foreign competitors. According to a recent study the average embarkation costs per ton in 1985 were about US \$ 15.0 in Brazil compared with US \$ 5.6 for the United States, US \$ 4.2 for the EC, US \$ 5.5 for Japan and US \$ 5.1 for Taiwan [FUNCEX, 1986, p. 10-27]. About 66 per cent of these costs (US \$ 10 per ton) accrued only to labour costs. Estimates for 1983 suggested even a higher average for Brazilian ports, about US \$ 18.4 [IBS, a, p. F/13]. Since 1984 concerted actions have been initiated by steel producers to reduce the cost of embarkation. The suggested measures, if approved by the government, would reduce the embarkation costs to between US \$ 6-9 per ton [FUNCEX, 1986, p. 10-27], which still would be around 4-5 per cent of the average price of ordinary flat rolled products.

Sea freight rates also have a considerable impact on the final price of Brazil's exports. Sea traffic is heavily regulated and subject to reference freights; in addition, freight rates tend to vary substantially according to the type of product and the volume of total shipment. Calculations for

the implicit freight rates (1) for steel products (basic ordinary flat rolled products) imported by Brazil suggest an average rate of US \$ 100-140 per ton for the transport from the main industrialized markets. This is mainly the rate for imports from Germany (US \$ 102-105 per ton for shapes and hot-rolled sheet) and Japan (US \$ 107 for hot-rolled sheet, US \$ 147 for welded tubes). The sea freight for imports from the United States are, according to this source, much higher, ranging around US \$ 200, though these rates seem to apply mainly to small shipments of special steel products. Freight rates for some neighbouring countries are obviously much lower, between US \$ 8-12 for Uruguay and Argentina (for plates and seamless tubes, respectively). In the case of Mexico, freight rates tend to average at about US \$ 110, while for South Africa they range at around US \$ 90. Though some differences may be expected concerning actual rates paid by exporters from Brazil to other markets, the average rate for basic products in 1983/84 also ranged around US \$ 100-120 [IBS, a, p. F/12-15].

### 3. Summary

A standard indicator like the RCA-ratio shows a considerable improvement of the competitive position of Brazil's steel industry. International price comparisons have revealed that prices for steel products from Brazil compare favourably with those of competitors from industrialized countries, particularly in ordinary flat and non-flat products. The margin becomes smaller as the value added and the quality specifications of the products increase. In terms of production costs, Brazil has been found to be at a disadvantage compared with its competitors, mainly due to heavy capital (financing) expenditures. Unit labour costs have also increased over the last ten years, while the prices of major raw material inputs, essentially iron ore, have remained more or less stable.

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(1) Derived from a comparison of cif and fob prices, as given by CACEX.

#### **IV. Major Determinants of Production Costs in the Brazilian Steel Industry**

The previous section has shown that Brazil's export performance has improved markedly since the mid-1970s although the country has remained a high-cost producer by international standards. This section seeks to analyse the underlying reasons for this development by looking at factor intensities of steel production and technological progress in the Brazilian steel industry. Finally, the impact of government policies on output growth and trade expansion will be considered.

##### *1. Factor Intensities of Steel Production*

###### *a. International Standardization in Steel Production*

According to the concept of comparative advantage the performance of the Brazilian steel industry depends (among other things) on whether the use of factors of production by the industry corresponds to the country's factor endowment. To test the validity of the product cycle hypothesis (see Chapter A) it is necessary to investigate whether the production of steel is highly standardized internationally and therefore does not draw excessively on the scarcest factor of production in Brazil, namely human capital. One way of testing the validity of this hypothesis is an international comparison of factor intensities of steel production. Standardization as it is understood in this context would imply low human capital intensity relative to physical capital intensity, particularly in the traditional producer countries.

This analysis relies on the Lary concept of capital intensity (see Section B.IV.1), i.e. total value added, non-wage value added and wages per employee are used as proxies for total, physical, and human capital intensity, respectively. Table 47 presents these measures for six major steel-producing countries in the early 1970s and 1980s. In all six countries steel production is more capital-intensive than the manufacturing sector as a whole. However, with the exception of South Korea in 1982/84, human capital intensity always exceeded physical capital inten-

Table 47 - Relative Factor Intensity of the Iron and Steel Industry, Brazil and Selected Countries, 1973-1975 and 1982-1984 (Manufacturing Sector = 1.00)

	Total capital intensity (value added per employee(a))		Physical capital intensity (non-wage value added per employee(a))		Human capital intensity (wages per employee(a))	
	1973-1975	1982-1984	1973-1975	1982-1984	1973-1975	1982-1984
Brazil	1.52 (3)	1.51 (3)	1.07 (4)	1.06 (4)	1.24 (6)	1.28 (5)
South Korea	2.68 (1)	2.33 (2)	1.22 (1)	1.28 (1)	1.47 (2)	1.22 (5)
Spain	1.73 (3)	1.15 (6)	1.16 (11)	0.91 (22)	1.46 (1)	1.30 (2)
West Germany	1.15 (6)	1.10 (6)	1.06 (6)	1.05 (10)	1.15 (4)	1.09 (8)
United States	1.15 (7)	1.12 (8)	0.90 (18)	0.82 (24)	1.37 (1)	1.47 (1)
Japan	1.57 (3)	1.56 (3)	1.07 (8)	1.10 (4)	1.46 (1)	1.44 (1)

(a) Relative to the average for the manufacturing sector in each country (rank among 24 manufacturing branches in brackets).

Source: UNIDO [b, 1986]; own calculations.

sity relative to the average of total manufacturing. This evidence is contrary to the standardization hypothesis and suggests that human capital intensity rather than physical capital intensity was mainly responsible for high overall capital intensity.

However, this finding needs to be qualified in several respects. Firstly, non-wage value added is likely to be subject to considerable cyclical fluctuations. Therefore, percentage deviations of physical capital intensities from the average of total manufacturing as shown in Table 47 may underestimate the true physical capital-intensity relative to human capital intensity. In the case of the two developing countries in the sample (Brazil and South Korea) this is indicated by the ranking of the steel industry among 24 branches of manufacturing industries. For physical capital intensity, this ranking is higher than for the human capital intensity.

Secondly, a relatively high average wage in a particular industry, which has so far been interpreted as an indication of high human capital intensity, may also reflect compensation for more adverse working conditions or a greater degree of unionization compared with other manufacturing industries. This would again exaggerate the degree of human

capital intensity as measured by the Lary concept. Similarly, physical capital intensity in industrialized countries may be understated by this measure since losses incurred by many firms as a result of adverse market conditions are likely to have depressed the profit component of non-wage value added during the period under consideration.

A third qualification concerns the fact that non-wage value added includes interest charges not only on fixed capital, which is usually associated with physical capital intensity, but also on working capital. The amount of working capital employed by a firm depends on the stocks of primary, semi-finished and finished goods and other non-interest-bearing assets that need to be maintained to ensure a smooth functioning of the production process. The fact that "materials intensity" need not be proportionate to physical capital widens the margin of error attached to conclusions based on the Lary measure of physical capital intensity.

Lastly it needs to be noted that steel is not a homogeneous product. There is reason to assume that the production of special steels is less standardized internationally and more human capital-intensive than the production of ordinary varieties. If the product mix differs between countries such that special steels account for a larger share of total production in industrialized countries, human capital intensities for total steel production are misleading indicators for factor intensities in the production of ordinary steel, which is relevant for developing countries.

In light of these qualifications, average factor intensity estimates for the total steel industry provide little economically sound indication of the degree of standardization achieved in the production of traditional steel products, in particular. Therefore, the following section discusses in greater detail the question of to what extent factor use in subbranches of the Brazilian steel industry corresponds to Brazil's factor endowment. There is little doubt that even for ordinary steel the procurement of inputs and marketing of output, the analysis of the chemical composition of locally available inputs (ores, fluxes, reducing agents), and the adaptation of the production process to the varying quality of inputs require considerable competence in both business administration and metallurgical engineering. Given Brazil's status as a NIC, such human

capital requirement should, however, not necessarily go beyond the skill levels already attained by the labour force.

#### b. Factor Intensities in Sub-Branches of Brazil's Steel Industry

Table 48 presents Lary-estimates of capital intensity in various sub-sectors of the Brazilian iron and steel industry for selected years. In general terms the estimates support the conclusion drawn from Table 47 of a relatively high human capital intensity in iron and steel production. However, the very considerable variations in some estimates for individual years suggest that these data, while being useful as a general indicator of factor intensity, do not provide a sound basis for a precise assessment. Specifically, no convincing explanation has been found for the fact that for some important categories 1979 data give much higher values for physical capital intensity and lower values for human capital intensity than either 1975 or 1980 data. Differences in the number of establishments covered are likely to account for some of the divergence between 1975 and 1980 data (see footnotes to Table 48), while different methods of data collection are most likely to be responsible for the deviations of 1975 and 1980 census data from 1979 "Pesquisa" data [IBGE, b, 1975, 1980; c]. In addition, the qualifications attached to the interpretation of Lary measures in the preceding section also apply to this analysis.

Bearing in mind those caveats, it may nevertheless be concluded from Table 48 that both physical and human capital intensity exceed the iron and steel industry average in rolling operations, and are below the average in the production of pig iron and castings. Human capital intensity is high in relation to the average in crude steel production (semi-finished products) and in the manufacture of forgings and drawn products (including steel wire), and low in the production of ferro-alloys. Physical capital intensity is high in the production of ferro-alloys and apparently also in the manufacture of drawn products in more recent years, and low in the production of tubes. These findings suggest that the export structure that prevailed until the late 1970s with its strong emphasis on pig iron and ferro-alloys reflected well the country's com-



Table 48 - Factor Intensities in Subbranches of the Brazilian Iron and Steel Industry, 1975, 1979 and 1980

	Total capital intensity (value added per employee)			Physical capital intensity (non-wage value added per employee)			Human capital intensity (wages per employee)		
	1975 (a)	1979 (a)	1980 (b)	1975 (a)	1979 (a)	1980 (b)	1975 (a)	1979 (a)	1980 (b)
Manufacturing sector	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Metallurgical industry	0.96	1.06	1.03	0.88	1.04	0.97	1.39	1.10	1.40
Total iron and steel industry	1.37	1.58	1.45	1.35	1.67	1.41	1.54	1.25	1.71
Pig and sponge iron	1.08(-)	1.29(-)	1.26(-)	1.07(-)	1.41(-)	1.24(-)	1.10(-)	0.83(-)	1.37(-)
Semi-finished iron and steel products	1.33(-)	1.57(-)	1.78(+)	1.28(-)	1.63(-)	1.73(+)	1.61(+)	1.37(+)	2.10(+)
Ferro-alloys	1.47(+)	2.40(+)	2.45(+)	1.51(+)	2.71(+)	2.58(+)	1.24(-)	1.22(-)	1.65(-)
Flat and non-flat rolled products of ordinary or special steel	2.46(+)	3.12(+)	2.25(+)	2.58(+)	3.58(+)	2.31(+)	1.72(+)	1.40(+)	1.88(+)
Tubes: welded, cast, drawn	1.38(+)	1.39(-)	1.27(-)	1.34(-)	1.40(-)	1.21(-)	1.64(+)	1.33(-)	1.67(-)
Cast iron or steel products (cylinders, valves, etc.)	0.70(-)	0.64(-)	0.64(-)	0.59(-)	0.52(-)	0.50(-)	1.34(-)	1.10(-)	1.47(-)
Steel forgings	1.52(+)	1.41(-)	1.18(-)	1.43(+)	1.38(-)	1.05(-)	2.05(+)	1.50(+)	1.99(+)
Steel wire	1.29(-)	2.20(+)	2.86(+)	1.23(-)	2.40(+)	3.00(+)	1.70(+)	1.43(+)	2.02(+)
Rerolled or drawn steel products	1.59(+)	1.57(-)	1.71(+)	1.56(+)	1.66(-)	1.73(+)	1.80(+)	1.33(+)	1.60(+)

(-) Smaller, (+) greater than the average for the whole iron and steel industry.  
(a) Figures relate to establishments employing 5 or more persons. - (b) Figures relate to all establishments.

Source: IBGE [b, 1975, 1980; c].

parative advantage in goods that require relatively less human capital. A similar conclusion cannot be drawn with respect to finished steel exports, which figured prominently in total iron and steel exports in the 1980s due to a shortfall of domestic demand.

Some information is available on the structure of employment in Brazil's metallurgical industry (which comprises non-ferrous metals in addition to iron and steel) that may shed light on the question of whether the relatively high average wage level in the iron and steel industry really reflects a higher human capital content. The evidence in Table 48 indicates that the average wage in the metallurgical sector was above the average of total manufacturing. However, the structure of employment in the metallurgical sector was very similar to that of the manufacturing sector as a whole (Table A26). Both the shares of the individual skill categories in total employment, and each category's share of the total wage bill corresponded rather closely. The only significant difference concerns the average wage level in the metallurgical sector, which exceeded the manufacturing average by 13.5 per cent in 1975 and 14.4 per cent in 1980. This finding strongly suggests that the relatively high average wage level in the iron and steel industry is also, at least to some extent, the result of factors other than an overproportionately large number of very highly qualified employees. Furthermore, in as far as high wages reflect higher skill requirements in all ranks of the workforce, the wage level does not suggest that the industry makes in appropriate use of the available factors of production, given that Brazil as a relatively advanced NIC can be expected to be in the process of building up a skilled industrial workforce [Spinanger, 1988, Chapter V].

An early survey by Baer [1969, pp. 103-108] points in the same direction. He analysed problems encountered by steel enterprises during the 1950s and 1960s in securing a sufficient supply of engineers and skilled labour, and concludes that although the shortage of qualified staff compelled firms to implement large-scale training programs for technicians and engineers, the supply of skilled personnel never really constituted a bottleneck that would have retarded the development of the industry. Brazilian nationals tended to quickly take over functions from foreign advisers when new plants were established. If this was true 20

years ago, Baer's conclusion should still hold true today. Further support for the hypothesis that factor proportions were in line with factor endowments can be derived from Taniura [1986]. His study of the history of the USIMINAS firm arrives at a positive assesement of "development effects" which include forward and backward employment linkages to labour-intensive industrial and service sectors.

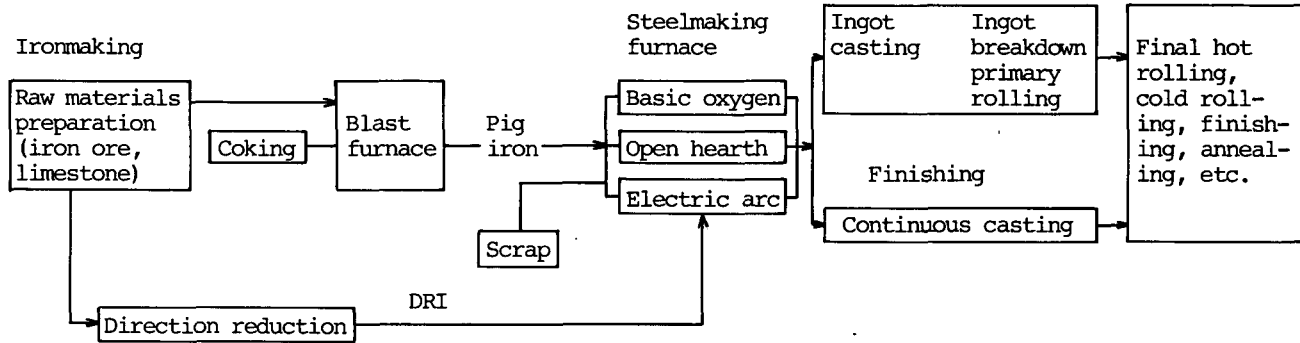
The general findings that Brazil has locational advantages in steel production may, however, not be applied indiscriminately to the production of all steel products or the implementation of all types of technology. Certain non-traditional products and/or most advanced technologies may overtax the factors of production available in Brazil. This cautioning remark is based on a study by Braga [1984]. He analysed two recent extensions of existing plants in the flat product sector (CSN, stage III; COSIPA, stage III). Using the domestic resource cost concept, which represents an empirical measure of the static efficiency of factor use, he finds that both projects fail the static efficiency test. The significance of this finding for the whole of the Brazilian steel industry stems from the fact that both projects represent the latest stage of capacity extensions, occurring on the site of already existing plants ("brownfield" sites), and in enterprises that had accumulated many years' experience in steel-making. On a priori grounds these projects could therefore have been expected to perform better than other investments previously undertaken in the industry.

## *2. The Technology-Adoption Hypothesis*

The importance of technology has been stressed repeatedly in the previous sections. This section attempts to establish how the technological level attained by the Brazilian steel industry affects its competitive position in the world market. Two conflicting hypotheses will be surveyed in the light of empirical evidence: Firstly, developing countries with rapidly expanding steel-making capacity may enjoy an advantage vis-à-vis industrialized countries because new capacity will tend to include technology of the most recent vintage. Industrialized countries may suffer a disadvantage because it does not pay to replace equipment



Figure 3 - Flow Chart of Iron and Steel Production



Possible major routes: Integrated : coking - blast furnace - basic oxygen furnace - ingot casting - finishing;  
 Semi-integrated: scrap (+ directly reduced/sponge iron) - electric furnace - continuous casting - finishing.

Source: Goldberg [1986, p. 5].

Table 49 - Steel Production by Process and Casting Method by Regions and Countries, 1973, 1981 and 1985 (per cent)

Region/Country	Production process(a)									Continuous casting	
	basic oxygen furnace			electric arc furnace			open hearth				
	1973	1981	1985	1973	1981	1985	1973	1981	1985	1973	1985
EC(9)	58.8	75.0	74.9	15.2	23.7	25.1	16.9	1.4	0.0	9.4	71.1
Belgium	77.7	93.7	91.9	3.5	6.3	8.1	1.7	0.0	0.0	0.0	60.0
France	51.9	82.4	80.4	10.6	17.2	19.6	12.9	0.3	0.0	7.3	80.6
West Germany	67.8	80.3	81.5	10.4	15.8	18.5	18.3	3.9	0.0	16.3	79.5
Italy	41.6	48.6	47.5	41.1	51.3	52.5	17.3	0.0	0.0	16.1	78.4
Netherlands	91.9	94.6	96.1	6.5	5.4	3.9	1.6	0.0	0.0	0.0	39.1
United Kingdom	47.4	67.7	71.1	18.8	32.4	28.9	31.8	0.0	0.0	3.0	54.8
Other Western											
Europe	n.a.	54.7	52.7	n.a.	36.2	41.8	n.a.	9.1	5.5	17.4	68.6
Austria	71.2	86.6	90.2	12.9	10.8	9.8	16.0	2.7	0.0	11.9	93.4
Spain	50.6	46.1	38.9	35.9	49.3	61.1	13.5	4.7	0.0	18.9	56.8
Turkey	48.9	53.3	63.2	0.5	24.7	36.2	50.6	22.0	10.6	0.0	74.3
Other industrialized countries											
Canada	65.0	67.4	67.2	18.2	25.8	30.0	17.9	6.7	2.7	12.9	67.4
United States	42.8	58.6	72.1	17.6	27.9	27.9	39.5	13.5	0.0	11.6	43.6
Japan	55.2	60.6	58.8	18.4	28.3	33.9	26.4	11.1	7.3	6.8	44.4
Australia	80.5	75.2	71.0	17.9	24.8	29.0	1.5	0.0	0.0	20.7	91.1
South Africa	48.9	76.3	94.9	3.1	2.2	5.1	48.0	21.6	0.0	1.7	27.1
Total industrialized countries	29.4	69.5	70.5	18.9	24.4	27.6	34.8	5.0	0.0	16.0	64.7
Total industrialized countries	n.a.	68.8	68.2	n.a.	26.0	29.6	n.a.	5.3	2.1	12.0	68.7
Developing countries(b)											
Brazil	40.0	64.8	71.8	24.0	27.8	24.6	35.9	7.3	3.7	3.2	43.7
Mexico	8.8	38.8	42.4	42.1	44.0	43.9	49.1	17.2	13.6	12.1	55.1
India	14.2	24.0	34.3	12.9	19.9	23.0	75.2	54.7	42.7	n.a.	n.a.
South Korea	n.a.	76.2	68.6	n.a.	23.3	31.4	n.a.	0.5	0.0	0.0	63.3
Taiwan	n.a.	48.7	65.8	n.a.	51.4	34.2	n.a.	0.0	0.0	0.0	87.2
Total Western Countries	n.a.	66.6	66.4	n.a.	26.6	30.0	n.a.	6.7	3.5	11.8	67.2
Eastern Europe											
GDR	n.a.	30.5	34.3	n.a.	12.6	14.2	n.a.	56.4	51.4	4.4	15.2
Poland	n.a.	9.0	22.8	n.a.	28.7	30.8	n.a.	60.8	44.9	6.8	33.7
Romania	22.1	38.3	42.3	9.2	14.0	14.9	68.7	47.8	42.8	2.2	10.5
Soviet Union	36.2	44.5	48.8	8.5	19.7	21.8	55.3	35.9	29.4	0.0	32.0
	21.4	29.5	32.3	10.0	10.9	12.3	67.8	59.1	55.4	5.3	13.3

(a) Percentages for individual countries and years do not always sum up to 100 because the category of other (obsolescent) processes has not been included. -  
(b) Since data are only available for selected developing countries, no averages for this group can be given.

Source: IISI [f, 1983; 1986, Tables 4, 5]; Wirtschaftsvereinigung Eisen- und Stahlindustrie [1976, p. 307]; own calculations.

Table 50 - Adoption Rates of Process Innovations and Indicators of Efficiency in Steel Production, Brazil and Selected Countries, 1978-1983

	Brazil	Mexiko	South Korea	United States	Canada	EC	West Germany	Japan
	adoption rates of selected process innovations							
Bell-less systems (1983, per cent; best practice: 100 per cent)	37	62	20	12	51	46	41	23
Steel melting (1983, per cent)								
Basic oxygen furnace	69.7	34.1	70.9	62.4	66.2	74.1	80.5	71.6
Electric arc furnace	24.5	45.0	29.1	30.4	26.6	25.9	19.5	28.4
Obsolete (open hearth)	5.8	11.9	-	7.1	7.2	-	-	-
Continuous casting (1983, per cent; best practice: 90 per cent)	44.4	36.1	56.6	31.2	37.4	60.4	71.8	86.3
	efficiency indicators							
Fuel rate (1980; best practice: 0.460 - 0.480)	0.506	n.a.	n.a.	0.596	0.546	0.538	0.540	0.466
Yield estimates(a) (1982, per cent)	76	76	83	74	77	78	77	86
Energy use(b) (1978, million British thermal units)	25.6	n.a.	n.a.	30.0	24.8	24.9	25.0	20.4
Scrap ratios(c)	42.2	n.a.	n.a.	51.5	47.4	43.8	58.3	31.9
Labour productivity(d) (1982)	20.0	24.8(e)	14.0	18.3	9.4(e)	10.1	9.7	8.3
(a) Finished steel per net ton of raw steel, adjusted for product mix. - (b) Per net ton of finished steel. - (c) The greater the use of scrap, the less should be the energy use. - (d) Manhours per net ton of finished steel (inclusive both white and blue-collar employees as well as contract workers. - (e) Estimated.								

Source: Mueller [1985, Tables 9-7].

and, hence, the country has hardly benefited from a particularly fast adoption of new technology in the course of capacity expansion.

This finding is confirmed by the adoption rate of continuous casting, which was a significant innovation of more recent years. This innovation has facilitated the production of semi-finished steel and leads to considerable energy savings. With a continuous casting rate of 3.2 and 43.7 per cent in 1973 and 1985, respectively, Brazil ranks behind the EC (9.4 vs. 71.1 per cent), Japan (20.7 and 91 per cent), and also South Korea, Taiwan, and even Mexico (Table 49). While this may not indicate a major disadvantage, it certainly does not indicate the presence of a positive "vintage" effect of capacity expansion.

The impact of many other technological innovations in steel production is more difficult to assess. Table 50 provides some indicators of the technical efficiency of steel industries in various countries in the late 1970s and early 1980s. Japan occupied the leading position in most of the performance indicators (including continuous casting, finished steel per net ton of raw steel, energy use and labour productivity), usually followed by European countries. However, Brazil does not suffer from technical inefficiency in this international comparison, except with respect to labour productivity (20 man hours per ton of finished steel vs. 18 in the United States, 14 in South Korea, 10 in Europe, and 8 in Japan). This evidence is compatible with the hypothesis that steel production is sufficiently standardized to be viable both in industrialized and relatively advanced developing countries. Serious gaps in the adaptation of modern technology exist particularly in the United States.

### *3. The Role of Economies of Scale*

In many branches of manufacturing industry the level of per-unit costs is inversely related to the scale of production (i.e. installed capacity). The reductions in per-unit costs that may be achieved by expanding the



scale of production are referred to as economies of scale (1). Their importance with respect to a firm's (or country's) competitive position stems from the fact that in order to reduce per-unit cost to a competitive level the firm has to increase its scale of production to the point where most economies are realized (minimum efficient scale) (2). Economies of scale may arise from a variety of sources in the areas of technology, procurement, marketing and finance; a further distinction is between economies at the firm, plant, and product level.

This section attempts to establish whether the Brazilian iron and steel industry suffers from a disadvantage, compared with its competitors, in terms of scale efficiency. To that end, estimates of the minimum efficient scale and the long-run average cost function (3) in steel-making are compared with the scale of production in Brazil. Due to the limited availability of firm-specific data on production (or capacity) international comparisons have to be restricted to a small number of countries. Furthermore, the wide range of technologies applied in steel-making (4) makes a detailed analysis difficult. Finally, the estimates of the cost function relate only to economies in the area of technology, but exclude possible savings in procurement, marketing and finance.

Estimates of the minimum efficient scale in steel-making available in the literature are shown in Table 51. According to these estimates the minimum efficient scale for a fully integrated flat products mill with blast furnace/basic oxygen technology is in the range of 5 to 6 million tons of crude steel per year (5). Electric arc furnaces may be operated effi-

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- (1) See Gold [1981] for an extended survey of the theoretical and empirical foundations of this concept and Lücke [1987, p. 3 f.] for a discussion of some problems involved in developing an operational definition that can be applied to empirical analysis.
  - (2) Scale efficiency is of course only one determinant of a firm's per-unit costs and, therefore, competitive position. Advantages in other areas may compensate for a disadvantage in terms of scale efficiency.
  - (3) The long-run average cost function relates changes in per-unit costs to changes in installed capacity at full utilization.
  - (4) Mainly the basic oxygen and direct reduction/electric processes, each with a variety of feasible combinations of inputs.
  - (5) Tarr [1984] argues that the estimate by Pratten [1971], i.e. 9 million tons for a blast furnace/basic oxygen shop, is too high. See also Gold [1975] for a discussion of the strategies pursued by

Table 51 - The Minimum Efficient Scale in Steel Production - A Survey of Estimates (million tons per year)

Stage of production	Source		
	UNIDO [d, p. 33](a)	Tarr [1984]	Pratten [1971, p. 122]
Blast furnace shop (to produce pig iron)	1.0 - 4.0	5.5	} 9.0(b)
Basic oxygen furnace shop	up to 10.0	6.0	
Direct reduction plant (to produce sponge iron)		} 0.5 - 3.0	
Electric arc furnace shop			
Continuous slab caster	up to 2.0		
Continuous bloom caster	up to 1.0		
Continuous billet caster	up to 0.5		
Rolling mills - flat products			
Plate mill	0.5 - 3.0		
Hot strip mill	1.0 - 6.0		4.0(c)
Cold strip mill	0.1 - 2.5		
Rolling mills - nonflat products			
Structural mill	0.3 - 1.5		
Bar mill	0.01 - 1.0		
Rod mill	0.1 - 1.0		

(a) "Approximate range of economic viability". - (b) Average total costs at 50 per cent of minimum efficient scale increase by 5 to 10 per cent. - (c) "Production of a range of rolled products including wide strip". Average total costs at 50 per cent of minimum efficient scale increase by 8 per cent.

Source: Own compilation.

ciently already at a capacity of about half a million tons, independent of whether they are fed with scrap or directly reduced (sponge) iron. The minimum efficient scale for direct reduction facilities corresponds to that of electric furnaces. Most economies of scale in the rolling of many non-flat products can be realised at a capacity of 1 million tons annually or less, depending on the type of product. These data all refer to the production of ordinary steel. Special steels are usually produced at a much smaller scale because demand for each variety is more limited and quality needs to be controlled more tightly.

In absolute figures total capital costs per ton of crude steel are considerably lower for the direct reduction/electrical furnace approach than for the blast furnace/basic oxygen process [see OECD, 1987, p. 68; UNIDO, d, pp. 36-38]. The optimal choice between the two technologies thus depends on the product mix and the availability of raw materials: Flat product mills require a larger scale of production than is necessary for non-flat products; at the same time, scrap may not be available in sufficient quantities or at competitive prices (compared with iron ore) to produce the large amounts of crude steel in electric furnaces that are needed to feed a flat product mill. Since the practicability of direct reduction facilities with a capacity of millions of tons annually still needs to be proven, particularly in the absence of abundant supplies of natural gas [see OECD, 1987, pp. 62-66], the basic oxygen process may still be the appropriate technology for a large integrated flat-product mill. By contrast, non-flat products may be made more efficiently in smaller plants with electrical furnaces, and, possibly, direct reduction facilities. For countries such as Brazil with large reserves of fast-growing tropical rain-forests the use of charcoal may offer an alternative to coke as a reducing agent in blast furnaces [UNIDO, b, pp. 15-16]. The pig iron obtained can then be processed further in basic oxygen or electric furnaces. It appears that the technological structure of the Brazilian iron and steel industry (Table 33) is broadly compatible with the relative advantages of the production technologies discussed here.

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Japanese firms that led to the construction of the giant blast furnaces on which Pratten's estimates are based.

Turning to the actual scale of production in Brazil and competing producer countries, Table A27 compares the size of coke-based blast furnaces in Brazil to those in Japan, which are suspected by some authors to be even larger than the minimum efficient scale [Tarr, 1984; Gold, 1975]. In Japan, the lowest size class is apparently considered to become obsolete, as is demonstrated by the fact that of the 11 blast furnaces which were closed down during 1985 eight belonged to this group [Kawata, 1986, p. 48]. Even though the scale of production in Brazil is apparently lower than in Japan, it seems unlikely that Brazil finds itself at a great disadvantage in this respect, given that about 70 per cent of the country's capacity falls into the upper two size classes (1).

Table A28 presents a survey of the scale of steel production in the three main sectors of the Brazilian steel industry. In the flat products sector average capacity per firm (slightly above 3 million tons per year) is lower than the minimum efficient scale of 6 million tons. According to the estimates of the long-run average cost function (Table 52) this implies an extra cost in the order of at least 10 per cent compared with the imputed optimum size. In the non-flat sector, capacity per firm is concentrated in the 100000 to 400000 ton range (involving mainly electrical furnaces), which also implies a significant excess cost compared with the optimum level of about 700000 tons (2). Conditions in the special steel sector are more difficult to assess in the absence of an estimate of the long-run average cost function. At about half a million tons for each of the two basic oxygen furnace shops and an average of about 200000 tons for the electrical furnace shops, capacity is certainly not so low as to indicate a dramatic lack of scale efficiency.

Assuming that the capacity of rolling mills in Brazil corresponds to that of steel-making furnaces, the scale of rolling operations seems to be rather at the lower end of the "range of economic viability" (Table 51). This is also true for the capacity of continuous casters [Suma Eco-

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(1) The charcoal-based blast furnaces in Brazil, which play an important role in the non-flat sector as well as for independent producers, cannot be included in this comparison because their optimum size is much lower than for coke-based furnaces.

(2) An increase of capacity beyond this level leads only to a very small reduction in unit costs.

Table 52 - Indices of Capital Costs per Unit of Output for Important Steelmaking Technologies, 1978 and 1987 (500000 tons of crude steel = 100)

Capacity (a)	UNIDO [d](b)			OECD [1987]	
	Blast furnace/basic oxygen process	Direct reduction (including site costs)	Electric arc furnace	Blast furnace/basic oxygen process	Direct reduction/electric arc furnace
0.1	.	.	.	.	138
0.2	137	140	141	.	.
0.3	116	119	120	.	.
0.4	106	108	109	.	.
0.5	100	100	100	100	100
0.6	94	95	93	.	.
0.7	90	91	91	.	.
1.0	83	90	89	76	87
1.5	.	.	.	64	84
2.0	74	90	88	.	.
3.0	71	89	88	52	84
5.0	65	.	.	.	.
6.0	.	.	.	42	.

(a) 1 million tons of crude steel. - (b) The data apparently relate to the mid-1970s.

Source: UNIDO [d, p. 95]; OECD [1987, pp. 65-66]; own calculations.

nómica, 1985, p. 74]. It is impossible to assess scale efficiency in these areas more precisely without a much more detailed analysis of the product structure of firms and the cost functions of the installed equipment.

Finally, Table 53 compares a very broad measure of the scale of production, namely average actual production per furnace, in Brazil, West Germany, and Japan. In determining whether Brazil suffers from a competitive disadvantage with respect to scale efficiency, such an international comparison needs to supplement the above analysis based only on a comparison with the imputed optimum levels (1). Capacity utilization was probably higher in Brazil than either in West Germany or Japan. There-

(1) Note that these data relate to the number of individual furnaces, rather than furnace shops (as referred to earlier) that may consist of up to five furnaces in the case of Brazil.

Table 53 - Average Production per Steel-Making Furnace in Brazil, West Germany, and Japan, 1985

Process/Country	Number of furnaces	Crude steel production	Average production per furnace
Basic oxygen steel			
Brazil	21	14680	699
West Germany	39	33020	847
Japan	85	74776	880
Electric furnace steel			
Brazil	64	5029	79
West Germany	100	7477	75
Japan	555	30503	55

Source: IBS [b, 1986]; Suma Económica [1985, pp. 68, 73, 76, 78]; Wirtschaftsvereinigung Eisen- und Stahlindustrie [1986]; Kawata [1986].

fore, the figures for basic oxygen steel may understate somewhat the difference in the scale of production (i.e. installed capacity as opposed to capacity utilization) between Brazil and these two countries. Still, the evidence does not point to a major disadvantage in terms of scale efficiency and, therefore, per-unit costs in Brazil. Steel production in electrical furnaces in Brazil seems to be scale-efficient compared with the other competitors.

It may be concluded that the competitive position of the Brazilian steel industry in the world market is not worsened by low scale efficiency, although the scale of production in Brazil appears to be smaller in many operations than the (imputed) minimum efficient scale. Most of the major competitors of the country operate at similar "sub-optimal" levels of installed capacity.

#### 4. *The Impact of Government Interventions*

Differences among economic policies of national governments concerning taxation and subsidies, environmental protection, industrial relations and

regional development will not affect the comparative advantage of a particular industry such as the iron and steel industry since comparative advantages are determined by the factor endowment of the countries concerned. They may, however, have a significant impact on the competitive position of economic activities in world markets. As long as a policy adopted by a national government affects all economic activities of the country roughly to the same degree, its principal effects would be an adjustment of the country's exchange rates vis-à-vis the trade partners. However, competitive positions will be changed when a policy favours or discriminates against a particular industry, and economic incentives such as fiscal and financial bonuses and protectionist measures are by their very nature unevenly distributed among economic activities. Hence, the observed international competitiveness of the Brazilian steel industry may have been artificially boosted by policy interventions rather than have resulted from an efficient use of factors of production in accordance with the country's factor endowment.

International factor-cost differentials are also reflected in exchange rates, as are international differences in inflation rates. A particular industry will experience a reduction of its international competitiveness if its factor costs rise more rapidly than the general price level, while the factor costs of foreign suppliers increase at a lower rate than price levels in their respective home countries. Furthermore, exchange rates do not always balance diverging cost and productivity trends among different countries; they are themselves subject to policy interventions. Distorted exchange rates may also cause competitive advantages or disadvantages.

In the following sections the impact of major economic policy measures applied in Brazil on iron and steel exports is analysed empirically.

#### a. Domestic Price Controls

Since the mid-1960s the control of steel prices by the Brazilian government (mostly through the implementation of price ceilings) has gone through three distinct phases: from 1964 to 1967 real prices (relative to

the general price level) declined considerably, in 1967 to 1975 the downward pressure on prices was relieved, and thereafter price increases again lagged considerably behind general inflation [Azzoni et al., 1985, p. 724]. Table 54 shows the more recent decline for some important flat-rolled as well as two non-flat products (1), along with the wholesale price index for all iron and steel products [IBS, c, provides rather similar results].

In setting maximum prices the government was guided initially by a desire to promote the development of the steel-consuming industries (and thereby the industrialization of the country) by ensuring low-cost supplies. Later the pricing policies for state enterprises (including those in the steel industry) were also oriented towards (purportedly) helping to hold down inflation. Predictably, this approach caused the profitability of the steel enterprises to deteriorate markedly. Lower prices immediately led to lower profits, while the companies' debt to equity ratio increased in the medium term. In a highly inflationary environment interest charges especially on working capital skyrocketed. Hence the companies' ability to finance investment out of their own resources was undermined and they became even more dependent on subsidized credit and infusions of equity capital from the government to meet their targets for capacity expansion (which had been laid down for them in the various "steel plans" formulated under government guidance) (2).

While the maximum price policy appears to affect flat and non-flat products in a similar way, there are some indications that the large state-owned enterprises in the flat product sector have been hit hardest, since their profitability seems to have declined more sharply than in the private sector [Suma Económica, 1985, pp. 18-51]. One source from the industry also indicated that at least for some less important non-flat or special steel products maximum prices are fixed so as to allow the

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- (1) Since price data were only available from SIDERBRAS the more important non-flat products are not included.
- (2) Azzoni et al. [1985] provide a more detailed analysis of the conflicting objectives in government steel policy and of the impact of such policy on the flat product sector.



Table 54 - Internal Prices of Steel Products, Deflated by Wholesale Price Index (oferta global), Brazil, 1977-1985 (1977 = 100)

	Plates	Hot-rolled sheets and coils	Cold-rolled sheets and coils	Tin plates	Galvanized sheets
1977	100	100	100	100	100
1978	101	95	94	104	91
1979	95	88	87	103	81
1980	96	88	88	111	74
1981	98	89	89	101	73
1982	74	68	68	69	57
1983	60	55	55	54	47
1984	55	54	53	52	44
1985	53	58	54	67	60
	Rails		Structural shapes heavy	Wholesale price index, all iron and steel products	
1977	100		100	100	
1978	153		96	96	
1979	205		86	88	
1980	206		87	73	
1981	207		87	69	
1982	157		70	66	
1983	127		54	49	
1984	119		51	43	
1985	120		52	40	

Source: Unpubl. data provided by SIDERBRAS (nominal prices); Conjuntura Econômica [various issues] (price indices); own calculations.

marginal producer to survive; this guarantees some degree of profitability for the more efficient firms.

Overall it seems clear that the urgent need to reduce the government budget deficit and to improve the efficiency of state enterprises in Brazil calls for a revision of the present policy of artificially holding down steel prices. Besides, economic history has shown that price controls for basic goods (such as steel) are completely ineffective and even become counter-productive because of the negative impact on the government deficit.

## b. Exchange Rate Policies and Their Effects on Steel Exports

A firm's inclination to export a unit of output rather than sell it domestically can be assumed to depend, among other things, on the ratio of the export price to the domestic price. In terms of domestic currency that ratio may be defined as the export price, multiplied by the nominal exchange rate (units of domestic currency per unit of foreign currency), and divided by the domestic price.

In an empirical analysis a comparison between export and domestic prices at any one point in time may not contribute much to an explanation of the firms' propensity to export, since the costs of marketing a product abroad may significantly exceed those incurred domestically. However, over time a change in the relative price, which may also be looked upon as the real exchange rate relevant to the particular industry, can be expected to exert some effect on exports. In the case of the Brazilian iron and steel industry, government policy influences the real exchange rate in two separate ways, namely, by fixing the nominal exchange rate (presumably in relation to general inflation levels domestically and abroad), and by fixing the domestic price of iron and steel products. By contrast, export prices are determined by demand and supply conditions prevailing in international markets, including such factors as protectionism in importing countries.

Table A29 presents time series of the real exchange rate for total rolled, flat, and non-flat exports, as well as for its constituent elements (export and domestic prices and the nominal exchange rate). For all three categories of exports, the real exchange rates show a rising trend, i.e. a depreciation of the domestic currency. This seems to be a result of the limited increase of the domestic price relative to the nominal exchange rate. The considerable fluctuations about this trend are likely to be caused largely by fluctuations of export unit values. The time trend of relative product prices suggests in any case that it became increasingly attractive to export rather than to sell domestically.

To test for the impact of the real exchange rate on the volume of export, a regression analysis of the determinants of flat, non-flat and total

rolled steel exports from Brazil has been undertaken (Table 55). In addition to the real exchange rate the following explanatory variables are included: production (as a scale variable), a recession-boom variable as a proxy for capacity utilization (see footnote (b) of Table 55), and the lagged dependent variable to account for the fact that due to various restrictions (such as the availability of means of transport, limitations in the foreign sales network) exports cannot increase abruptly from one year to the next.

Because of collinearity between production and the real exchange rate the two variables are not included in any equation simultaneously. Even so, the real exchange rate, somewhat surprisingly given the considerable variation about its mean during the period under consideration, is not found to have any statistically discernible effect on exports. The influence of the remaining variables is difficult to assess due to a high degree of collinearity between some of them. It may be stated with some degree of confidence, though, that both production and the recession-boom variable play an important role, given that their coefficients are statistically significant in most equations. By contrast, the impact of the lagged dependent variable is less clear, as its coefficient becomes significant only in two out of three equations that involve the real exchange rate but not production.

In interpreting these findings the question needs to be addressed whether a simultaneity problem exists in relation to the production and recession-boom variables. For example, production might expand because of a rise in exports rather than vice versa, or the difference between production and domestic consumption might grow larger because of export growth and not only due to a shortfall of domestic demand (with exports filling the gap). If true this would invalidate the use of a single-equation model to analyse the determinants of export supply, and require the estimation of a system of equations with several endogenously determined variables.

This problem arises partly because actual production had to be used as a proxy for productive capacity. In the absence of time series data on capacity utilization, however, this does not seem inappropriate since

Table 55 - Determinants of Brazil's Exports of Rolled Steel Products, 1970-1985 - Regression Results

Dependent variable	Constant	Lagged dependent variable (log)	Production (log)	Real exchange rate (a) (log)	"Capacity utilization" (b)	Durbin-Watson statistic (c)	$\bar{R}^2$	Standard error
Total rolled exports (log)	0.83 (3.38)	0.94** (0.35)		0.016 (0.744)	0.000060 (0.00018)	1.16	0.86	0.51
Flat rolled exports (log)	8.48 (4.83)	0.36 (0.26)		-0.23 (1.08)	0.00091** (0.00034)	1.56	0.81	0.77
Non-flat rolled exports (log)	0.98 (2.93)	0.94** (0.34)		-0.03 (0.63)	0.00012 (0.00037)	1.88	0.74	0.58
Total rolled exports (log)	-5.35* (2.53)	0.34 (0.22)	1.55*** (0.37)		0.00023* (0.00011)	1.32	0.94	0.32
Flat rolled exports (log)	-1.24 (4.99)	0.30 (0.21)	1.13* (0.55)		0.00063* (0.00031)	2.02	0.86	0.66
Non-flat rolled exports (log)	-7.46* (3.46)	0.21 (0.29)	2.08** (0.67)		0.00061* (0.00030)	1.56	0.86	0.42
Total rolled exports (log)	-0.65 (2.71)		1.51*** (0.30)		0.00043*** (0.000070)	1.21	0.90	0.41
Flat rolled exports (log)	4.67 (4.03)		0.85 (0.49)		0.0011*** (0.00021)	1.76	0.83	0.69
Non-flat rolled exports (log)	-3.99 (3.25)		1.98*** (0.40)		0.00087*** (0.00019)	1.05	0.81	0.49

Standard errors in parentheses. - \* Significant at the 10 per cent level. - \*\* Significant at the 5 per cent level. - \*\*\* Significant at the 1 per cent level.

(a) This variable attempts to represent the relative incentive for enterprises to sell their output abroad rather than domestically. It is calculated as the product of the nominal exchange rate index and an export unit value index, divided by the domestic wholesale price index for iron and steel products. - (b) Difference between production and domestic apparent consumption. This variable attempts to account for the fact that with internal prices heavily regulated quantity changes (such as a fall in domestic demand) may not be fully reflected in price changes (such as a tendency for the domestic price to decline). It would be preferable to use productive capacity instead of actual production, but data are not available for the whole period of observation. The possibility of a simultaneity problem distorting the results is discussed in the text. - (c) Note that for the equations containing the lagged dependent variable among the explanatory variables the Durbin-Watson statistic is biased toward two. However, in most cases it was technically impossible to correct for this by calculating the Durbin-h statistic.

Source: CONSIDER [1986]; IBS [b, various issues]; Conjuntura Econômica [various issues]; own calculations.

even in a very bad year (1982) the capacity utilization rate was 80 per cent, and actual production and capacity may therefore be expected to

be very highly correlated. Given the long gestation period of investment in steel-making capacity, productive capacity cannot be determined by current exports, and the inclusion of production as a proxy for capacity among the independent variables seems justified due to the lack of better alternatives. Similarly, there is evidence [see for example IBS, a, pp. B 6-9] that steel enterprises placed considerable emphasis on increasing their share of the domestic market as long as there were significant imports, and only began to expand their exports (to more than 10 per cent of output) when domestic demand collapsed in the early 1980s. It is assumed here that this a-priori information is valid. Given that domestic demand is determined independently of exports or production, the causality between the difference of production and domestic consumption on the one hand and exports on the other may safely be assumed to be uni-directional as postulated by the estimated model.

Summarizing, it may be concluded that growth of exports in the period under consideration was a consequence firstly of the expansion of overall productive capacity in the industry, and secondly of the variation of domestic demand relative to capacity. The real exchange rate, crudely estimated, was not found to have a discernible impact (1).

The absence of a discernible effect of the real exchange rate (2) corresponds to the findings with regard to automobile exports (Section B.IV.2.a). There it has been concluded that a stable real exchange rate, measured in terms of general inflation rates in Brazil and its more important trading partners, is only a necessary rather than a sufficient condition for successful export expansion. This conclusion also seems to apply to steel exports.

- 
- (1) This result may change if data were available to construct a more refined measure of the real exchange rate, which might involve, for example, individual time series on domestic prices of flat and non-flat products.
  - (2) An essentially similar result was obtained by C.A. Braga [1986] who found that the exports of one large flat steel producer were related almost exclusively to the behaviour of domestic demand while the relative price in the international vs. the domestic market (including the more important export incentives) did not play an important role.

The real exchange rate measured in terms of the prices of iron and steel products at home and abroad depreciated considerably because domestic price controls kept the rise of the price index for iron and steel products below the general level of inflation. On the other hand firms were apparently preoccupied during most of the period under consideration with increasing their share of the domestic market. This leads to the conclusion that either profits from domestic sales at regulated prices were still so large that the depreciating real exchange rate in itself did not provide a sufficient incentive to switch to exports, or losses from domestic sales were offset by other government interventions such as subsidized loans and equity participation. Losses incurred by the state-owned sector point in the latter direction, but there is no solid evidence on which an assessment for the industry as a whole can be based. Whether the observed behaviour will continue to prevail in the future is likely to depend on how profitable (directly or indirectly) domestic sales at regulated prices will be relative to exports, and whether firms will be free to decide about exports or domestic sales solely on the basis of economic considerations.

#### c. Nominal Incentives to Domestic Sales and Exports of Iron and Steel Products

Since the mid-1960s trade policy measures affecting the Brazilian iron and steel industry have included both a significant degree of protection from imports, which promotes sales in the domestic market, and incentives for exports. An assessment of the role of trade policy for the expansion of steel exports from Brazil requires one to know whether export incentives merely compensated for the effects of protection or whether exports were effectively subsidized.

For this purpose the available data on the impact of the more important policy instruments stimulating Brazil's iron and steel exports will be presented (1), and will subsequently be compared with export-retarding effects of protection and the overvaluation of the domestic currency.

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(1) For a broader discussion of the range of instruments stimulating exports in Brazil, see Section B.IV.2.b.

It needs to be borne in mind that estimates of the impact of trade policy measures, and especially of protective tariffs and non-tariff barriers, can only be tentative. Estimates of protection which are based on a comparison of domestic and international prices depend crucially on the choice (and availability) of the appropriate "world market" price. In addition, low domestic prices may not only result from the absence of trade policy measures but also from domestic price controls (such as in the case of steel prices in Brazil). When rates of protection for individual products are aggregated to the sector level, the choice of the weights for calculating the sector averages (for example, import values or values of production) may lead to widely different results. Finally, the real value of export incentives may differ from the legal or ad valorem rate as a result of the form of payment in an inflationary environment.

Unfortunately, the only estimates available that cover consistently the impact of the whole range of trade policy measures relate to the years 1980/81 and the whole of the metallurgical industry (including non-ferrous metals along with iron and steel; Table 28). Financial and adjusted fiscal export incentives for the total metallurgical sector amounted to 16.9 per cent of export sales. This figure is significantly below the rates estimated for the sectors benefiting most from Brazil's export incentives, namely electrical machinery and transport equipment (35.5 and 34.1 per cent, respectively), and also below the average for all manufacturing industries (20.8 per cent). The level of implicit nominal protection (1) which takes into account nominal tariffs, non-tariffs barriers (NTBs), and production subsidies was calculated at 10.8 per cent, indicating that domestic prices in Brazil were higher than international prices for the metallurgical industry. Nonetheless, the metallurgical industry was less protected than manufacturing industries on average.

The net result of protection and export incentives was a pro-export bias of about 5 per cent for the metallurgical industry after adjustment for currency overvaluation, which was very low compared for example with transport equipment (34 per cent). At the same time a modest anti-

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(1) For a discussion of the problems involved in calculating implicit nominal protection rates, see Section B.IV.2.c.

export bias of 2 per cent was calculated for the average of all manufacturing industries.

The World Bank [1983] study which provides these estimates also relates some information on the protection of individual branches of the metallurgical industry (Table 56). Protection rates for the more important exported products (pig iron, semi-finished ("primary forms") and rolled steel products) are generally lower than for the metallurgical sector as a whole. Unfortunately, similarly disaggregated information is not available for export incentives. However, incentives tend to be more uniformly distributed across sectors. Therefore the net pro-export bias of the trade policy measures affecting the steel industry may be slightly greater than the 5 per cent calculated for the metallurgical industry (Table 28). Nevertheless, such a relatively low figure cannot be taken to support the hypothesis that trade policy played an instrumental role in the rapid growth of Brazilian steel exports that began in the early 1980s.

Only scattered evidence is available for the post-1980 period. Table 57 presents some preliminary estimates of protection levels in 1985 based on a comparison of export (fob) and domestic prices. Nominal legal tariffs have apparently been reduced somewhat. However, it is impossible to state with a sufficient degree of reliability whether the differences to the World Bank estimates of implicit nominal protection reflect substantial policy changes, or result from different methods of calculation or other short-term influences on the relationship between the domestic and international prices.

Some additional information on export incentives is available from the findings of anti-dumping investigations conducted by the U.S. International Trade Commission (USITC) in 1983 (Table 58). It turns out that apparently the most important export incentive is the IPI tax credit (credito prêmio) (1). This incentive has been steadily reduced since 1981 and was finally phased out for most firms (except those participating in

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(1) The supply of equity capital to state enterprises does not affect the decision whether to export a given unit of output or sell it in the domestic market.



Table 56 - Tariffs and Protection Rates (a) for Selected Iron and Steel Products, Brazil, 1980/81

IBGE Code		Nominal legal tariff(b)	Implicit average tariff	Implicit nominal protection	Implicit effective protection	Net effective protection
11	Metallurgy	77.4	3.0	10.8	34.2	15.0
1101	Pig iron, iron alloys, primary steel	<u>49.2</u>	<u>-13.7</u>	<u>-0.5</u>	<u>33.0</u>	<u>11.9</u>
11011	Pig iron	80.0	-32.9			
11012	Iron and steel, primary forms	37.6	-8.9			
1102	Rolled steel products	<u>37.4</u>	<u>-8.5</u>	<u>5.5</u>	<u>21.9</u>	<u>2.6</u>
11021	Flat products	38.4	-9.9			
11022	Non flat products	37.5	-22.2			
11023	Scrap metal	16.6	9.5			
11031	Iron and steel castings	<u>95.9</u>	<u>31.3</u>	<u>51.4</u>	<u>105.9</u>	<u>73.3</u>
1105	Miscellaneous metal products	<u>105.7</u>	<u>10.3</u>	<u>27.2</u>	<u>50.6</u>	<u>26.7</u>
11051	Iron and steel wire	38.5	13.4			
11052	Iron and steel forgings	107.5	-16.4			

(a) For definition see Table 28. - (b) December 1980.

Source: World Bank [1983, Tables 33, 7.1 and 7.2].

the BEFIEX program) in 1987. Thus it seems that the pro-export bias of the incentive structure is more likely than not to have declined after 1980, since protection levels apparently have at least been maintained while export incentives have been reduced. This supports the conclusion drawn above that export incentives have not been instrumental in increasing Brazilian steel exports (1).

(1) This conclusion is also confirmed by C.A. Braga's [1986] case study on one large flat steel producer, where the relative price between the export and the domestic market including export subsidies did not contribute significantly to the explanation of exports.

Table 57 - Tariffs and Protection Rates (a) for Selected Iron and Steel Products, Brazil 1985

IBGE Code		Nominal legal tariff	Implicit average tariff	Implicit effective protection
	Manufacturing	61.1	29.7	50.3
11	Metallurgy	51.7	24.9	43.1
11011	Pig iron	45.0	-6.9	-15.3
11012	Iron and steel, primary forms	36.8	46.6	n.a.
11020	Rolled steel products	32.3	24.4	16.5
11031	Iron and steel castings	54.8	-31.0	-53.3
11032	Iron and steel forgings	72.2	35.2	53.7
11050	Drawn products	66.1	76.4	72.6

(a) For definition see Table 28.

Source: Guimerães [1988, Tables 4, 9, A1, A2].

Tables 56 and 57 also contain information on the implicit effective protection enjoyed by the Brazilian steel industry, which indicates how the industry's value added (rather than its final product price) is affected by trade policy. The reservations expressed in the beginning of this section as to the accuracy of protection estimates also apply to these. Even with this qualification, however, it seems safe to state that the metallurgical sector as a whole has benefited less from protection than the average of all manufacturing industry. This is demonstrated not only by below-average rates given in the 1980/81 and 1985 studies. A survey of a wide variety of studies covering the period since 1958 also reveals consistently low rankings of the metallurgical industry in terms of effective protection, compared with 20 other manufacturing sectors [Guimarães, da Costa, 1987, Table 5]. Hence one may conclude that the Brazilian government relied largely on measures other than trade policy (such as the supply of equity to state enterprises, subsidized loans to private producers, etc.) to promote the expansion of the steel industry.

Table 58 - Composition of Subsidy Estimated for Various Brazilian Steel Products Exported to the United States, 1983 (per cent of export price)

	Hot- and cold-rolled carbon steel sheets			Various stainless steel products products
	COSIPA	CSN	USIMINAS	VILLARES/PIRATINI/ACESITA
Government transfers through equity	20.36	24.50	3.73	-
Long-term government loans	0.20	0.37	0.06	1.36 (a)
Short-term financing for exports	4.61	22.36	1.82	1.85
Export financing circular CICEGE 14-11	0.33	0.79	-	-
IPI tax rebate	7.50	10.78	8.71	10.65
Income tax exemption for export earnings	-	-	-	0.55
Tax rebate for investments	3.21	3.06	2.95	0.80
CDI Program	0.45	0.37	0.22	0.18
Total	36.66	62.23	17.49	15.41

(a) VILLARES only.

Source: USITC [1983b; 1983c].

## V. Prospects for Steel Production in Brazil

### 1. Domestic Demand

#### a. Methodological Issues

Since steel is used as an input in a variety of manufacturing industries producing a broad range of final products, the current and future demand for steel is largely determined by developments in the markets for steel-intensive products. However, alternative materials (such as other metals or plastics) are available for some end uses, and quality

improvements in steel products may allow to reduce the quantity of steel used for specific purposes (for example the thickness of sheets). The relative price of steel versus alternative materials as well as technical progress in the form of quality improvements may, therefore, be considered as additional important determinants of steel demand.

For forecasting steel demand, an adequate approach would be to estimate a multi-sector model, which would make it possible to assess steel demand by the most important consuming industries. A disaggregated model could also generate demand forecasts for individual steel products, which may depend heavily on output in a particular steel consuming industry. Disaggregated multi-sector models have been set-up for a number of countries (1). However, no such model is available for estimating steel demand in Brazil. This may be a reflection of the limited availability of the highly disaggregated data required for this forecasting approach (2). Nevertheless, there is some limited evidence on the prospects for output expansion in selected sectors (3).

The prospects for the Brazilian automobile industry are discussed in detail in Section B.V. Published forecasts vary widely. Given many uncertainties (growth of national income in Brazil and abroad; protectionist measures directed against Brazilian automobile exports; domestic policies with regard to price controls, imports of electronic components, etc.), the most plausible outcome seems a slow growth of motor vehicle production at a rate of 2 to 3 per cent in the medium term (Section B.V.1). Since specific steel consumption in the automobile sector is likely to decline at a similar rate, total steel consumption by the Brazilian motor vehicle industry can be expected to remain more or less constant unless overall economic growth and, consequently, demand for motor vehicles accelerate dramatically.

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- (1) For example relating to Canada, India, Japan, South Korea, and the United States see IISI [e, Chapter 3] and Pal [1985].
  - (2) Table A19 presents the available information on steel consumption by sectors for Brazil. Data on steel consumption by sectors in the EC [EUROSTAT, c] provide an example of the type of information needed for multi-sectoral model-building.
  - (3) It is helpful in this context to disaggregate the development of total steel consumption by an industry into changes in specific consumption (i.e. per unit of output) and the development of output.

A study undertaken by the IISI [b] on steel use in physical infrastructure concludes that investment in new infrastructure and maintenance of the existing installations have been seriously neglected in recent years. Both areas are important sources of employment in the construction industry. In both industrialized and developing countries the main reason for the cutback has been the need to curtail government spending. Although necessary repairs cannot be put off indefinitely in industrialized countries and the shortage of physical infrastructure in developing countries remains pressing, steel consumption in infrastructure in both groups of countries seems bound to remain at a reduced level unless a dramatic reversal of the recent trend occurs.

As an alternative to a multi-sector model, aggregate output measures such as gross product or fixed capital formation may be used to explain total steel demand. In such estimates, a time trend or a relative price variable may be added to cover the influence of technical progress in terms of possible weight reductions (with constant quality of steel products) or the increasing use of alternative materials. Various functional forms of aggregate demand models have been applied [see for example OECD, 1974; IISI, e, Chapter 1, Section A]. The following version, which has been found to perform well for a wide variety of countries and over long periods of time (1), has been selected for an empirical analysis of the relationship between apparent steel consumption (ASC) and gross domestic output (GDP) in Brazil:

$$[V.1] \quad ASC = a \cdot e^{bT} GDP^c$$

where T is a time trend. The coefficients in [V.1] can be estimated empirically in a linear fashion if the model is transformed into logarithms:

$$[V.2] \quad \ln ASC = \ln a + bT + c \ln GDP$$

---

(1) Wienert [1984; 1985]; it may be worth noting that a study of steel consumption in the United States based on several investment variables [ibid., 1986] did not produce superior results compared with an analysis, similar to the present one, based on GDP and a time trend [ibid., 1985].

This model implies a constant income elasticity of total apparent steel consumption ( $c$ ) and a secular trend in steel consumption with a constant rate of growth or decline ( $b$ ). By differentiating with respect to time and dividing through by ASC it is seen that Equation [V.1] also implies a linear relationship between the growth rates of apparent steel consumption and gross domestic product:

$$[V.3] \quad \frac{dASC/dt}{ASC} = b + c \cdot \frac{dGDP/dt}{GDP}$$

#### b. Empirical Results

Table 59 summarizes the regression results for total steel consumption as well as the consumption of flat rolled and non-flat products in Brazil in 1966-1985. The estimated coefficients turn out to be rather similar across product categories for each dependent variable: the income elasticity of consumption is in the order of 2.3. Over time, however, consumption experiences a secular decline with a rate of approximately 6 to 7 per cent per annum (1).

The result for total consumption is illustrated diagrammatically by Figure 4 (cf. Equation [V.3]). For forecasting purposes it may be concluded that as long as GDP grows with an annual rate of less than 2.6 per cent, steel consumption will fall, i.e. the secular decline will dominate. Growth rates of GDP between 2.6 and 4.6 per cent will be sufficient to compensate for the secular decline, but steel consumption will still grow more slowly than GDP. Only if GDP expands at a rate of more than 4.6 per cent the increase of steel consumption will outpace economic growth.

The high coefficients of determination ( $R^2$ ) and low standard errors suggest that this model offers a reliable basis for medium-term projections of

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(1) An interpretation of the rate of secular decline is discussed in Section C.V.2.a below. While the size of the coefficients may be influenced by multicollinearity between the independent variables, this does not affect the usefulness of the model for medium-term forecasting.

Table 59 - Apparent Steel Consumption in Brazil, 1966-1985 - Regression Results

Dependent variables	Independent variable			Test statistic			
	GDP (a)	time (b)	constant	F	standard error	adjusted R <sup>2</sup>	Durbin-Watson
Total consumption	2.30*** (0.16)	-0.06*** (0.01)	-11.54*** (1.32)	686.20***	0.07	0.99	1.64
Consumption of flat rolled products	2.36*** (0.19)	-0.06*** (0.01)	-12.81*** (1.58)	577.09***	0.08	0.98	2.11
Consumption of non-flat rolled products	2.28*** (0.17)	-0.07*** (0.01)	-12.00*** (1.44)	475.30***	0.07	0.98	1.52

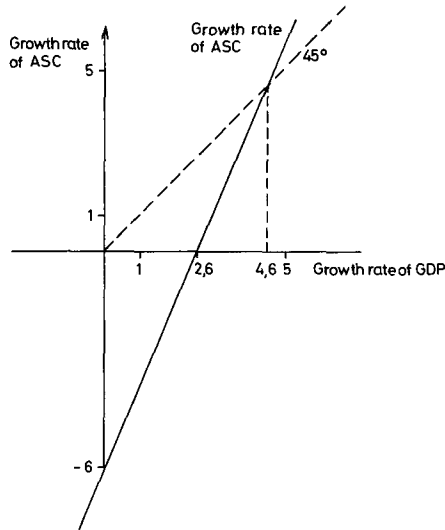
Standard errors in parentheses. - \*\*\* Significant at the 1 per cent level.  
(a) Coefficient gives income elasticity of the dependent variable. - (b) Continuous growth rate.

Source: CONSIDER [1986]; IBS [b, various issues]; Conjuntura Economica [various issues]; own calculations.

steel demand in Brazil. Apparently the relationship between the growth rate of steel consumption and GDP is fairly robust with respect to changes in the structure of steel consumption, such as the increase in the importance of steel-intensive manufactured exports relative to fixed investment in Brazil since the late 1970s (1). The relatively low value of the Durbin-Watson statistic in two of the three equations is likely to result from inventory demand by the steel-consuming industries, which is included in apparent consumption and tends to show strongly pro-cyclical features. This may cause some auto-correlation in the residuals [Wienert, 1985, p. 149, footnote 6]. However, fluctuations of inventory demand will normally average out over the length of a business cycle. Finally, it may be noted that the inclusion of a relative price variable to account for substitution effects with respect to alternative materials does not lead to plausible results, as Brazilian steel prices were regulated during the period under consideration [see Herken-Krauer, 1987a, p. 117].

(1) See IISI [a, pp. 1-28] for a discussion of the significance of indirect international trade in steel.

Figure 4 - The Relationship between the Growth Rates of GDP and Apparent Steel Consumption, Brazil, 1966-1985 (per cent)



Source: Table 59.

Concerning the long-term outlook for steel consumption, many projections rely upon the development of the steel intensity of gross output (i.e. ASC/GDP), which is usually assumed to rise during the early stages of economic development and to decline subsequently while national income per capita continues to rise (steel intensity curve). Due to differences in the structure of steel consumption between countries the steel intensity of GDP does not appear to correlate strongly with the level of economic development (as measured by GDP per capita) in a cross-section analysis (see Section C.V.2.a below). Nevertheless, long time series for individual countries do in fact reveal a pattern similar to the steel intensity curve [IISI, e, pp. 2-1 to 2-2].

In order to assess whether steel demand in Brazil could reach the peak of the steel intensity curve in the near future, two alternative formulations of a model relating steel intensity (SI) to GDP per capita (GDP PERCAP) and a secular time trend (T) have been tested.

The results (Table 60) for

$$[V.4] \quad \ln(SI) = a + bT + c \ln (GDP \text{ PERCAP})$$



Table 60 - The Evolution of Steel Intensity in Brazil, 1966-1985 - Regression Results

Dependent variable	Independent variable			Test statistic			
	GDP per head	time trend	constant	F	standard error	adjusted R <sup>2</sup>	Durbin-Watson
Steel intensity							
Total consumption A	1.27*** (0.15)	-0.03*** (0.01)	-5.76*** (0.62)	74.57*** (0.62)	0.07	0.89	1.69
B	0.88*** (0.12)	0.02*** (0.00)	-3.00*** (0.47)	55.21*** (0.47)	0.05	0.85	1.40
Flat rolled products							
A	1.34*** (0.18)	-0.02** (0.01)	-6.77*** (0.73)	83.37*** (0.73)	0.08	0.90	2.17
B	0.46*** (0.07)	-0.01** (0.00)	-1.62*** (0.27)	67.18*** (0.27)	0.03	0.87	1.57
Non-flat rolled products							
A	1.25*** (0.17)	-0.03*** (0.01)	-6.30*** (0.68)	38.14*** (0.68)	0.07	0.80	1.56
B	0.42*** (0.05)	-0.01*** (0.00)	-1.39*** (0.24)	34.20*** (0.24)	0.03	0.78	1.41

A: logarithmic model. - B: semi-logarithmic model. - Standard errors in parentheses. - \*\*\* Significant at the 1 per cent level. - \*\* Significant at the 5 per cent level.

Source: Data from CONSIDER [1986]; IBS [b, various issues]; Conjuntura Económica [various issues]; own calculations.

have turned out to be slightly superior to the semi-logarithmic version (1):

$$[V.5] \quad SI = a + bT + c \ln (\text{GDP PERCAP}).$$

Again, the coefficients do not differ much among equations explaining total consumption and consumption of flat rolled and non-flat products. An income elasticity of about 1.3 (implying a 1.3 per cent increase of the steel intensity for every 1 per cent increase in GDP per capita) goes along with a secular decline at a rate of between 2 and 3 per cent (2).

- (1) Apart from slightly lower coefficients of determination, autocorrelation of the residuals appears to be a more serious problem in the case of the semi-log model.
- (2) Both the income elasticity and the secular rate of decline are smaller in absolute value than those given in Table 59. For the income elasticity it is easily seen by manipulating Equation [V.1] that the coefficient for the steel intensity should be lower than the one for steel consumption by a value of 1 (i.e. equal to c-1):

$$SI = \text{ASC}/\text{GDP} = a \cdot c^{bt} \cdot \text{GDP}^{c-1}$$

Whether or not the steel intensity will rise over time thus depends on whether increased demand as a result of GDP growth is strong enough to counteract the substitution effect caused by the availability of lighter high-quality steels and alternative materials. If one assumes the validity of the usual steel intensity curve for Brazil, the high income elasticity of steel intensity suggests that the country still finds itself on the upwardly sloped part of the curve. It seems unlikely, therefore, that the relationship between GDP and ASC as described by Equation [V.1] and the empirical results in Table 59 will be altered substantially in the near future.

It would go beyond the scope of this study to provide an independent forecast of GDP growth in Brazil as a basis for a projection of steel consumption. Table 61 provides some scenarios for the relationship between GDP growth and apparent steel consumption on the basis of the estimates presented in Table 59 in addition to reporting independent estimates of future steel consumption. The span of assumed GDP growth rates has been kept wide in our own estimates as an indication of the uncertainty surrounding the future growth of the Brazilian economy. The projections indicate a declining apparent consumption of steel when the Brazilian economy remains sluggish (a 2 per cent rate of GDP growth). In the more optimistic scenario of 5 per cent GDP growth our estimates remain well below Abreu's [1984] projections for flat rolled products (higher bound projections). The difference may reflect the perception of secularly declining demand which figures rather prominently in our own projections (Table 59). Concerning the high growth scenario, CONSIDER is clearly more pessimistic in projecting future consumption of rolled products compared to our estimates of total steel consumption. The difference is most likely related to lower income elasticities of demand for steel products included in the CONSIDER projections.

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The secular rate of decline is likely to come out lower in the steel intensity model because GDP per capita (as opposed to total GDP) is used as an explanatory variable. With population growth between 2 and 3 per cent during the period of observation, stagnant GDP per capita was equivalent to moderate growth of total GDP, which accounts for the difference in the estimated rates of secular decline.

Table 61 - Projections of Apparent Steel Consumption under Varying Assumptions about GDP Growth, Brazil, 1990-2000 (million tons)

Assumed average annual growth rate of real GDP	Actual value	Projected values		
	1985	1990	1995	2000
Own calculations		total apparent steel consumption		
2 per cent	10.2	9.1	8.4	7.8
5 per cent		12.7	16.4	21.1
8 per cent		17.5	31.3	55.9
		flat rolled products		
2 per cent	5.8	5.3	5.1	4.8
5 per cent		7.5	10.0	13.5
8 per cent		10.4	19.5	36.6
		non-flat rolled products		
2 per cent	4.5	3.8	3.4	3.0
5 per cent		5.3	6.5	8.0
8 per cent		7.3	12.4	21.0
Abreu (1984)		consumption of uncoated flat rolled products		
Lower bound				
1985-1990: 3 per cent				
1991-2000: 5 per cent		5.6	7.9	11.2
Higher bound				
1985-1990: 5 per cent				
1991-2000: 6 per cent		6.9	11.4	19.1
CONSIDER (1985)		apparent consumption of rolled products		
8 per cent		15.0	22.0	33.0

Source: IBS [a, pp. G/23-G/25; forecast by Abreu, 1984]; Soares [1986, p. 22; forecast by CONSIDER, 1985]; Table A1 (for 1985 values).

## 2. The International Environment

### a. Trends in World Demand

The evidence on steel consumption by regions and important consumer countries indicates that consumption declined in industrialized market

economies and increased in the centrally planned economies and in developing countries (Table 37). The question is whether these trends will continue in the future. Projections with respect to world steel demand are, of course, fraught with the same methodological problems discussed in the context of the projections for Brazil. However, projections for a large number of heterogeneous countries exacerbate the empirical difficulties. Basically, the same two types of models have been applied as in the case of Brazil: time series estimates and estimates of steel intensity curves, this time based on cross-country data.

A comparison between actual values of steel consumption and those predicted by Wienert [1985] point to a good "fit" of the time series model which estimates the relationship of rates of growth of apparent steel consumption and GDP. His findings [Table A30] suggest that apparent steel consumption will decline in absolute terms in most countries unless GDP grows at an annual rate of at least 3 per cent.

He shows furthermore that the declining growth rates of steel consumption since the early 1970s are not the result of some fundamental change in the pattern of steel use but merely a consequence of slower GDP growth.

While Wienert's model provides a satisfactory explanation of steel consumption in the short to medium term a frequently used approach for long-term projections is based on the concept of the steel intensity curve, relating apparent steel consumption per unit of gross output to the level of national income per capita. While long time series for the United States do indeed show a strong rise in steel intensity during the earlier stages of economic development and a more gradual reduction later on [OECD, 1974, p. 58], cross-country studies lead to less conclusive results (1).

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(1) The OECD has found that in a regression analysis involving a sample of 70 countries at very different stages of economic development, differences in the level of national income per capita contributed very little to an explanation of the observed variation in steel intensity. By grouping countries according to income level (in accordance with World Bank classification) it could only be established through separate calculations that average steel intensity in two

This is confirmed by the regression results summarized in Table A31. They indicate that total gross domestic product (as used by Wienert) is a more reliable predictor of apparent steel consumption than gross national product per capita (as used in the steel intensity approach) (1).

These findings place the published projections of steel demand in proper perspective (Table 62). Irrespective of methodological differences there seems to be a consensus that steel demand in developing countries is likely to increase more strongly than in the industrialized market economies. Concerning growth of total world demand the IISI projections are far more optimistic than World Bank estimates (3.4 versus 1.5 per cent and 2.8 versus 1.4 per cent for 1985-1990 and 1990-1995, respectively). In light of the above methodological consideration World Bank projections should be rated as more reliable than the IISI projections.

#### b. Technological Changes and Steel Use

The secular decline of steel consumption observed in the previous two sections has so far been interpreted as a consequence of technological change in the steel-consuming sectors, mainly in the form of increased availability of lighter types of steel and of alternative materials. Estimates of the secular rate of decline may partly reflect cyclical rather than technological phenomena (2), but there still remains a tendency for economizing on and substituting steel inputs.

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groups of middle-income countries was significantly higher than in the industrialized market economies [OECD, 1974, pp. 109 f.].

- (1) See also IISI [e, pp. 2-1 to 2-9] for a report on some forecasting exercises performed with a steel intensity model. Wienert [1985, p. 161] goes as far as to suggest that the concept of steel intensity should no longer be used for forecasts of consumption, except perhaps for very long-term projections of steel demand in developing countries.
- (2) Wienert's [1984; 1985; 1986] estimates are based on time series containing cyclical elements in the explanatory variables that are not fully captured by the model. In particular, many steel-consuming sectors that produce investment goods or consumer durables tend to expand faster than overall GDP during boom periods and contrast more sharply during recessions. Similarly, apparent steel consumption is inflated (compared with actual consumption) through inventory build-ups during boom periods and vice versa. Either way

Tabelle 62 - Forecasts of World Steel Demand, 1985-2000

World Bank (1983) Area	Consumption (crude steel equivalent; annual growth rate in per cent)			
	1985-1990		1990-1995	
World	1.5		1.4	
Market economies	1.4		1.3	
Industrialized countries	0.2		0.6	
Developing countries	3.7		2.8	
Centrally planned economies	1.3		1.0	
IISI (1984/85)	steel demand (crude steel equivalent; million metric tons)			
Area/country	actual value	projected values		
	1985	1990	1995	2000
World	721.4	850.7	978.5	1128.7
Industrialized countries	326.4	387.4	432.4	482.7
Japan	73.4	85.4	96.7	109.6
EC	93.4	104.4	113.0	122.3
United States	105.3	136.6	135.4	176.8
Developing countries	103.6	133.6	165.7	206.3
Latin America	27.1	38.3	50.2	65.6
Asia(a)	47.8	60.2	36.6	97.5
Africa(b)	11.7	14.5	16.9	19.6
Middle East	17.0	20.6	22.0	23.6
Centrally planned economies	291.4	329.4	380.4	439.7

(a) Without Japan, China, South Korea. - (b) South Africa excluded.

Source: Barnett [IBS, a, p. C/8; forecast by World Bank (1983)]; Kramarski et al. [1986, pp. 278-286; forecast by IISI, 1984/85]; IISI [f, 1986 (for 1985 values)].

Table 63 presents some estimates (by the Statistical Office of the EC) on the changes of specific steel consumption (i.e. consumption per unit of output) in some important steel-consuming industries in 1975-1984. The evidence suggests that the steel intensity of output was considerably reduced in all industries. However, the secular decline affected the

the estimated coefficients both for the time trend and the income variable are likely to be higher in absolute value than they would be in a world with less pronounced business fluctuation (in which case the coefficient attached to the time trend would more closely reflect the impact of technological change).

Table 63 - Steel Consumption in Selected Manufacturing Industries of the EC, 1975-1984 (1980 = 100) (a)

Branch of industry	Index of specific steel consumption								
	all steel products			ordinary rolled steel (b)		special rolled steel (b)		other steel products (c)	
	1975	1984	average annual rate of decline (per cent)	1975	1984	1975	1984	1975	1984
			1975-1984						
Mechanical engineering	100	91	(-1.0)	111	93	100	105	88	84
Electrical engineering	133	76	(-10.6)	126	75	88	74	103	68
Vehicles	113	90	(-2.5)	124	92	113	85	93	88
Construction industry	116	85	(-3.4)	116	81	-	-	113	95
Boilers	118	108	(-1.0)	113	109	106	107	135	107

(a) Figures have been taken from charts, and are therefore only approximations. - (b) European Community for Coal and Steel (ECCS) steel. - (c) Non-ECCS steel (castings, forgings, drawn products, etc.).

Source: EUROSTAT [b, pp. 27-31].

various types of steel rather differently. Consumption of ordinary rolled steel fell sharply, while the group of "other" steel products experienced a generally less pronounced (but still considerable) decrease. By contrast, the specific consumption of special steels diminished only in the electrical engineering and vehicle sectors, and remained more or less constant in the mechanical engineering and boiler industries. This finding is consistent with the hypothesis that special steels replaced ordinary steels in some applications. The average annual rate of decline in overall specific steel consumption ranged between 1 and 10 per cent for the individual sectors. This indicates that a significant portion of the estimated secular rates of decline in steel consumption is indeed explained by technological change in steel use.

An example of this process is provided by a study of the IISI [d] on steel use in the automobile industry. In the design of automobiles, and particularly passenger cars, the overriding concern over the last decade has been to improve fuel efficiency. Various strategies have been pursued to this end, including increased engine and power train ef-

efficiency, improvements in aerodynamics, and the application of micro-processors. The downsizing of models and use of lighter materials had particularly significant effects on steel use [IISI, d, p. 5-12 to 5-18]. Downsizing implies a reduction in the average weight of passenger cars with more or less constant shares of the individual materials in total car weight, whereas the use of lighter materials should change weight shares in addition to causing total weight to decline.

From 1980 to 1995 car manufacturers expected a decrease of the average weight of passenger cars of about 25 per cent for cars produced in North America, 20 per cent for European, and 15 per cent for Japanese cars. In Latin America, the average weight was expected to decline to between 82 and 89 per cent of its 1980 level by 1990, depending on weight groups. However, relatively little change was foreseen in the share of steel in total car weight until the early 1990s [ibid., p. 5-17].

Car manufacturers in North America, Europe and Latin America also indicated that they expected the use of lighter materials to become more important in improving fuel efficiency after 1990, while in Japan downsizing rather than lighter materials was expected to continue to be the main strategy. Therefore, it is difficult to assess the overall effect the use of lighter materials will have on the steel content of automobiles. Various types of plastics, non-ferrous metal alloys and cast irons all compete with steel as an input. The main advantages of ordinary steel are its relatively low price, easy workability, and the fact that substantial investment would become obsolete if other materials were introduced. Disadvantages of ordinary steel include limited mechanical properties, a low ratio of strength to weight, and low resistance to corrosion. Some of these disadvantages may be avoided if high strength low alloy steels or coated sheets are substituted for ordinary steel, but higher costs and problems of workability may be incurred. Similar problems arise with respect to other materials; in addition, their long-term properties are unknown in some cases, and they may be less easy to repair [IISI, d, p. 6-6]. Therefore it may be concluded that if fuel prices do not increase dramatically, the overall competitive position of steel in the manufacture of automobiles is unlikely to deteriorate sharply in the short to medium term. Only in the long run alternative materials



could become commercially viable to a significant extent for some uses. For example, reinforced plastics might replace steel sheets in car bodies or fuel tanks, or ceramics which are resistant to both high temperatures and thermal shocks could be used for a number of engine components, thereby greatly reducing the requirements for cooling systems [IISI, d, pp. 6-7 and 6-17].

Summarizing, the analysis of past performance has shown that the steel intensity per unit of output was reduced steadily in all manufacturing industries. The rate of this secular decline depended on relative prices of steel products vis-à-vis alternative inputs and on relative user costs for the final product which are determined e.g. by energy prices. Insofar, projections of future declines of steel intensity involve extrapolation of past trends induced by the relative prices prevailing then. If past price trends change, technological progress may take a different direction and reinforce or retard the propensity to use steel intensively.

c. The Impact of Protection in Industrialized Countries on Brazil's Steel Exports (1)

α. Protectionist Measures in the United States, the EC, and Japan

The decline in global demand for steel products and the successful penetration of the world steel market by NICs has led to substantial overcapacity in industrialized countries since the mid-1970s (2). Structural adjustment in industrialized countries, however, was retarded by a wave of protectionism and subsidization in response to the newcomers' competitive edge.

In the *United States* the government resorted to restrictive trade policies, such as antidumping and countervailing duties, escape clauses,

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(1) This section heavily relies on Amelung [1988].

(2) For the causes of the steel crisis in the United States, the EC and Japan see Saxonhouse [1986], Scheuerman [1986] and Tarr [1987]. See also Wolter [1974] for a very early study of the structural adjustment problems of the German steel industry.

and voluntary export restraints (VERs). Especially the latter became important after 1982, as the so-called "trigger price mechanism" (TPM) (1) turned out to be ineffective with respect to lowering imports. The antidumping and countervailing duty petitions investigated in the 1982-1984 period and their impact on a wide variety of iron and steel exports from Brazil are shown in Table A32. In many cases, Brazilian producers voluntarily limited the volume of steel exports in return for a withdrawal of petitions submitted by US producers. Though several petitions were dismissed due to insufficient evidence, there was a preference on the part of most Brazilian firms for market sharing agreements rather than exposing oneself to the risks of new complaints and affirmative rulings. As a result of the investigations carried out against Brazilian steel exporters the US Department of Commerce had proposed wide ranging protective measures [Amelung, 1988, Table 4]. These measures were directed against all product categories that figured prominently in Brazil's steel exports, and would have covered 77 per cent of Brazil's steel exports to the United States. When the International Trade Commission (ITC) was about to announce its final decision on the antidumping margins against one specific import category, carbon steel, the Brazilian authorities proposed to negotiate an orderly marketing agreement. The US producers accepted this offer to negotiate on the condition that the new quota should be restricted to one quarter of Brazil's 1983 export volume. When negotiations failed, the US government imposed duties of more than 27 per cent on the respective Brazilian carbon steel imports. In the case of stainless bars and wire rods investigations were suspended, when the Brazilian representatives gave in and eventually agreed on rather restrictive unilateral VERs. This example demonstrates that countries like Brazil do not have the bargaining position to maintain access to US markets.

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(1) The TPM was a minimum price arrangement based on Japanese production costs. In cases of underpricing, it automatically led to antidumping measures. Despite initial price increases, the TPM failed to improve the competitive standing of the US steel industry, which became impatient with the administration's apparent inability to act on independent antidumping complaints.

After July 1983, Brazil was also hit by US-imposed safeguard measures in the form of duty increases and global quotas (1) (as they were provided in GATT article XIX), resulting from the determination of material injury in the case of cast-iron pipe fillings. In addition, in January 1984 a new escape clause petition (under Section 201 of the US Trade Act of 1974) was filed by US firms in order to generally restrict all imports of carbon and alloy steel. After an affirmative determination of injury issued by the US ITC the government announced its official steel decision in September 1984. It was based on negotiated "surge control" arrangements with countries whose exports had increased rapidly, excessively and unfairly to the detriment of the US economy. Except for the EC, which kept its limits agreed upon in the 1982 US-EC steel pact, global steel arrangements were negotiated with all major steel exporters (Table 64). The allocation of market shares was expected to reduce import penetration to 18.5 per cent, which was believed to be the market determined level.

For Brazil this allocation was equivalent to an export decrease of at least 43 per cent, causing it to suffer harder from these bilateral agreements than Japan or South Korea. The quota regulation should lead to an absolute decline of Brazilian steel exports to the United States in subsequent years if US steel consumption continues to stagnate. Steel consumption in the United States has been declining at an average annual rate of 1.5 per cent between 1980 and 1985. If this trend continues, the quota allocation to Brazil would cause an export decline of at least 46 per cent in 1986 compared to 1983. Hence, the US market does not seem to provide much scope for an expansion of Brazilian steel exports in the near future.

The EC has applied a far more interventionist approach than the United States. The agreement on the establishment of the European Community for Coal and Steel (ECCS) provides instruments to intervene in all stages of the production process: wide-spread subsidization of research and development and social benefits, setting of maximum and minimum

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(1) This import relief was granted on the grounds that imports were a source of injury to the US speciality steel industry.

Table 64 - The 1984 Steel Pact Agreements of the United States compared with Market Shares of Respective Countries (per cent of US annual consumption)

Country	Market Shares			Pact Agreement
	1982	1983	1984 (a)	
Total	21.8	20.5	26.1	~ 17-20
of which:				
Japan	6.3	5.1	6.7	5.8
South Korea	1.4	2.1	2.4	1.9
Brazil	0.8	1.5	1.4	0.8
Spain	0.7	0.7	1.6	0.67
South Africa	0.7	0.7	0.7	0.42
Mexico	0.1	0.8	0.9	0.36
Australia	0.2	0.2	0.3	0.18
Argentina	0.2	0.3	0.3	n.a.
Finland	0.2	0.2	0.4	n.a.
Canada	2.4	2.9	3.2	n.a.
EC (b)	7.3	4.9	5.9	5.9

(a) 1984 values include only first nine months. - (b) EC values are subject to the 1982 US-EC arrangement.

Source: Jones [1986, p. 152].

prices, implementation of allocation schemes, common trade policies, indicative planning for investment and production. The establishment of mandatory production and distribution quotas as well as "target guide prices" for a number of steel products represent other measures applied internally by the EC Commission (1). In 1980, support at the national level was harmonized in a code on state interventions, which aimed at progressively phasing out subsidies in the medium term and required approval of all national measures by the Commission. Nevertheless, subsidization in all EC member countries reached unprecedented levels in 1984-1985 (Table A33). Government support is almost always granted through preferential supply of capital, since capital costs in steel production are considerable relative to variable costs due to the high capital intensity of steel production.

(1) The mandatory quotas have replaced the voluntary quotas set by the privately organized EUROFER cartel, so that now most products are subject to mandatory quotas.

The maintenance of the quota system implies a tight import control policy which comprises both voluntary agreements on export restraint and a basic import price system. The latter is the basis of a system of anti-dumping regulations established in 1978 (1). However, the EC did not have to resort to antidumping investigations on a broad basis. Since minimum import prices are only applicable to countries which have not entered into VERs with the EC, import price regulations have served as an "incentive" to agree to VERs. Under these bilateral arrangements, foreign suppliers may sell at discounted prices which are up to 6 per cent below basic import prices. 15 bilateral agreements were signed by all major non-EC suppliers to the Community. They covered 90 per cent of the total EC steel imports in the period 1979-1984 [Amelung, 1988, p. 15].

Table 65 shows the import quotas set in bilateral agreements with the EC for the years 1979 and 1982. Some of these arrangements include a "triple clause" provision which allocates imports for specific subperiods within the duration of the arrangement (one year), regulates the geographical distribution among EC countries and the volume of imports by product categories. These regulations are applied with respect to import quotas exceeding 100000 tons. Hence, the "triple clause" has also been applied to Brazilian steel products. As a newcomer to the European market Brazil was only granted a quota for pig iron, all other products are subject to the import price system. Since the Commission has emphasized its intention to maintain the present steel policy in the medium run, an increase of Brazilian exports to the EC beyond the present level appears to be rather unlikely. Nevertheless, taking into account the historical market share, Brazil has achieved a high degree of market penetration, even compared with South Korea.

In contrast to other industrialized countries, *Japan* refrains from subsidization of its declining steel industries, though it used to subsidize

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(1) The basic import price is the threshold for antidumping and countervailing duty investigations. According to the GATT rules it should reflect the lowest production cost in third countries. In practice, the basic import price is calculated referring to minimum costs in EC producer countries.

Table 65 - Import Quotas Provided in Bilateral Agreements with the European Community 1979 and 1982 (1000 tons)

Country	Import quotas for constant quota countries	
	1979	1982
Total		
of which:	5110	7913
Hungary	264	371
Czechoslovakia	612	637
Romania	324	394
Bulgaria	492	252
Poland	456	420
Austria	312	1017
Finland	312	389
Norway	192	568
Sweden	588	879
Spain	744	780
Japan	492	1220
South Korea	72	225
Australia	132	407
Brazil	-	253

Source: Trautlein [1984, p. 161].

steel production excessively in its infant industry and early growth stage. Government authorities have preferred to relax their anti-trust policy in order to facilitate cartellization among steel producers. As far as import protection is concerned, the Japanese government was only indirectly involved by allowing the foundation of the Japan Iron and Steel Importers' Institute (JISII). This institution was formed in an effort to maintain "orderly" imports of steel products. To be able to do so, JISII is granted the status of a monopolist importer which controls all steel imports to Japan. In January 1984, JISII has decided to reduce imports of steel-plate and hot-rolled sheet and coil. These measures were primarily intended to reduce imports from low cost suppliers such as South Korea and Taiwan. It is not clear to what extent discretionary import decisions have actually affected the Brazilian export position. However, there can be no doubt that a general import reduction of these products, as envisaged by the JISII, will seriously threaten Brazil's export capacity to Japan.

### β. Competitive Export Subsidization in the World Market

Although in most industrialized countries no specific export subsidies are given for steel products, the subsidization of capital invested in steel production constitutes an implicit subsidy. In addition, the existing trade barriers favour cross-subsidization of steel exports. Due to relatively weak anti-trust policies this trend is facilitated by the foundation of national and international cartels, such as the German "Verkaufskontore", the Japanese Steel Exporters Association as well as the EUROFER II cartel. As a result, Brazil's steel exports have to compete with subsidized exports from the EC and Japan.

The extent to which Brazil's exports are affected by these subsidies is difficult to assess, since subsidies in industrialized countries are usually not product-specific. It is plausible to assume that domestic and foreign sales of steel producers in industrialized countries are equally subsidized. Since the product composition of Brazilian steel exports differs substantially from the product mix of both other NICs and developed countries, there is some reason to believe that Brazil's export structure is at least partly the outcome of a crowding-out process resulting from excessive competition in some segments of the world steel market. However, it can be maintained that general export subsidization in industrialized countries does more harm to countries such as South Korea and Taiwan (with a product mix similar to that of developed countries) than to Brazil.

### γ. Multilateral Negotiations on World Steel Trade

World steel trade belongs to the so-called grey areas in which GATT principles have been eroded. The increasing number of bilateral agreements involves a clear violation of the "most-favoured nation" principle, since the outcome of these agreements depends on the relative economic and political power of the contracting parties. As a result of their bargaining power the big trade blocs are in a position to discriminate against suppliers such as Brazil. Evidence of this can be found in the treatment of Brazil by the United States concerning VERs, as compared with the concessions made to the EC. In the same vein, Japan and the

EFTA countries are given easier access to the EC market than Brazil, which is subject to highly restrictive import quotas.

The Uruguay Round of multilateral negotiations is supposed to bring back GATT rules to the grey areas, although the focus will most probably be on products other than steel. Hearings of the US Senate indicate that the protection granted by the Brazilian government to the local steel industry is of major importance for decisions on US import protection. Therefore, it can be expected that the principle of reciprocity will gain in relevance for Brazil and other large NICs. Reciprocity is also involved in steel trade with the EC. Thus, it is likely that Brazil may have to reconsider its tight import protection on steel (i.e. the application of the "law of the similars"). Concerning the EC, preferential treatment is - if at all - likely to be given to associated countries rather than to third countries such as Brazil. Similarly, Brazil has lost its GSP treatment granted by the US administration. All this suggests that the Uruguay negotiations are rather likely to result in a better treatment of Brazilian exports other than steel.

### *3. Domestic Supply Conditions*

Despite the uncertainty of future domestic and international demand for steel products, the Brazilian government has recently launched an ambitious expansion plan for the domestic steel industry. This plan, drawn up by CONSIDER, aims at raising the country's production capacity from 27 million tons to 50 million tons per year by the year 2000 at an investment cost of US \$ 22.5 billion. If carried out, this would make Brazil the world's fourth largest steel producer by the end of the century. The plan is justified by a sharp rise of domestic steel demand. However, a significant increase of demand over previous trends appears to be rather unlikely as has been shown in Section C.V.1. Further doubts with respect to the envisaged expansion of capacity concern domestic supply conditions. The analysis presented in Section C.IV has supported the hypothesis that Brazil has a comparative advantage in steel production. This advantage has not been fully exploited, though. Policy-induced bottlenecks have prevented Brazilian steel producers from achieving the



degree of international competitiveness which they would enjoy on the basis of comparative advantage. Three major areas of concern stand out: Firstly, many Brazilian steel companies are confronted with severe financial problems and a considerable worsening of their debt/equity ratios. Most of the losses have accrued to the three biggest steel companies (CSN, COSIPA, and USIMINAS). According to the Brazilian Ministry of Industry and Commerce, the size of the foreign debt of SIDERBRAS (the state holding company) is due to, first, the cost of the third stage expansion plans at CSN, COSIPA, and USIMINAS, which were carried out with foreign loans and suffered from delays in implementation. This added US \$ 3.9 billion to the debt. Secondly, government price policies since 1978 have added a further US \$ 7.5 billion to outstanding debt (Metal Bulletin, January 27, 1987, p. 30). At the end of 1986, total debt of the state steel group amounted to US \$ 17.2 billion and was ten times higher than equity capital (Börsenzeitung, April 14, 1988, p. 30). Whether the government rehabilitation programme (1), which is to cover some US \$ 12 billion of SIDERBRAS' total debt, will provide a sustainable consolidation of the financial situation remains to be seen. In addition to debt relief it is also intended to privatize certain state-controlled companies whose financial problems are particularly serious, most notably COSIPA. Privatization of this firm, which specializes in flat rolled products, would signify the end of the traditional division of the steel market between state enterprises (flat products) and private firms (non-flat products). The other candidates for privatization are mostly small, highly specialized producers of non-flat products and special steels. Since the move towards privatization has only started very recently, it is as yet impossible to assess how successful it is likely to be.

Secondly, government pricing policies threaten to damage the profitability of individual companies especially in the private sector, as inflation has rekindled after the collapse of the Cruzado-Plan. If steel prices are not allowed to fluctuate in response to changes in supply and

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(1) The debt of the five biggest companies will be transferred first to SIDERBRAS, and then absorbed by the treasury, the state development bank BNDES, and the newly-created National Development Fund (Fundo Nacional de Desenvolvimento).

demand, expansion plans may be undermined. In addition, inflation rates of up to 20 per cent per month create considerable uncertainty concerning the future performance of the Brazilian economy. Since the growth of steel demand depends crucially on overall economic growth (see Section C.V.1), this uncertainty also affects the steel companies' demand projections on which their plans for capacity expansions are based. Besides, high inflation increases the risk premium included in long-term real interest rates, and therefore raises capital costs for the steel producers. Hence, the target of doubling steel capacity by the year 2000 may turn out to be illusionary if uncertainty over future steel prices or over the country's general economic performance discourages or misdirects investment planning.

The third major area of concern relates to various distortions in the markets for inputs. The prices of many raw materials and electricity have fluctuated widely in relation to the general level of inflation, at least partly as a consequence of government price controls (see Section C.III.2.b.β). The resulting uncertainty concerning the profitability of new steel capacity discourages investment in the industry. Therefore the government should aim to reduce factor price instability through less erratic price policies. Similarly, efforts should be made to keep real wage increases in line with productivity developments, because rising unit labour costs (as in the past - see Section C.III.2.b.α) are bound to undermine the Brazilian steel industry's international competitiveness. Finally, improvements in the transport system should help to reduce transport costs that have so far taken up a relatively large share of the final product price, compared with Brazil's competitors in world markets (see Section C.III.2.c).

## D. Summary and Conclusions

It has been the major aim of this study to assess the attractiveness of Brazil as a location for automobile and steel production in the future. For this purpose, the export performance of Brazil's motor-vehicle and steel industries in different markets has been evaluated, and major determinants of the country's current position in world markets have been identified. In the longer run, the involvement of foreign and domestic investors in the two industries is likely to depend on whether automobile and steel production fits into the pattern of industrial specialization which is in line with the country's endowment with physical and human capital as well as (unskilled) labour. Export expansion is hardly sustainable in the long run if mainly based on policy interventions that artificially create a competitive edge in world markets. Therefore, the following hypotheses figured prominently in explaining the past export performance:

- Export success might have been due to an industrialization strategy that concentrated on areas which made intensive use of Brazil's relatively abundant productive factors.
- Alternatively, policy interventions might have been responsible for the export performance in the 1970s and early 1980s.

The empirical tests of these hypotheses provided the basis for evaluating the future prospects of automobile and steel production in Brazil. The results confirm the need for a fairly disaggregated analysis in order to identify the major determinants of Brazil's export performance, and especially of the rising share of capital-intensive products in manufactured exports. The Brazilian government heavily discriminated between industries and even between different branches and types of enterprises within industries, as concerns economic incentives granted to domestic and export sales. Even for priority sectors such as the automobile industry and the steel industry, the relative importance of the various factors determining world-market performance differed in some important respects.

The sector studies can be summarized as follows. A first overview on the economic performance of the Brazilian *automobile industry* revealed that the relocation of automobile production from advanced economies to Brazil and other new competitors proceeded more slowly than might have been expected. It has virtually been interrupted since the second half of the 1970s. The production of motor vehicles in Brazil continued to be mainly directed towards the domestic market, although export shares increased substantially. The improvement in Brazil's world-market shares was largely restricted to the 1970s; subsequently, the country's participation in world trade of automotive items stagnated. As concerns the structure of automotive exports, the analysis has pointed to a considerably improved competitive position of Brazil in advanced markets, which was most evident for autoparts. However, notable differences were observed between products and major importing countries. The export performance was most favourable for engines shipped to the United States and Western Europe, whereas exports of passenger cars figured prominently only in exports to the latter region.

These findings suggest that the export potential of Brazil's automotive industries was not fully exploited in the past. The parent companies of automobile subsidiaries operating in Brazil seemed reluctant to integrate their Brazilian plants fully into the worldwide sourcing of parts and components and to see their own traditional markets usurped by the Brazilian subsidiaries. However, this behaviour might have been rational under the economic-policy framework prevailing in Brazil. Government interventions created internal bottlenecks and impeded the companies' readiness to intensify their engagement in this country. Restrictive import policies hindered worldwide sourcing, which would have required that automotive items could easily flow to Brazil at international prices.

The attractiveness of automobile production in Brazil for foreign companies depends crucially on the country's position in production costs, relative to the motor-vehicle industries of its major competitors in world markets. Both Brazil's factor endowments and government interventions have an impact on production costs. The analysis has shown that cost disadvantages of Brazil were reduced considerably since the late 1960s

and early 1970s. The empirical findings for major cost elements can be summarized as follows:

- Unit-labour costs turned out to be an important determinant of the competitive position of the automobile industry. International differences in unit-labour costs were sufficiently large to conclude that Brazil continued to benefit from significant labour-cost advantages against the traditional automobile suppliers. Its position was increasingly challenged, however, by a small number of other NICs, especially Mexico and South Korea. Moreover, Brazil's relative position in unit-labour costs can be supposed to deteriorate if the automobile industry fails to achieve higher increases in productivity in the future than were realized in the past.
- Scale efficiency in Brazilian automobile production improved substantially in the past. As concerns the scale of production at the basic-model level, however, Brazil was not only outperformed by industrialized countries but also by South Korea, despite the latter country's small volume of total car production. Model proliferation in Brazil was largely to be attributed to restrictive import policies which prevented intra-firm specialization of multinationals at an international scale.
- With the exception of some products such as tyres, Brazilian automobile companies did not suffer from international cost disadvantages as far as material inputs were concerned. For important inputs such as steel, domestic prices were even below international prices. Clear disadvantages emerged with respect to freights and financial costs. Large and short-term fluctuations in real interest rates caused disadvantages for Brazilian producers vis-à-vis their overseas competitors in raising investment funds. Moreover, certain types of machinery, particularly NC-machine tools, were significantly more expensive in Brazil than in the world market.

Hence, labour-cost advantages of Brazil's automotive industries were eroded at least partly by higher costs in other areas. Cost disadvantages were mainly due to mis-guided economic policies, particularly import restrictions, the obligation to use the services supplied by national producers, and ad-hoc interventions in capital markets.

In the early 1980s, however, export-promoting incentive schemes more than compensated for export-retarding effects arising from import-substituting policies and the overvaluation of the Cruzeiro. Automobile companies represented the main beneficiaries of the BEFIEX scheme, which not only provided compensatory export incentives, in order to guarantee a balanced incentive structure towards domestic and overseas sales, but also granted genuine export subsidies. The (nominal) export-incentive rate enjoyed by transport-equipment industries far exceeded the average rate for all manufacturing industries. Comparing the incentives to domestic sales of transport equipment on the one hand and to export sales on the other (both adjusted for exchange-rate overvaluation), a clear pro-export bias emerged for this sector in 1980/81, whereas a modest anti-export bias was calculated for the total manufacturing sector. For the more recent past, comprehensive information was largely lacking so that similar calculations could not be carried out. Export incentives were reduced in the 1980s. But it is rather unlikely that the situation of 1980/81 changed dramatically until the mid-1980s; this is because the maxi-devaluation of the Cruzeiro in 1983 limited the negative impact of weaker export incentives on the exchange-rate adjusted (i.e., net) export bias.

Considering effective incentive rates, i.e., accounting for policy-induced price distortions at the level of input-supplying industries, the conclusion was confirmed that export-promotion schemes provided genuine subsidies to overseas sales of transport equipment, rather than merely compensating for export discrimination due to other government interventions. The analysis thus lends support to the hypothesis that Brazil's favourable performance in exporting automotive products in the 1970s was helped considerably by policy interventions of the Brazilian government.

It is open to question to what extent automobile exports will be affected when the BEFIEX-scheme expires in 1989 and the government is not prepared to introduce alternative measures which guarantee similarly strong net export incentives. The fact that automobile exports continued in the most recent past, despite some reductions in export subsidies, may indicate that genuine subsidies, to the extent observed in the past, are no

longer essential to guarantee a favourable export performance. In the early 1980s, the motor-vehicle industry of Brazil might have reached a position where government support could be reduced without affecting the industry's export performance dramatically.

The evaluation of factor intensities in the automobile industry, relative to the manufacturing average, has indicated that high wages per employee were largely due to factors other than differences in the absorption of highly qualified labour (particularly firm size and unionization). However, automotive production in Brazil had not become standardized to the extent hypothesized by the product-cycle argument. The relative importance of standardization and flexible automation was found to differ between the various stages in automobile production and various automotive products. This applied particularly to autoparts, where human-capital intensity proved to be extraordinarily high in some product categories (e.g. motors), but significantly below the average in others (e.g. bodies and axles). While Brazil could be assumed to enjoy locational advantages in the production of the latter goods, production of autoparts was in fact concentrated on the former goods. This indicates that Brazil's locational advantages were not fully exploited in the past as far as the automobile industry is concerned.

Similar to the automobile industry, the Brazilian *steel industry* was assigned a strategic role in industrialization policies of successive Brazilian governments. As iron and steel products were considered to be key inputs for the development of other manufacturing industries and most raw materials required for steel production were available domestically, Brazilian governments undertook to promote the establishment of a diversified domestic iron and steel industry which could supply inputs at low cost. In the 1980s, two thirds of the industry were state-owned, and the government intervened in trade, investment, and prices. State-owned companies hold a quasi monopoly in the production of flat products, while private firms have specialized in the production of non-flat products.

The iron and steel industry accounts for about one tenth of total manufacturing value added, and its performance has been impressive in terms of output expansion, particularly since the mid-1970s. Significant back-

ward and forward linkages to the rest of the economy have been developed as intended by the government. The technological level of the industry is highly diversified, including almost all internationally available technologies for the production of crude steel and the rolling of final products. Also since the mid-1970s but even more so in the 1980s, exports of steel products have become an important feature of the so far inward oriented industry with an export to output ratio of up to 40 per cent (1983). In the early 1980s, rapidly expanding exports were not so much a result of voluntary reorientation away from domestic towards international markets but rather a side effect of slackening domestic demand. When the Brazilian economy recovered more recently (1985-1986) and domestic demand put pressure on installed capacity, steel exports declined somewhat relative to total output, but a significant export orientation has been maintained to date.

This latter observation contradicts the hypothesis that Brazilian steel exports are a residual merely created by the desire to maintain a high rate of capacity utilization in times of slackening domestic demand. A comparison of regulated domestic and world market prices shows that there were in fact incentives to switch from domestic to international sales much earlier; price controls had kept domestic prices well below world market prices. These incentives had, however, been offset by government interventions in the form of increasing equity participation in state-owned steel companies and preferential loans to private enterprises which artificially rendered domestic sales profitable. Outright export discrimination through import protection did not play a significant role; for the steel industry, net effective rates of protection remained well below the average for all manufacturing industries in the 1980s.

Economic reasoning and the experience from other developing countries suggest that NICs such as Brazil should acquire locational advantages in iron and steel production which would enable these countries to become viable exporters of the respective products. Comparative advantages in steel production accrue from the local availability of important inputs and a relatively skilled labour force which can cope with standardized technologies efficiently. As major subsectors of the iron and steel industry are characterized by standardized, internationally transferable production



processes, these activities are candidates for relocation from industrialized to newly industrializing countries.

The composition of Brazil's steel exports matches this consideration. A considerable improvement of the competitive position of the Brazilian steel industry in world markets was observed mainly for semi-finished and more traditional rolled products of ordinary steel, such as hot and cold-rolled sheets, concrete-reinforcing bars, and wire rods. Brazil was able to penetrate the markets of industrialized countries for semi-finished and ordinary flat products, while exports of non-flat products were mainly directed to other developing countries, notably in the Middle and Far East (China). This general pattern is in line with the experiences of other competitors from the developing world such as South Korea.

Comparative advantage in the production of specific manufactures does not automatically translate into a favourable competitive position vis-à-vis suppliers from other countries, however. Locational advantages in steel production which a country such as Brazil should have are easily offset by an adverse internal economic environment created by policy interventions and/or market imperfections. Such adverse influences have, in fact, impeded the exploitation of comparative advantage in Brazil. This country has remained a high cost location for steel producers in comparison to major competitors in developing and industrialized countries. Favourable prices for important inputs such as iron ore, alloys and fluxes, and electricity are more than outweighed by supply constraints and cost disadvantages in other areas.

The examination of important cost factors in the steel industry revealed striking similarities to automobile production:

- Unit labour costs have increased substantially, in particular in the last few years, due to both high wage increases and an unsatisfactory productivity performance. High wages in relation to other countries are the result of unionization and labour market segmentation introduced through - among other things - minimum wage policies. Slow growth of labour productivity indicates the lack of incentives in a domestic iron and steel market sheltered from foreign competition to exploit all options for rationalizing and streamlining production processes. Labour

hoarding may be an additional reason in state-owned enterprises, since their losses have always been covered by the public budget. By comparison, South Korea, Taiwan, and Japan have been able to reduce their unit labour costs since increases of labour productivity exceeded wage increases.

- The most important distortion concerns the extremely high capital costs which accrue from high interest rates for both domestic and foreign loans. High interest rates domestically and abroad have contributed to staggering debt service ratios that threaten to strangle the future development of the Brazilian iron and steel industry. In the domestic market, they are a reflection of inflationary government policies, while the large foreign debt has directly been encouraged by government guarantees to the creditors.
- Domestic freight rates for both raw materials and final products as well as embarkation costs are excessively high and have a major impact on final prices.
- Finally, the competitive position of steel production suffered from high costs of coke and charcoal.

On balance, it can be stated that the government-induced inward orientation has contributed to the emergence of a highly diversified iron and steel industry in Brazil, but has prevented this industry from fully exploiting its comparative advantage domestically and abroad. Inefficiencies of production and domestic price controls have burdened public budgets, discouraged foreign investors and impeded a further expansion of exports.

Turning from the past and present to the future, uncertainty about technological developments and abundant government interventions in both Brazil and international markets render it difficult to assess the prospects of the Brazilian steel and automobile industries. Technological innovations may have an impact on the future relocation of automobile production in particular. The diffusion of flexible automation is likely to proceed most quickly in the production of passenger cars of medium and upper size. Other areas of automotive production may remain largely unaffected by recent technological innovations. An attempt to employ the

latest techniques, which are appropriate for production in industrialized countries, would conflict with Brazil's locational advantages, since the new technologies can be supposed to require considerable inputs of human capital. Principally, lines of production which make intensive use of special-purpose machines, rather than general-purpose or NC-machines, seem best-suited for economies such as Brazil, considering the relative factor endowments of NICs. Especially in the production of auto-parts, but also in the production of commercial vehicles and passenger cars of small and mini size, the potential of further standardization may still be considerable.

Major protectionist constraints on the external front are likely to impede export expansion of the steel industry in particular. Interventionist policies implemented by virtually all industrialized countries constitute a major obstacle to world market penetration and may even reduce steel exports to some countries as has happened in the case of the United States. This problem is common to all steel producers of developing countries, but it has not prevented a rapid increase of steel exports from Brazil and other suppliers such as South Korea and Taiwan. This indicates that protectionism should not be considered as a binding restriction. As in the past, steel demand from other developing countries will continue to grow as industrialization progresses in the Third World. Access to markets in industrialized countries will improve with structural adjustment achieved in these countries. Protectionism cannot be maintained indefinitely because the associated drain on government budgets (mainly for subsidizing inefficient domestic enterprises) renders such policies unsustainable in the longer term.

Structural adjustment in the steel industries of industrialized countries is likely to be facilitated if these countries can achieve or maintain high rates of economic growth. Alternative employment opportunities would then become more readily available in "new" industries for those who lose their jobs in the steel industry. This would help to reduce protectionist pressures. At the same time, faster economic growth in industrialized countries would also increase steel demand and thus facilitate market penetration by NICs such as Brazil.

Although Brazil's automobile industry is currently not affected directly, the rising protectionism especially in the United States threatens the future growth of automotive exports of Brazil as well. It would be most important for industrialized countries to commit themselves to free trade in automotive products. External bottlenecks should be removed so that Brazil can exploit its export potential and specialize according to its locational advantages. World market conditions would be further improved if debt-ridden developing countries recover from economic recession and balance-of-payments problems, so that it becomes easier for them to relax import restrictions. Due to the traditionally strong links in trade with neighbouring Latin American economies, Brazilian exports are likely to benefit substantially.

Although world market conditions are of considerable importance, the major responsibility for whether or not the international competitiveness of the steel and automobile industries can be maintained or improved rests with the Brazilian government. As concerns the steel industry, there are several options to improve the lot of existing enterprises and the attractiveness of Brazil for the relocation of steel production from industrialized countries. Most pressing are an abolition of domestic price controls and solutions to the financial crises of most enterprises. The substantial capacity expansion envisaged by the Brazilian government for the coming years will hardly improve the competitiveness of the Brazilian iron and steel industry vis-à-vis other new suppliers such as South Korea if no progress can be achieved on those two fronts. Present intentions to relieve the debt burden by covering interest payments through the public budget can at best be an interim solution. Instead, it seems more advisable to pursue another option discussed presently, namely the privatization of state-owned enterprises. There seems to be no reason why an essentially viable industry should still be depending on government control and subsidies. Privatization may lead to the streamlining of production processes, i.e. less product diversification, but it may also increase the economic efficiency of existing enterprises and will, thus, help to reduce the present debt burden. Less diversification and unregulated domestic prices will not promote the iron and steel industry at the expense of user industries if imports of steel products are not restricted.

In the long run, new producer countries such as Brazil will only benefit from their growing comparative advantage in the manufacture of the more basic (standardized) products if their internal policies do not discourage the inflow of capital and if efficient resource allocation is not impeded by serious distortions in product and factor markets.

Economic policies of Brazil have to be revised in several respects to overcome internal bottlenecks. The presently pursued strategy to compensate exporters for discriminations which are due to import-substituting policies involves considerable costs. The strategy best-suited to encourage exports and foster economic growth requires to reduce the need for compensation. This would also help to reduce protectionist threats, arising from the United States' practice to impose countervailing duties irrespective of whether export incentives provide genuine subsidies or only compensated for discrimination against export. Automotive imports should be liberalized, for example. Ongoing efforts to reduce transport and embarkation costs should be intensified, which would improve the competitiveness of semi-finished and rolled steel products in the first place. Overvaluation of the domestic currency must be avoided. Exchange-rate policies must be flexible enough to keep fluctuations in the real exchange rate to a minimum, in order to reduce uncertainties for exporters. Restrictive import policies should be relaxed, because:

- the mechanisms introduced to provide for duty exemption or repayment in the case of exports as well as other compensatory measures cause significant administrative costs on the side of exporters and public authorities;
- import restrictions hinder the intra-firm specialization of automobile multinationals particularly, and render it impossible to reap the full benefits from economies of scale;
- such policies seriously impede the integration of Brazil's automobile plants into the worldwide sourcing of autoparts and create bottlenecks to further standardization.

In order to encourage domestic and foreign investors to strengthen their engagement, government efforts to increase the supply of human capital in Brazil are well chosen, since skilled labour is an important precondi-

tion for a further expansion of the steel and automobile industries. In addition, the Brazilian government must aim at reducing political and economic risks. Due to the dominant role of foreign-based companies, a favourable climate for foreign direct investments is most important in the automobile industry. However, if the present trend towards a rather hostile treatment of foreign direct investments in Brazil is not reversed, the relocation of steel production might be affected as well. Other new suppliers such as South Korea rather than Brazil are then likely to benefit from the shift of steel production from unprofitable locations in developed countries to newly industrializing economies. If Brazil forgoes the technology transfers typically associated with foreign direct investments, the country's position in labour productivity vis-à-vis its competitors will continue to deteriorate and the scope for improving scale efficiency will not be exploited. International competitiveness would not only be affected negatively in the case of Brazil's steel industry, but also for steel-consuming industries such as the automobile industry.

Economic policies in Brazil should be re-orientated so that predictability is assured and investment decisions can be made on a sound and stable basis. Price controls in product markets are not an efficient means to fight excessive inflation, but only impair the profitability of automobile and steel production, unless the causes of inflation are tackled. Longer-term investment will also be stimulated if discretionary fiscal and monetary policies, which presently result in heavily fluctuating real interest rates, are abandoned.

The proposed policy reforms would create conditions which render it most likely that the product mix and production techniques in Brazil's automobile and steel industries are in line with the country's resource endowments. In the long run, such reforms would improve Brazil's attractiveness for foreign capital and thus strengthen its position in world markets, which, otherwise, would be increasingly threatened by the intensified competition of new suppliers such as South Korea.

## Appendices

### 1. Normal Pattern and Actual Automobile Production in Brazil and Other Major Producing Countries - Calculation Methods and Illustrations

Empirical investigations have shown that the production structure of countries is determined at least partly by their stage in overall economic development [see e.g. Fels et al., 1971]. Such relationships were also found at the level of individual industries [Fels, 1972; for the automobile industry, see Dicke, 1978, pp. 39 ff.]. To determine the "normal" role of industries within specific countries, i.e., the hypothetical volume of industrial production, the calculation has to proceed in two steps:

- Firstly, cross-country regressions are run to reveal the average impact of differences in per-capita income on industrial production volumes.
- Secondly, the estimated parameter values are applied to the actual development of per-capita income in specific countries.

The regression equations may be specified in various ways. Table A1 presents parameter estimates for the automobile industry, applying a rather simple equation of the double-logarithmic functional type with per-capita income as the only exogenous variable. This variant has been chosen since, in earlier studies, it proved to be superior to more sophisticated model specifications [Dicke, 1978, pp. 28 ff.]. The results indicate that total vehicle production per capita increased by 1.1-1.3 per cent when per-capita income increased by 1 per cent. The income elasticity of production was slightly higher when, in addition to the 21 most important producing countries, countries with major assembly facilities were included in the regression. The latter result held true for both passenger cars and commercial vehicles. Not surprisingly, income elasticities for passenger cars significantly exceeded the reaction of commercial-vehicle production to increases in per-capita income.

Table A1 - Motor-Vehicle Production and Income Level: Cross-Country Regression Results (a), 1983

Dependent variable(b)	Const.	ln GNPPC	N	R <sup>2</sup>	F
ln VEHPC (prod.)	-13.85* (-7.67)	1.131* (5.35)	21	0.58	28.64
ln VEHPC (prod. + ass.)	-15.43* (-10.07)	1.304* (7.05)	30	0.63	49.75
ln CARPC (prod.)	-16.79* (-7.24)	1.430* (5.26)	21	0.57	27.68
ln CARPC (prod. + ass.)	-17.48* (-9.79)	1.507* (6.99)	30	0.62	48.87
ln CVPC (prod.)	-12.15* (-6.89)	0.742* (3.59)	21	0.37	12.90
ln CVPC (prod. + ass.)	-14.33* (-8.90)	0.986* (5.07)	30	0.46	25.68

(a) VEHPC : total vehicle production (passenger cars, trucks, and buses) per capita of the respective country's population (number);  
 CARPC : production of passenger cars per capita of the respective country's population (number);  
 CVPC : production of trucks and buses per capita of the respective country's population (number);  
 GNPPC : gross national income per capita (US \$; source: World Bank)  
 Const.: constant term;  
 N : number of countries included in the regression; in parentheses: t-statistics; \* significant at 1 per cent level of confidence (two-tailed t-test). - (b) In parentheses: "prod." = only those countries are included in the regression that are considered as producing countries in the source; "prod. + ass." = in addition to the aforementioned producing countries, countries with major assembly facilities are included in the regression (for New Zealand, the Philippines, and South Africa, data on motor-vehicle sales).

Source: Automobile International [1984]; MVMA [1986]; World Bank [1985]; own calculations.

Applying the estimated parameter values to the development in per-capita incomes of Brazil, South Korea, and Spain (representing the group of new competitors in the automobile industry), as well as West Germany, Japan, and the United States (representing the group of traditional sup-

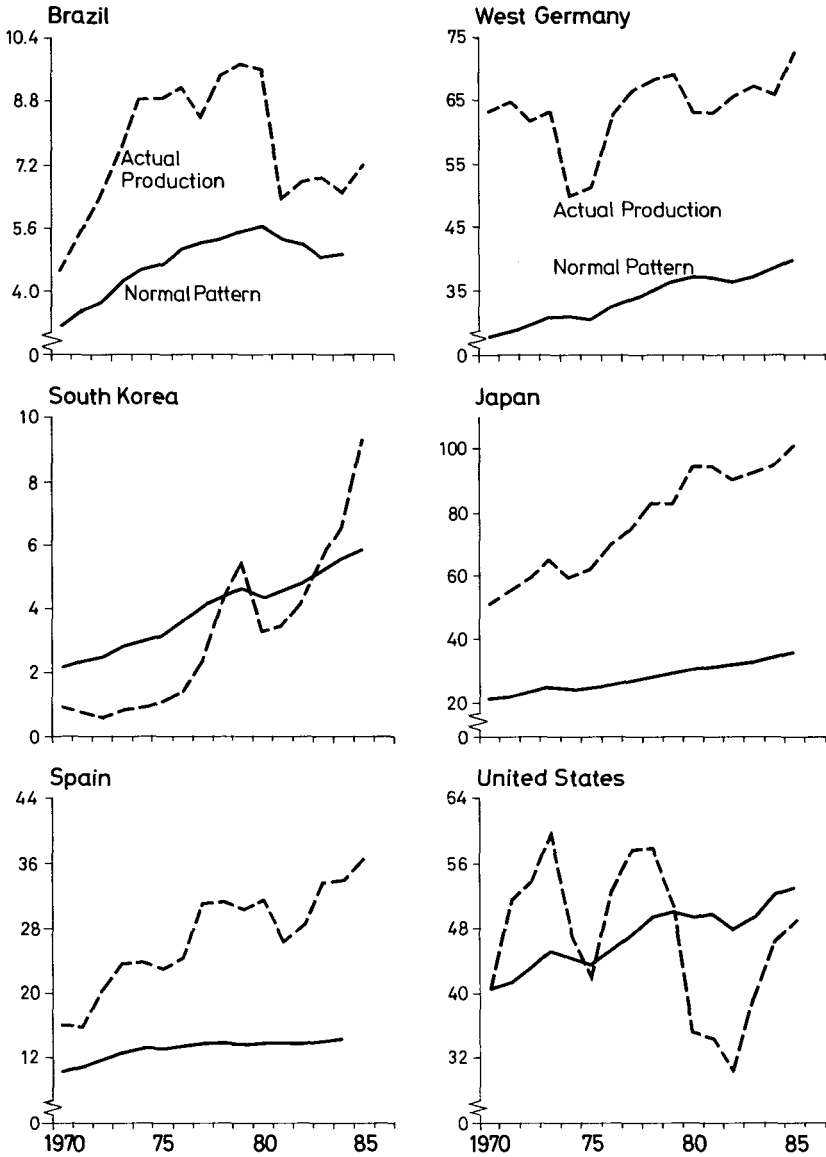


pliers) revealed the normal pattern of automobile production in these countries, as depicted in the following figures. The normal pattern serves diagnostic purposes, rather than providing a sound basis to forecast future developments of the automobile industry in specific countries. As a reference system, the normal pattern indicates whether the actual role of the automobile industry within specific countries was typical for economies of similar income levels, or whether country-specific influences have caused the automobile industry to lag behind or to play a more prominent role as compared to the average.

In the case of Brazil, it is evident from the figures that, throughout the 1970s, a huge positive gap prevailed between actual automobile production and the level of production considered as typical for countries that have achieved a stage of development similar to Brazil. The gap was most pronounced for passenger cars and considerably smaller for commercial vehicles. A similar picture emerged in the case of Spain, whereas the Korean automobile industry was still somewhat lagging behind in the 1970s, although the remarkable catch-up started in 1976. Two alternative explanations may apply as concerns the significantly positive deviations from the normal pattern in Brazil and Spain in the 1970s. NICs of higher-income range may have enjoyed locational advantages in automobile production, especially when domestic markets were already sufficiently large to reap benefits from economies of scale and (physical) capital was easily available. Alternatively, policy interventions that have fostered automobile production in these countries may have been responsible for the great surplus of actual over normal production. Section B.III deals with these hypotheses in considerable detail.

In the early 1980s, the development of the automobile industry differed markedly between the three major new competitors. The decline in motor-vehicle production in 1981, when worldwide automobile markets remained in depressed conditions, was rather modest and quickly offset within the following two years in Spain. In South Korea, the decline was somewhat stronger but completely wiped out by another steep increase in production starting in 1982. In sharp contrast, Brazil suffered from a drastic set-back in 1981 and did not succeed to regain the production levels of the late 1970s until 1986.

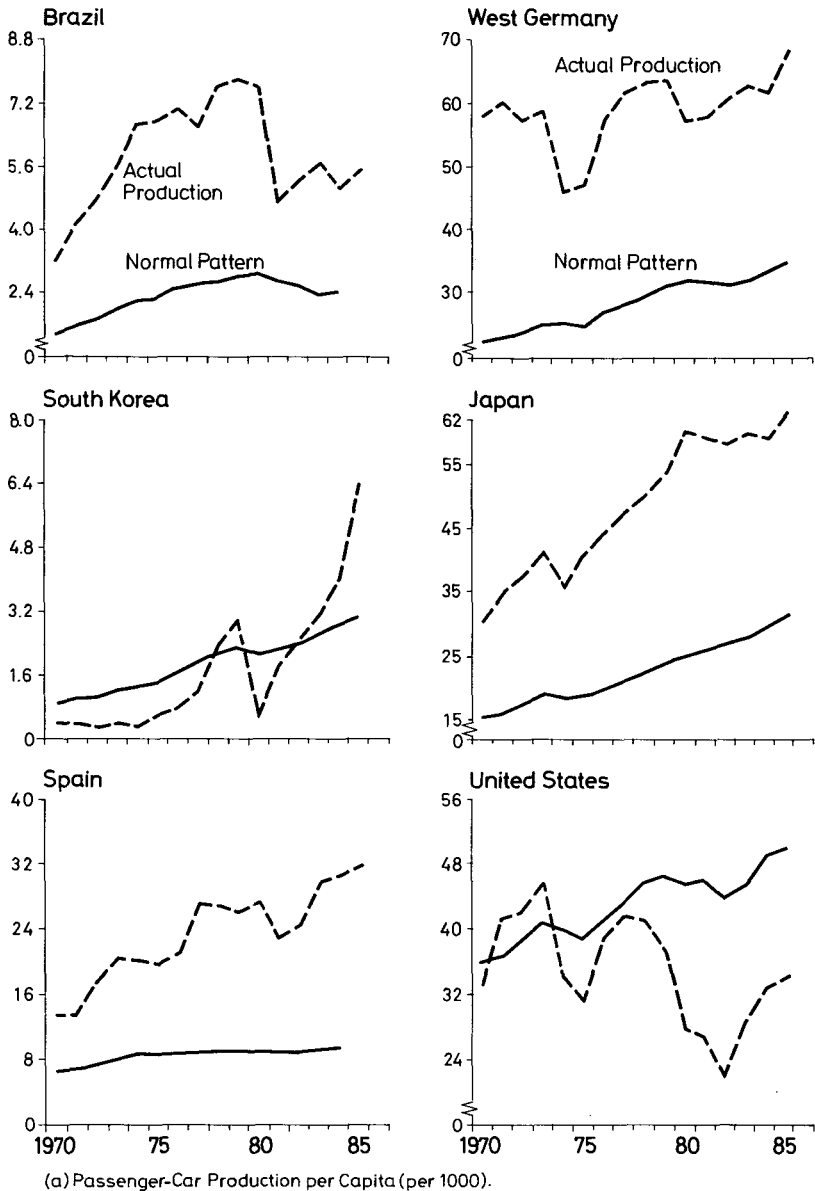
Figure A1 - Normal and Actual Production of Motor Vehicles (a) in Selected Countries, 1970-1986



(a) Total Vehicle Production per Capita (per 1000).

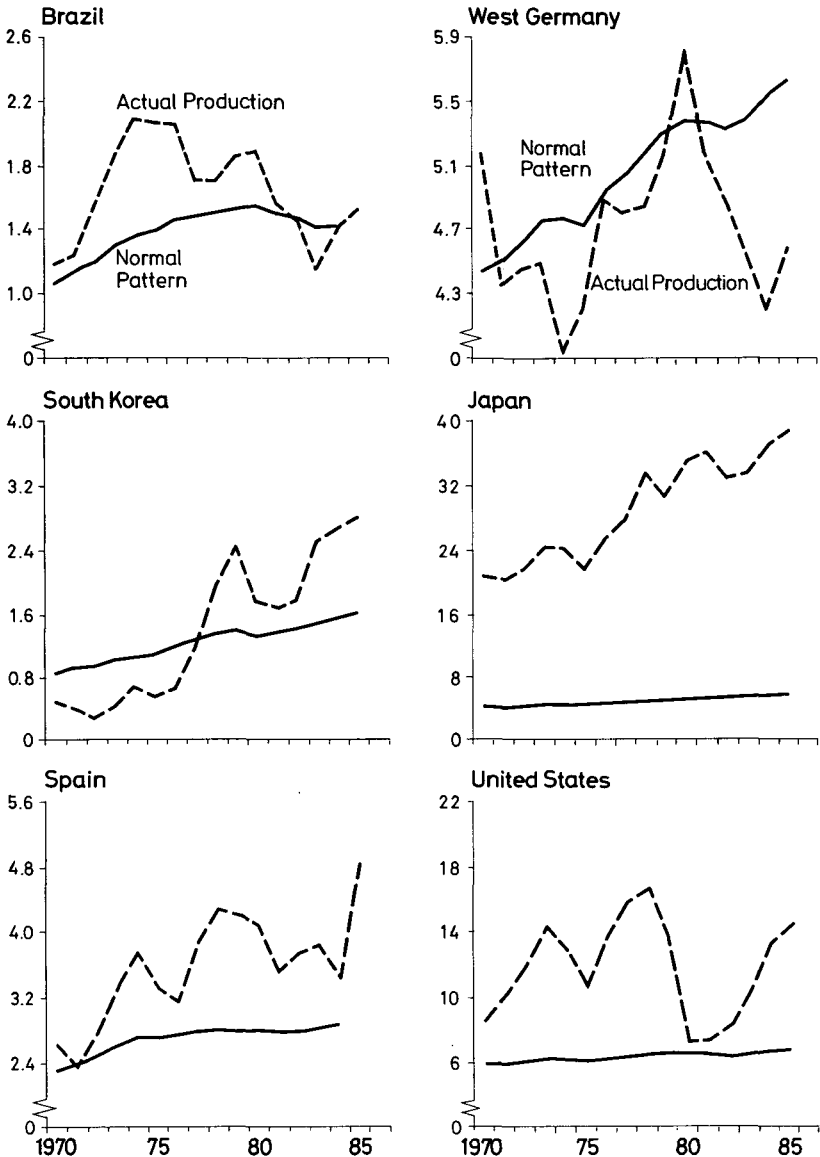
Source: MVMA [1986]; VDA [c]; IMF [1985; 1986]; UN [c].

Figure A2 - Normal and Actual Production of Passenger Cars (a) in Selected Countries, 1970-1986



Source: See Figure A1.

Figure A3 - Normal and Actual Production of Commercial Vehicles (a) in Selected Countries, 1970-1986



(a) Production of Buses and Trucks per Capita (per 1000).

Source: See Figure A1.

Such differences were of course partly due to different conditions in the domestic markets. However, additional factors may explain the extremely unfavourable development in Brazil. The relatively strong export concentration on the neighbouring Latin American countries rendered compensatory export sales difficult for Brazil, since the whole region suffered from seriously depressed economic conditions. Moreover, the dominant role of multinational automobile firms, which were interested primarily in preventing production and employment to decline drastically in the industrialized home countries, may have hindered the Brazilian subsidiaries to enter new export markets (for a detailed account on the Brazilian export performance and export structure see Section B.II).

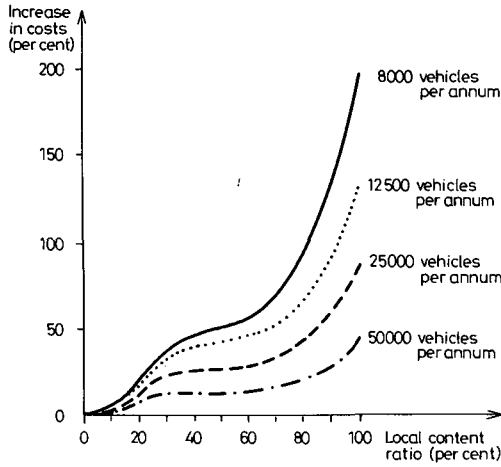
According to this reasoning, the relocation of automobile production from industrialized countries to Brazil was also impeded by political considerations, apart from purely economic considerations of the multinational parent companies. At a first glance, the figures for West Germany, Japan and the United States in Figure A1 indicate that such political considerations may have been particularly relevant in the first two countries. Total vehicle production of Japan and, though to a somewhat lesser extent, of West Germany remained well above the normal pattern and declined only modestly (1); whereas US-production experienced a remarkable erosion since 1978, and the recovery in 1983-1986 was not strong enough to reach the normal pattern again. However, whether the latter development was indeed due to relocation of US-production of automobiles to new competitors remains open to question. As discussed on pp. 18 ff. in the text, controlling variables have to be introduced to account for various other influences, which otherwise would obscure the rather long-term impact of structural relocation. For Brazil as a potential beneficiary of relocation, the regression analysis in Section B.II.1 provides some evidence.

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(1) In the case of West Germany, passenger-car production and commercial-vehicle production showed completely different patterns, however (Figures A2 and A3).

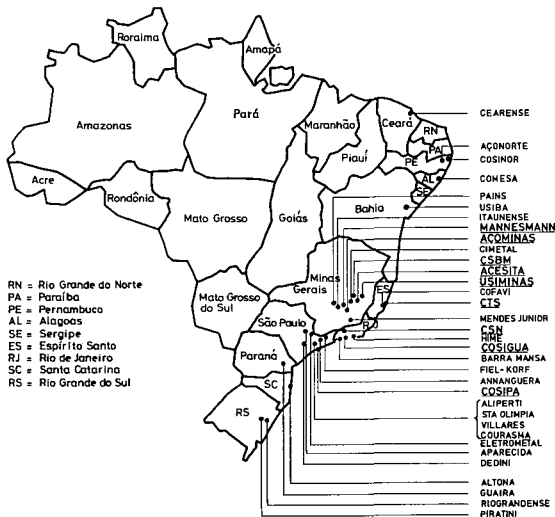
2. Appendix Figures

Figure A4 - Production Costs in the Automobile Industry as a Function of Local-Content Ratio and Production Volume



Source: Sékaly [1981, p. 254].

Figure A5 - Localization of the Brazilian Steel Plants



## 3. Appendix Tables

Table A2 - The Relationship between Brazilian Production of Passenger Cars, Trucks and Buses and Production in Major Industrialized Countries - Regression Results (a)

Dependent variable	Const.	D	EMAN	CARW	GACAR	JACAR	UACAR	SACAR	R <sup>2</sup> N	F D.W.
passenger cars, exclusive buses										
BACAR	1.91 (1.34)	-1.84*** (-6.34)	0.05*** (7.18)	0.15* (1.99)	-0.08** (-2.85)				0.91 15	36.39 2.20
BACAR	0.78 (0.50)	-1.24* (-2.13)	0.08*** (4.84)	0.06 (0.80)		-0.10* (-1.86)			0.88 15	26.43 2.25
BACAR	0.86 (0.38)	-1.86* (-2.03)	0.06* (2.15)	-0.09 (-0.26)			0.04 (0.33)		0.84 15	19.23 1.65
BACAR	0.52 (0.24)	-2.17*** (-5.14)	0.05*** (3.40)	0.01 (0.12)				0.01 (0.11)	0.84 15	19.02 1.53
trucks and buses										
BACV	1.43** (2.84)	-0.49*** (-4.43)	0.002*** (4.16)	-0.14* (-1.95)	-0.26** (-2.48)				0.71 15	9.63 2.04
BACV	0.40 (1.02)	-0.21 (-1.04)	0.001*** (3.43)	-0.02 (-0.17)		-0.04 (-1.60)			0.63 15	6.93 1.44
BACV	0.38 (0.97)	-0.24 (-1.30)	0.002*** (3.33)	-0.27* (-2.03)			0.05 (1.57)		0.63 15	6.85 1.42
BACV	0.49 (1.13)	-0.47*** (-3.25)	0.001*** (2.50)	-0.09 (-0.95)				-0.08 (-0.37)	0.54 15	5.11 0.97
<p>(a) Regressions are for the period 1970-1985; definition of variables as follows (t-statistics in parentheses; *** significant at 1 per cent level of confidence; ** 5 per cent level; * 10 per cent level; two-tailed t-test):</p> <p>BACAR : actual Brazilian production of passenger cars per 1000 inhabitants (number);  BACV : actual Brazilian production of trucks and buses per 1000 inhabitants (number);  Const. : constant term;  D : dummy variable (1970-1980=0; 1981-1985=1; for explanation, see the text);  EMAN : index of total manufacturing production in Brazil at constant prices;  BGNPPC : gross national income per capita of Brazil at constant prices (in US \$ of 1983);  CARW : world production of passenger cars (million);  CVW : world production of trucks and buses (million);  GACAR, JACAR : actual production of passenger cars per 1000 inhabitants in West Germany, Japan, the United States, and Spain respectively (number).  UACAR, SACAR : actual production of trucks and buses per 1000 inhabitants in West Germany, Japan, the United States, and Spain respectively (number).</p>										

Source: MVMA [1986]; VDA [c]; ANFAVEA, unpubl. data on motor-vehicles production of Brazil; IMF [1986]; UN [c, various issues]; IBGE [a, 1985]; own calculations.

Table A3 - Growth of Automotive Exports of Selected Producing Countries (per cent) (a), 1973-1983

	Automotive exports, most important items (b) (SITC 7321, 7322, 7323, 7328)	Passenger cars (c) (SITC 7321)	Buses (c) (SITC 7322)	Lorries, trucks (c) (SITC 7323)	Tractors (SITC 7325)	Motor-vehicle parts (c) (SITC 7328)	Automotive electrical equipment (SITC 7294)	Internal combustion engines (SITC 7115)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Developed countries</b>								
France	9.4 (8968.6)	6.2 (52.6)	7.5 (0.6)	13.6 (9.8)	9.3	15.1 (37.0)	10.1	10.7(d)
West Germany	10.9 (24547.7)	11.2 (66.1)	10.1 (1.0)	9.9 (9.2)	16.2	10.7 (23.7)	8.0	8.0(d)
Japan	22.5 (29021.3)	22.3 (67.3)	23.6 (1.0)	21.5 (19.9)	13.8	26.5 (11.8)	15.9	18.7(d)
United States	8.8 (13237.8)	8.8 (32.1)	12.7 (0.5)	4.8 (9.2)	n.a.	9.6 (58.2)	5.4	10.4(d)
<b>Developing countries</b>								
<b>Latin America</b>								
Argentina	-3.0 (60.6)	-0.8 (36.1)	-2.3 (9.7)	-17.4 (9.2)	n.a.	7.7 (44.9)	-6.6	-2.1(e)
Brazil	31.1 (905.8)	37.1 (47.4)	9.4 (0.7)	29.4 (27.2)	n.a.	26.9 (24.7)	28.4	48.0
Mexiko	16.2(f) (428.1)	4.3 (12.5)	n.a. (-)	-9.0 (0.4)	n.a.	21.0 (87.1)	n.a.	35.3
<b>Asia</b>								
India	n.a. (n.a.)	n.a. (-)	-3.7 (-)	n.a. (-)	n.a.	4.8 (-)	n.a.	26.9(g)
South Korea	76.5(h) (96.6)	93.3 (90.5)	81.3 (1.6)	43.2 (7.9)	-6.9	n.a. (-)	n.a.	n.a.
Malaysia	9.0 (10.1)	4.6 (22.0)	14.1 (3.0)	9.7 (22.6)	-2.9	11.1 (52.5)	n.a.	n.a.
<b>Other</b>								
Turkey	n.a. (n.a.)	n.a. (-)	36.3 (-)	n.a. (-)	n.a.	n.a. (-)	n.a.	n.a.
Yugoslavia	18.3 (410.9)	26.4 (27.0)	2.8 (7.0)	28.0 (7.7)	n.a.	19.2 (58.4)	17.1	12.7

"n.a.": not available or negligible export value.

(a) Nominal annual averages. - (b) In parentheses: export values in US \$ millions, 1983. - (c) In parentheses: share in export values of column (1), per cent. - (d) 1983: SITC 7132, 7139 (rev. 2); Japan: SITC 7132, 7133, 7139; United States: SITC 7132, 7138, 7139; due to the revision in the international trade classification, the growth rate is likely to be slightly understated. - (e) 1973-1982. - (f) Without buses, for which exports are likely to be negligible. - (g) 1973-1980; 1980: SITC 7132, 7139 (rev. 2); due to the revision in the international trade classification, the growth rate is likely to be slightly understated. - (h) Without vehicle parts, for which exports are likely to be negligible; extremely low exports in 1973 (US \$ 0.33 million).

Source: UNCTAD, unpubl. foreign trade data; UN [a; d]; own calculations.





Table A5 - US-Imports of Passenger-Car Engines: Unit Values, 1978-1982 (US \$)

Exporting countries (a)	1978	1979	1980	1981	1982	Market share (per cent)	
						1978	1982
Canada	553	609	699	802	1043	72.9	50.2
Mexico	639	647	711	706	822	4.3	19.8
Japan	247	328	834	778	725	0.4	13.3
Brazil	- (b)	333	374	369	935	0.1	9.8
West Germany	468	550	585	491	465	21.2	3.9
Others	430	522	592	749	982	1.2	2.9
Total	536	589	651	733	922	100.0	100.0

(a) Listed by market share in 1982, as indicated by engine units shipped to the United States. - (b) Not calculated because of minimal export value.

Source: Laing, Rahn [1983, on the basis of data from U.S. Department of Commerce]; own calculations.

Table A6 - Cost and Price Comparisons for Automobiles Produced in Latin American Countries, 1970 (developed countries = 100)

	Production costs	Ex-factory prices	Retail prices
Argentina	194.9	199.2	209.1
Brazil	134.6	134.9	196.5
Colombia	193.8	308.8	373.4
Chile	263.9	305.5	305.1
Mexico	152.6	158.8	152.2
Peru	163.8	183.0	175.4
Venezuela	145.0	146.3	140.7

Source: CEPAL [1974, p. 82]; own calculations.

Table A7 - The Cost Structure in Manufacturing of Light Trucks in Brazil and the United States, 1967 (in per cent of total costs)

	Materials		Direct labour	Manufacturing overhead		Interest and other income expenses	Special tooling amortization	Administration and selling expenses
	national	imported		variable	other			
Brazil	67.5	4.3	1.2	14.7		4.2	1.5	6.6
United States	46.4		10.3	20.2	19.2	0.1	1.0	2.8

Source: Baranson [1968a, p. 37].

Table A8 - Transport Costs (a) of Various Autoparts and Components to Detroit from Selected Locations, 1980 (US \$ per unit)

	Mexico-City	São Paulo	Yokohama
Engine	22	48	44
Transmission	8	23	21
Body	64	211	183
Starter motor	0.97	1.87	1.65
Radiator	1.14	3.98	3.48
Front-coil spring	1.41	4.67	4.16
Engine-wiring harness	0.59	2.10	1.82

(a) Includes shipping and packaging costs, as well as inventory-carrying charges. Incremental inventory days were assumed to be 14 for Mexico, 25 for Brazil, and 33 for the Far East.

Source: Johnston [1982, p. 7], derived from internal company data and published and unpubl. freight rates.

Table A9 - Wholesale Prices (a) for Investment Goods and Machinery in Selected Automobile Producing Countries, 1975-1985 (1975 = 100)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
<b>Brazil</b>										
Investment goods (b,c)	98.1	104.1	113.4	109.5	101.7	139.3	151.0	105.9	93.8	88.3
Industrial machinery and equipment (b)	108.3	122.3	127.0	123.0	123.0	167.9	169.6	126.8	117.4	126.5
Machinery (d)	104.2	111.0	118.5	114.3	108.0	147.3	149.9	110.0	n.a.	n.a.
<b>West Germany</b>										
Investment goods (b,e)	n.a.	n.a.	n.a.	n.a.	100.0	83.3	81.2	78.7	72.8	72.1
Machinery (b)	101.3	115.4	137.1	154.5	162.7	136.2	133.9	130.9	120.6	119.5
<b>Japan</b>										
Machinery and equipment (b)	100.0	110.7	139.9	135.8	135.5	140.9	124.2	129.3	129.0	127.6
Machinery (d)	99.7	112.5	144.9	140.9	142.3	148.6	131.2	136.9	n.a.	n.a.
<b>Spain</b>										
Investment goods (d)	98.3	104.4	123.2	163.0	173.3	153.7	145.5	126.1	n.a.	n.a.
Machinery (d)	98.8	103.1	123.7	165.0	177.0	155.1	144.5	124.6	n.a.	n.a.
<b>United States</b>										
Capital equipment (b)	106.7	113.6	122.6	133.2	147.6	162.6	171.9	176.7	180.9	184.9
Investment goods (d)	106.6	113.5	122.5	133.4	147.6	162.6	171.9	176.8	n.a.	n.a.
Machinery (d)	106.5	112.0	121.4	132.5	148.6	163.1	171.5	177.4	n.a.	n.a.

(a) Price indices in national currencies transformed into US \$ by applying period-average-exchange rates. - (b) Data from national sources. - (c) Máquinas, veículos e equipamentos. - (d) Based on data presented in Statistisches Bundesamt. - (e) 1980 = 100.

Source: Statistisches Bundesamt [b; c, 1984]; Conjuntura Económica [various issues]; Bank of Japan [various issues]; U.S. Department of Labor [1986b]; IMF [1985]; own calculations.

Table A10 - Factor Intensities (a) in South-Korean Transport-Equipment and Vehicle Industries, 1978 and 1983

	Overall-capital intensity		Physical-capital intensity		Human-capital intensity	
	1978	1983	1978	1983	1978	1983
Transport equipment	124.8	129.6	112.3	120.8	158.3	154.0
Motor vehicles	129.0	138.3	124.3	138.6	141.3	137.5
Motor vehicles, except parts	201.5	251.8	210.0	275.1	178.7	186.3
Motor-vehicle parts and accessories	93.1	89.2	82.0	79.6	122.8	116.5

(a) According to the Lary-concept, the following indicators are calculated: Value added per worker as a proxy for overall-capital intensity, employees' remuneration per worker as a proxy for human-capital intensity, and non-wage value added per worker as a proxy for physical-capital intensity. All figures are for establishments of 5 and more workers, relative to total manufacturing (100).

Source: Republic of Korea [1980, Vol. I; 1985, Vol. I]; own calculations.

Table A11 - Change in Physical and Human-Capital Intensity in Sub-Branches of the Motor-Vehicle and Autoparts Industry of Brazil (a), 1975-1979 and 1975-1980 (b)

	Physical-capital intensity		Human-capital intensity	
	per cent	rank(c)	per cent	rank(c)
Passenger cars, pick-ups, etc.	-42.9 (61.5)	3 (18)	-3.2 (15.2)	17 (16)
Trucks, buses	-22.4 (141.3)	7 (19)	-9.2 (9.6)	8 (14)
Motors	17.1 (4.7)	18 (12)	-7.3 (22.9)	13 (17)
Motor parts	-0.4 (-16.6)	13 (9)	-15.5 (2.6)	4 (11)
Transmission parts	-7.5 (-39.4)	8 (5)	-8.6 (-6.4)	10 (7)
Suspension parts	6.1 (-25.9)	15 (7)	-18.9 (-1.7)	3 (10)
Axles, etc.	-3.8 (-52.3)	9 (1)	-2.5 (-12.0)	18 (4)
Wheels, brakes	-45.2 (-49.2)	2 (2)	-12.4 (-3.6)	5 (8)
Parts of wheels and brakes	-0.1 (17.7)	14 (16)	-27.9 (-10.3)	2 (5)
Gas-tanks, exhausts, etc.	-2.1 (13.1)	11 (15)	-12.3 (-19.9)	6 (1)
Other parts	7.9 (8.6)	16 (14)	-11.0 (3.6)	7 (12)
Maintenance of buses, trucks, taxis, etc.	-0.5 (37.0)	12 (17)	-6.3 (26.7)	15 (19)
Cabins and bodies for trucks	-28.1 (-22.4)	5 (8)	-3.5 (-12.6)	16 (3)
Bodies for buses	10.7 (-28.4)	17 (6)	-8.3 (-13.8)	11 (2)
Trailers, etc.	-23.9 (-41.1)	6 (4)	21.7 (23.7)	19 (18)
Bodies for passenger and utility cars	29.8 (-45.2)	19 (3)	-28.1 (-6.5)	1 (6)
Bodies, engine bonnets for other vehicles	-49.9 (-14.3)	1 (10)	-9.0 (3.7)	9 (13)
Parts of bodies and cabins	-30.1 (7.1)	4 (13)	-7.3 (10.2)	14 (15)
Seats and upholstery for vehicles	-2.9 (0.6)	10 (11)	-8.1 (-2.4)	12 (9)
Mean	-9.9 (-3.2)	-	-9.3 (0.9)	-
Standard deviation	22.0 (45.2)	-	10.4 (13.5)	-

(a) Based on capital intensities relative to total manufacturing. -  
(b) 1975-1980 in parentheses. - (c) Greatest reduction = 1.

Source: Table 22.

Table A12 - Factor Intensities (a) and Employment in South-Korean Transport-Equipment and Motor-Vehicle Industries, 1983

	Overall-capital intensity	Physical-capital intensity	Human-capital intensity	Workers	
				number (1000)	share (b) (per cent)
Transport equipment total	129.6	120.8	154.0	143.2	6.5
5-9	104.0	94.2	119.1	2.0	(1.4)
10-19	98.0	89.1	110.3	4.1	(2.9)
20-49	104.5	100.6	110.8	9.4	(6.6)
50-99	94.8	84.9	113.1	9.3	(6.5)
100-199	89.0	73.7	121.6	13.0	(9.1)
200-299	67.1	47.5	121.7	5.9	(4.1)
300-499	92.6	80.3	129.7	6.7	(4.7)
500 and more	112.4	101.7	151.9	93.0	(64.9)
unweighted average(c)	95.3	84.0	122.3	n.a.	n.a.
Motor vehicles total	138.3	138.6	137.5	58.7	2.6
5-9	110.8	108.6	114.0	0.9	(1.5)
10-19	97.6	92.4	105.4	2.2	(3.7)
20-49	107.4	107.8	107.4	5.5	(9.4)
50-99	94.2	88.9	103.6	4.8	(8.2)
100-199	98.4	92.5	110.6	6.9	(11.8)
200-299	86.6	75.4	118.1	2.5	(4.3)
300-499	99.2	92.4	119.7	4.6	(7.8)
500 and more	133.9	131.4	143.3	31.4	(53.5)
unweighted average(c)	103.5	98.7	115.3	n.a.	n.a.
Motor vehicles, except parts (d)	251.8	275.1	186.3	17.7	0.8
Motor-vehicle parts and accessories total	89.2	79.6	116.5	41.0	1.9
5-9	110.8	108.6	114.0	0.9	(2.2)
10-19	97.6	92.4	105.4	2.2	(5.4)
20-49	107.4	107.8	107.4	5.5	(13.4)
50-99	94.2	88.9	103.6	4.8	(11.7)
100-199	98.4	92.5	110.6	6.9	(16.8)
200-299	86.6	75.4	118.1	2.5	(6.1)
300-499	99.6	92.8	120.1	4.3	(10.5)
500 and more	82.6	71.3	123.9	14.0	(34.1)
unweighted average(c)	97.2	91.2	112.9	n.a.	n.a.

(a) According to the Lary-concept, the following indicators are calculated: Value added per worker as a proxy for overall-capital intensity, employees' remuneration per worker as a proxy for human-capital intensity, and non-wage value added per worker as a proxy for physical-capital intensity. All figures are for establishments of 5 and more workers, relative to total manufacturing of the respective size class (=100). - (b) Share in total manufacturing; in parentheses: share of the various size classes in total employment of the respective industry. - (c) Totals excluded. - (d) No further disaggregation into different size classes available in the source, because of confidential treatment of firm-specific data. All enterprises in manufacturing of motor vehicles (except parts) belong to the two upper size classes.

Source: Republic of Korea [1985, Vol. I].

Table A13 - Regression Variables (a) - Mean and Standard Deviation, 1970-1980 and 1970-1984

	1970-1980		1970-1984	
	mean	standard deviation	mean	standard deviation
Real exchange rate (1980=100; logarithmic form), vis-à-vis:				
World	4.41	0.08	4.44	0.09
Industrialized countries	4.45	0.07	4.44	0.07
United States	4.48	0.05	4.53	0.10
Europe	4.39	0.14	4.38	0.12
Developing countries	4.39	0.09	4.45	0.13
ALADI	4.41	0.09	4.45	0.11
Africa	4.22	0.21	4.34	0.28
Capacity utilization	0.00	0.11	-0.20	0.35
Motor-vehicles production (1000; logarithmic form)	6.71	0.34	6.72	0.29
Market share of Brazil in (per cent):				
World	0.38	0.25	0.53	0.33
Industrialized countries	0.09	0.07	0.18	0.17
United States	0.17	0.14	0.22	0.14
Europe	0.08	0.06	0.23	0.28
Developing countries	1.47	0.86	1.80	0.98
ALADI	4.80	2.40	6.17	3.44
Africa	1.24	1.09	1.37	1.00
(a) For the exact definition, see Table 27 and the text.				

Source: See Table 27.

Table A14 - Adjusted Fiscal Incentives to Exports (a) of Brazilian Manufacturing Industries, 1980

	Exports	Total export incentives	Incentive rates					
			total	export-tax credit	income-tax reduction	BEFLEX	drawback	other
			US \$ million			per cent		
Non-metallic minerals	163.2	6.49	4.0	0	3.0	0.2	0.4	0.4
Metallurgy	1037.6	71.03	6.8	0	3.7	0.8	1.9	0.4
Machinery	654.0	73.34	11.2	0	2.0	2.6	6.0	0.7
Electrical equipment	495.0	86.68	17.5	0	3.2	3.5	10.2	0.6
Transport equipment (b)	2201.0 (19.3)	499.25 (47.4)	22.7 (47.4)	7.1 (100.0)	2.0 (14.1)	8.1 (77.1)	5.3 (37.0)	0.1 (8.8)
Wood products	251.0	19.49	7.8	0	5.0	0.3	2.2	0.3
Furniture	28.0	0.89	3.2	0	2.5	0	0.4	0.4
Paper	274.0	20.64	7.5	0	5.7	0.4	0.5	1.0
Rubber	135.0	10.42	7.7	0	2.8	1.1	3.8	0.1
Leather products	112.0	6.56	5.9	0	2.0	0.1	2.6	1.2
Chemicals	875.0	30.94	3.5	0	1.5	0.1	1.7	0.3
Pharmaceuticals	59.0	5.01	8.5	0	1.9	0.5	5.4	0.7
Perfumes	13.0	0.45	3.5	0	3.2	0.2	0	0
Plastics	51.0	5.33	10.5	0	2.5	2.1	5.6	0.3
Textiles	580.0	47.08	8.1	0	5.2	0.4	1.8	0.7
Clothing, footwear	299.0	24.46	8.2	0	4.2	0	3.5	0.5
Processed food	3574.0	132.61	3.7	0	2.7	0	0.8	0.2
Beverages	25.0	0.82	3.3	0	2.8	0	0.1	0.4
Tobacco	247.5	0.53	0.2	0	0.0	0	0.2	0
Printing	21.0	0.22	1.0	0	0.9	0	0	0.1
Miscellaneous	288.6	11.67	4.0	0	2.4	0.3	1.1	0.2
Total manufacturing (c)	11383.6	1054.16	9.3	1.4 (156.0)	2.7 (312.8)	2.0 (232.2)	2.8 (315.7)	0.3 (37.5)

(a) For the description of the various incentives and the adjustments made, see the text (Section B.IV.2); incentive rates in per cent of export values. - (b) In parentheses: share of exports and export incentives (US \$ million) of transport-equipment industries in total manufacturing exports and incentives granted to all manufacturing industries respectively (per cent). - (c) In parentheses: US \$ million.

Source: World Bank [1983, p. 213]; own calculations.

Table A15 - Legal and Implicit Tariffs for Selected Input Items of the Brazilian Motor-Vehicle Industry, 1980/81 (per cent)

Industry (IBGE-code)	Legal tariff	Implicit tariff	Industry (IBGE-code)	Legal tariff	Implicit tariff	
Sheet glass (10021)	71.8	-18.4	Industrial equipment and machinery (1203)	51.8	29.5	
Pig-iron, iron alloys and primary steel (1101)	49.2	-13.7	Electric equipment (1303)	88.5	49.1	
Iron and steel sheets (1102)	37.4	-8.5	Electric machinery and appliances (1304)	61.1	34.7	
Iron and steel castings (1103)	95.9	31.3	Electronic equipment (1305)	55.4	96.4	
Non-ferrous metals (1104)	44.1	-16.5	Motors and vehicle parts (1403)	112.5	-15.5	
Miscellaneous metal products of which:	(1105)	105.7	10.3	Tires and inner tubes (18011)	85.0	-20.9
Iron and steel forgings (11052)	107.5	-16.4	Fuel and lubricating oils (20032)	40.0	0.0	
Other metal products (11054)	119.7	15.7	Pigments and paints (2007)	89.4	42.1	
			Plastics (2301)	203.8	14.3	

Source: Tyler [1981].

Table A16 - Persons per Car in Selected Countries (a), 1973 and 1985

	1973	1985	Per-capita income 1985 (US \$)		1973	1985	Per-capita income 1985 (US \$)
United States	2.2	1.8	16690	Mexico	35.5	15.9	2080
West Germany	3.8	2.4	10940	Soviet Union	136.3	23.2	n.a.
France	3.8	2.6	9540	Chile	47.7	23.4	1430
United Kingdom	4.3	3.2	8460	Taiwan	208.4	23.7	n.a.
Spain	10.7	4.3	4290	Colombia	93.3	34.1	1320
Japan	8.4	4.4	11300	Peru	62.4	50.2	1010
Yugoslavia	20.7	8.0	2070	Ivory Coast	72.1	57.4	660
Argentina	13.1	8.2	2130	Turkey	227.9	60.8	1080
Saudi Arabia	66.9	8.5	8850	South Korea	470.0	90.3	2150
Portugal	12.3	8.8	1970	Thailand	168.1	107.9	800
Greece	29.2	9.0	3550	Egypt	229.6	109.4	610
Singapore	12.2	10.9	7420	Nigeria	573.9	115.9	800
South Africa	14.8	11.0	2010	Kenya	80.4	154.3	290
Venezuela	14.5	12.1	3080	Indonesia	448.4	227.0	530
Brazil	33.8	14.1	1640	India	871.6	731.5	270
Malaysia	35.5	15.1	2000	China	n.a.	10349.0	310

(a) Ranked according to number of persons per car in 1985.

Source: Automobile International [various issues]; World Bank [1987].



Table A17 - Estimates of Car Parc, Domestic Automobile Demand, Production and Exports of Brazil by Caporale (1000), 1990 and 1995

	Registrations	Production		Domestic demand
		total	exports	
Total motor vehicles				
1990	16900	2570	1065	1670
1995	21600	3680	1685	2220
Passenger cars				
1990	13600	1500	650	1000
1995	17300	2100	950	1350
Commercial vehicles				
1990	3300	1070	415	670
1995	4300	1580	735	870

Source: Caporale [1980]; Caporale, Gross [1983].

Table A18 - Position of the Metallurgical Sector (a) Within the Brazilian Economy, 1965-1984

	Average annual growth rates (per cent)			
	1965-1967	1967-1973	1973-1980	1980-1984
GDP (constant 1970 prices)	3.5	11.5	7.0	0.1
Production at constant 1970 prices				
Industrial sector	6.3	13.2	7.5	-1.6
Manufacturing sector	6.8	13.3	6.8	-1.7
Metallurgical sector	13.4	11.7	9.3	-2.0(b)
	1965	1973	1980	1984
Share in value of manufacturing output (per cent)	10.9	12.2	13.8	12.6(c)
Employment (1000)	231.2	355.0	527.9	464.0(c)
Share in manufacturing employment	13.0	11.1	11.3	10.8(c)
Share in manufactured exports (steel products only)	n.a.	4.2	6.1	9.7

(a) Includes the non-ferrous metals sector in addition to the iron and steel industry. - (b) Calculated from the accumulated index of production in Anuario Estatístico. - (c) 1981.

Source: World Bank [1983, Tables 1.5, 1.7, 2.1, 2.2, 2.9, 2.10]; Conjuntura Económica [March 1985, pp. 111, 126]; IBGE [a; b, 1980; c, 1981].

Table A19 - Consumption of Rolled Steel Products by Sectors, Brazil, 1973-1983 (a)

	Share in total consumption (per cent)					
	1973	1975	1977	1979	1981	1983
Automobile industry	21.0	21.0	21.4	20.6	17.8	20.0
Railways	4.3	6.2	2.5	2.0	1.7	2.3
Shipbuilding	2.1	3.1	3.5	3.0	2.6	2.4
Agriculture	4.7	5.4	5.3	4.8	4.9	6.3
Mechanical engineering	11.3	12.4	12.5	14.5	15.6	10.5
Electrical engineering	2.2	2.1	2.2	1.6	2.7	2.0
Utilities	5.8	5.2	5.8	5.9	5.9	8.5
Packing material and receptacles	8.2	7.1	8.2	8.0	7.4	10.3
Construction	30.8	28.0	28.7	28.7	29.0	24.7
Re-rolling mills	7.7	7.4	8.0	8.8	10.1	11.0
Others	1.9	2.1	1.9	2.1	2.1	2.0
Total	100.0	100.0	100.0	100.0	100.0	100.0
Volume (1000 tons)	6900	8637	9162	10696	9700	7835

(a) Including imported drawn products and steel strips.

Source: Suma Económica [1985, Table 4.2.1].

Table A20 - Export Ratios of Steel Enterprises in Brazil, 1976-1985 (a)

Company	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
State-controlled										
CSN	3.2	5.8	18.2	25.7	15.7	13.2	18.3	26.1	29.6	24.5
COSIPA	1.6	-	0.3	1.3	18.0	20.9	27.5	39.2	29.5	18.3
CST	-	-	-	-	-	-	-	-	50.8	78.3
USIMINAS	5.8	0.3	0.4	1.4	5.5	5.4	15.6	25.6	21.6	17.1
ACESITA	0.0	0.0	2.5	11.3	8.0	11.4	4.4	26.6	29.0	24.9
Private										
PAINS	-	7.7	-	-	3.7	5.2	5.3	37.8	41.3	39.6
MANNESMANN	0.9	1.5	2.1	6.2	8.2	13.9	17.1	32.1	31.5	16.9
GRUPO GERDAU										
COSIGUA	-	0.0	0.1	-	1.1	18.3	14.1	47.5	65.3	22.5
GUAIRA	-	0.1	-	-	0.1	0.8	2.8	1.0	9.4	-
RIOGRANDENSE	0.4	3.7	0.6	1.0	7.9	12.3	1.8	1.8	17.7	0.1
GRUPO VILLARES										
AÇOS VILLARES	6.4	7.3	11.3	17.4	22.9	29.8	33.6	37.5	32.8	31.6
VIBASA	-	-	-	-	2.8	14.7	19.6	28.4	45.9	48.6
ANHANGUERA	-	-	0.5	4.3	3.4	1.4	5.3	37.6	18.7	36.9
APARECIDA	-	-	0.1	0.1	0.0	4.7	5.1	4.5	3.0	6.7
BELGO-MINEIRA	0.9	1.3	3.2	3.1	2.1	17.3	1.9	13.0	22.8	20.4
COFAVI	-	-	-	-	-	17.2	15.0	18.9	12.2	19.3
DEDINI	-	-	-	-	1.6	14.6	8.0	31.3	54.9	38.7

(a) Shares of export volume in total production of rolled and semi-finished products in per cent.

Source: Herken-Krauer [1987a, p. 100]; this table has been compiled from unpubl. export data provided by CACEX, and production data from CONSIDER [1986].

Table A21 - US General Imports Unit Values for Iron and Steel Products, 1976-1985

Product	Schedule A code (similar to SITC) (a)		1976		1977		1978	
			I (b)	II (c)	I (b)	II (c)	I (b)	II (c)
Pig iron	671 2020	Average all countries (d)	136	146	133	145	121	135
		Brazil (e)	-31.5	-37.9	-26.0	-19.3	-6.3	-3.2
		Canada (e)	21.3	17.8	19.5	15.2	27.3	19.3
		South Africa (e)	-	-	-	-	-7.4	-5.9
Ferrosilicon over 60 per cent silicon	671 6240	Average (d)	663	708	654	702	571	612
		Brazil (e)	-21.9	-21.1	11.2	12.3	19.3	22.3
		Norway (e)	-13.9	-14.0	-20.0	-19.9	-17.7	-18.8
		Venezuela (e)	-	-	-27.4	-27.3	-14.7	-17.8
Various ordinary semi-finished products	672 6020	Average (d)	197	213	178	195	198	223
		Brazil (e)	-	-	24.9	25.8	-25.4	-21.4
		West Germany (e)	14.7	21.1	53.9	67.7	46.5	45.7
		Sweden (e)	9.1	10.3	16.8	13.3	11.1	11.2
Wire rods unalloyed, not tempered, not treated, not part- ly manufactured	673 1325	Average (d)	245	273	245	274	274	305
		Brazil (e)	-22.9	-20.2	-23.8	-23.5	-17.3	24.8
		Japan (e)	2.4	4.0	12.2	12.8	15.7	14.4
		Trinidad (e)	-	-	-	-	-	-
Bars, of stainless steel, cold formed	673 2130	Average (d)	1400	1480	1619	1722	1783	1867
		Brazil (e)	-3.4	-5.3	-6.3	-7.5	-7.7	-6.6
		Japan (e)	0.4	0.7	3.5	4.4	7.9	6.5
		South Korea (e)	-14.7	-14.5	-39.0	-37.0	-32.2	-30.3
Deformed concrete reinforcing bars, unalloyed	673 2810	Average (d)	172	205	178	205	208	235
		Brazil (e)	7.5	5.2	-4.0	-0.4	-4.8	0.5
		Venezuela (e)	-	-	-	-	-	-
		South Korea (e)	-0.6	-0.5	2.8	4.4	-12.5	-9.8
Plates (not pickled), sheets (pickled), unalloyed, not coated, not clad	674 0115	Average (d)	233	251	236	255	263	289
		Brazil (e)	-	-	-	-	16.4	17.6
		Canada (e)	15.4	8.4	20.3	12.5	16.7	7.6
		Japan (e)	2.1	2.4	10.6	10.2	13.3	9.0
		West Germany (e)	0	0.8	1.3	3.5	2.7	4.5
		South Korea (e)	-15.0	-9.9	-18.2	-14.1	4.9	4.1

(a) The equivalent Schedule A codes are as follows (for two of the items the product specification varies):

1976 and 1977	1978 and onwards
671 2000	671 2020
671 5020	671 6240
(Ferrosilicon)	(Ferrosilicon, over 60% silicon)
672 4100	672 6020
673 1400	673 1325
673 2330	673 2130
673 2410	673 2810
674 1520	674 0115

(Plates of unalloyed iron or steel, not shaped, not coated, and not pickled or cold rolled). (Plates, not pickled; sheets, pickled; the foregoing unalloyed iron or steel, not coated, not clad).

(b) Customs value. - (c) Cif. - (d) In US \$/t. - (e) Deviation from average for all countries (per cent).

Table A21 continued

1979		1980		1981		1982		1983		1984		1985	
I (b)	II (c)	I (b)	II (c)	I (b)	II (c)	I (b)	II (c)	I (b)	II (c)	I (b)	II (c)	I (b)	II (c)
146	163	174	196	173	192	168	188	145	162	132	148	163	178
-11.3	-7.2	-24.4	-14.9	-29.2	-19.1	-25.6	-19.1	-19.3	-15.6	-13.2	-9.6	-28.7	-25.8
17.1	10.4	13.2	6.6	18.5	12.5	39.3	31.4	28.3	22.2	43.9	35.8	21.5	17.4
-6.2	0	-12.6	-3.6	-3.5	0	0	0	-0.7	3.7	22.0	24.3	9.2	11.8
774	822	856	916	743	797	714	768	658	703	786	838	760	814
4.3	5.0	-6.4	-6.6	-0.0	1.2	5.0	5.2	3.3	4.3	13.4	14.3	14.7	14.2
-12.8	-12.2	-23.6	-20.8	-12.3	-10.9	-24.6	-22.4	-6.4	-4.0	-8.4	-6.8	-16.6	-14.6
1.9	1.1	3.6	-0.8	-27.6	-28.1	-45.8	-46.4	-49.8	-46.9	-26.2	-26.8	-11.8	-12.0
219	248	254	270	252	260	241	262	222	236	213	237	202	228
-15.3	-12.3	-3.8	19.0	0.9	18.8	24.9	31.7	3.6	8.8	10.8	10.3	-1.6	-4.8
58.4	68.5	115.0	123.7	3.2	8.5	8.7	10.7	-1.3	5.5	2.8	3.8	11.9	13.6
11.9	18.2	24.4	35.6	4.8	13.8	-3.3	-1.1	-4.9	0	-8.9	-5.6	-10.4	-7.9
350	377	355	383	382	413	345	373	303	333	322	352	317	350
-	-	-	-	-6.5	-2.4	-8.1	-2.9	-22.2	-19.0	-11.6	-12.4	-20.7	-18.2
10.3	12.7	11.5	15.9	16.7	21.1	24.3	29.8	29.4	33.3	26.1	30.7	19.9	23.7
-	-	-	-	-13.4	-14.5	-15.9	-17.2	-14.5	-12.6	-11.8	-10.5	-12.0	-11.1
2075	2174	2268	2364	2446	2554	2044	2151	1806	1912	2101	2200	2231	2337
-17.6	-16.1	-7.7	-6.2	-13.9	-10.7	-10.0	-5.0	-15.1	-10.2	-30.6	-28.7	-13.5	-12.3
5.9	5.6	6.4	5.5	2.7	1.9	4.9	3.7	0.2	-1.0	4.1	3.2	5.8	4.6
-14.5	-14.9	-20.1	-19.8	-24.2	-23.1	-20.4	-18.8	-13.4	-12.9	-16.7	-16.6	-20.5	-19.3
312	346	333	374	314	362	270	322	207	234	222	252	237	266
-8.3	-3.1	2.1	5.7	-18.8	-8.8	-19.3	-11.8	-12.8	-2.9	-2.3	-1.3	0.5	1.0
-	-	-	-	-	-	-	-	-0.5	-5.6	-4.5	-3.9	-8.0	-7.5
-	-	2.4	4.0	9.2	9.7	58.1	53.7	10.6	11.1	3.6	4.8	-2.1	-0.7
324	355	348	385	385	425	359	395	284	314	306	336	288	317
1.4	3.2	-0.2	0.7	4.4	5.6	-2.5	-1.3	-10.7	-9.0	-26.2	-26.5	-32.5	-34.8
9.9	1.9	6.0	-4.2	4.9	-4.2	13.9	3.8	5.3	-4.8	10.5	0.6	15.6	5.4
2.8	0.8	1.1	0	-2.6	-3.1	6.7	6.6	19.7	19.4	20.3	20.2	30.2	30.9
-4.6	-2.8	-4.6	-1.3	-2.1	0	-6.7	-4.6	4.2	7.6	3.6	6.8	8.7	12.0
1.5	1.7	0.9	0.5	0.3	0.5	0	0	-9.9	-7.3	2.9	2.7	9.7	9.1

Source: U.S. General Imports (various issues).

Table A22 - Hourly Labour Costs for Production Workers in the Iron and Steel Industry and in Total Manufacturing, Brazil and Selected Countries, 1975-1985 (a) (United States = 1.00)

		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Iron and steel industry												
Brazil	(I)	0.17	0.18	0.19	0.20	0.24	0.26	0.28	0.29	0.39	0.37	n.a.
	(II) (b)	0.13	0.13	0.13	0.14	0.13	0.12	0.13	0.13	0.10	0.09	0.09
South Korea	(I)	0.13	0.16	0.19	0.24	0.25	0.22	0.23	0.21	0.25	0.30	n.a.
	(II) (b)	0.05	0.06	0.08	0.10	0.11	0.09	0.09	0.08	0.09	0.10	0.10
Mexico	(I)	0.32	0.33	0.30	0.30	0.29	0.28	0.30	0.19	0.14	n.a.	n.a.
	(II) (b)	0.23	0.22	0.17	0.18	0.20	0.22	0.24	0.11	0.09	0.11	n.a.
Taiwan	(I)	0.12	0.13	0.13	0.14	0.14	0.14	0.19	0.19	0.18	0.22	n.a.
	(II) (c)	0.06	0.07	0.07	0.09	0.09	0.09	0.10	0.09	0.08	0.10	0.09
West Germany	(I)	0.50	0.48	0.53	0.55	0.59	0.59	0.57	0.46	0.55	0.58	n.a.
	(II) (b)	0.70	0.67	0.71	0.79	0.84	0.79	0.61	0.51	0.54	0.52	0.52
Japan	(I)	0.39	0.46	0.53	0.41	0.47	0.39	0.39	0.35	0.42	0.44	n.a.
	(II) (b)	0.51	0.61	0.75	0.72	0.72	0.57	0.56	0.44	0.51	0.55	0.52
Spain	(I)	n.a.	n.a.	0.39	0.39	0.42	0.39	0.41	0.37	0.38	0.39	n.a.
	(II) (b)	n.a.	n.a.	0.33	0.35	0.45	0.43	0.38	0.31	0.28	0.28	0.28
Total manufacturing												
Brazil	(I)	0.17	0.18	0.18	0.19	0.19	0.18	0.30	0.33	0.24	n.a.	n.a.
	(II) (d)	0.18	0.19	0.19	0.20	0.19	0.17	0.20	0.21	0.12	0.10	0.10
Hong Kong	(I)	0.15	0.16	0.16	0.18	0.17	0.17	0.18	0.17	0.19	0.19	n.a.
	(II) (d)	0.11	0.12	0.13	0.14	0.14	0.15	0.14	0.13	0.13	0.13	0.14
South Korea	(I)	0.16	0.12	0.14	0.16	0.18	0.17	0.17	0.18	0.19	0.20	n.a.
	(II) (d)	0.06	0.07	0.08	0.10	0.13	0.11	0.10	0.10	0.11	0.11	0.11
Mexico	(I)	0.37	0.37	0.36	0.36	0.34	0.35	0.34	0.35	0.25	0.22	n.a.
	(II) (d)	0.30	0.30	0.23	0.25	0.26	0.30	0.33	0.17	0.12	0.14	n.a.
Taiwan	(I)	0.15	0.15	0.17	0.20	0.20	0.25	0.24	0.25	0.21	0.23	n.a.
	(II) (c)	0.08	0.08	0.09	0.10	0.11	0.13	0.14	0.13	0.11	0.12	0.11
West Germany	(I)	0.77	0.80	0.79	0.81	0.80	0.84	0.86	0.86	0.84	0.85	0.83
	(II) (d)	0.97	0.85	1.03	1.16	1.24	1.25	0.96	0.89	0.87	0.77	0.76
Japan	(I)	0.50	0.52	0.54	0.55	0.56	0.61	0.63	0.64	0.64	0.66	0.65
	(II) (d)	0.48	0.48	0.53	0.67	0.61	0.57	0.56	0.49	0.51	0.51	0.50
Spain	(I)	0.44	0.48	0.49	0.48	0.51	0.52	0.54	0.55	0.52	n.a.	n.a.
	(II) (d)	0.41	0.42	0.43	0.47	0.60	0.60	0.51	0.46	0.39	0.37	0.37

(a) Labour costs include direct and indirect wages. They are computed (I) at industry specific PPPs, and (II) at average annual exchange rates. - (b) The PPPs for non-residential housing as a proxy for iron and steel PPPs [Kravis et al., 1982] have been updated in own calculations by national data on iron and steel price indices. - (c) In the case of Taiwan the 1975 PPPs [Summers, Heston, 1984] for the GDP have been updated in calculations by corresponding price index data. - (d) The PPPs for tradables as a proxy for manufacturing PPPs [Kravis et al., 1982] have been updated in own calculations by resource to national data on manufacturing price index.

Source: Picht [1987, Table 3].

Table A23 - Labour Productivity Trends (Relative to the United States) in the Iron and Steel Industry and in Total Manufacturing, Brazil and Selected Countries, 1975-1984 (Base year 1975 = 100)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Iron and steel industry(a)										
Brazil	100.0	95.1	106.0	112.1	119.9	149.1	130.4	186.4	155.3	158.4
South Korea	100.0	105.0	101.9	105.4	132.0	167.5	198.5	284.2	n.a.	n.a.
Mexico(b)	100.0	91.6	90.8	94.0	97.5	106.1	94.5	116.1	88.9	n.a.
Taiwan	100.0	112.6	143.9	154.8	168.9	176.1	151.4	219.9	229.0	224.9
West Germany	100.0	99.6	104.1	106.2	120.1	126.3	114.3	140.1	157.0	n.a.
Japan	100.0	96.7	108.8	110.0	127.9	145.3	125.0	163.5	139.3	n.a.
Spain(c)	100.0	94.6	98.5	94.1	98.5	115.7	102.6	160.4	n.a.	n.a.
Total manufacturing(c)										
Brazil	100.0	102.6	98.5	101.7	103.4	103.1	102.8	107.2	104.1	109.0
Hong Kong	100.0	96.1	98.2	103.7	125.7	124.2	128.3	118.4	n.a.	n.a.
South Korea	100.0	109.7	117.5	133.0	148.7	153.2	170.7	175.0	n.a.	n.a.
Taiwan	100.0	11.2	114.2	130.5	131.9	134.2	139.2	140.8	153.0	152.4
West Germany	100.0	102.5	104.0	105.6	109.9	110.8	109.3	108.4	108.9	110.0
Japan	100.0	104.7	109.4	117.4	126.5	138.5	141.7	148.6	149.9	158.5
Spain	100.0	101.3	105.8	102.1	96.7	97.4	101.3	n.a.	n.a.	n.a.
<p>(a) In general productivity is calculated as real output per person engaged. - (b) Including non-ferrous metals. - (c) In general productivity is measured as constant value output per employee hour. The figures are calculated from data published by the U.S. Department of Labor, Monthly Labor Review, January 1986b, except for Brazil, South Korea, and Spain. In these cases data on the industrial production volume and the number of persons engaged [U.N., c] have been used in own calculations. Note that the national accounting methods for measuring real output differ considerably.</p>										

Source: Picht [1987, Table 5].

Table A24 - Production, Consumption, and Exports of Iron Ore, Pig Iron, and Iron and Steel Scrap, Brazil, 1976-1985

	1976- 1978 (a)	1979- 1981 (a)	1982- 1984 (a)	1985
Iron ore				
Total of domestic consumption and exports (apparent supply; 1000 tons)	78787	98405	99960	118500
Domestic consumption				
Iron and steel industry(b) (per cent)	14.5	14.9	16.6	19.1(c)
Independent producers of pig iron(c) (per cent)	4.2	3.8	4.3	5.4
Exports (per cent)	81.3	81.4	79.1	75.5
Pig iron				
Production (1000 tons)	9198	11690	13667	18961
Share of iron and steel industry(b) (per cent)	78.6	80.7	81.2	79.8
Share of independent producers(d) (per cent)	21.4	19.3	18.8	20.2
Share of exports in production (per cent)	(9.6)	(7.3)	(12.1)	(13.1)
Iron and steel scrap				
Consumption by the iron and steel industry (1000 tons)	4684	5951	5665	6998
Share of internally generated (plant) scrap in consumption (per cent)	51.0	50.7	48.6	51.9
(a) Annual average. - (b) Integrated steelworks producing steel and/or cast tubes. - (c) 1985 consumption of iron ore in the steel industry includes 1549000 t of pellets.- (d) Companies producing only pig iron.				

Source: IBS [b, 1986, Tables 42, 44, and 46].

Table A25 - Consumption of Raw Materials by the Brazilian Iron and Steel Industry, 1976-1985

	1976- 1978 (a)	1979- 1981 (a)	1982- 1984 (a)	1985
Charcoal				
Supply (million m <sup>3</sup> )	15.3	18.7	23.6	32.1
Consumption				
Iron and steel industry (per cent of supply)	41.9	44.6	38.6	31.4
Independent producers of pig iron (estimated; per cent of supply)	48.6	44.7	41.0	45.0
Coking coal				
Consumption (1000 tons)	4286	5571	6440	8519
Share of imports in consumption (per cent)	78.1	72.2	84.1	87.5
Electricity				
Consumption (1000 mwh)	6289	8300	9471	11918
Own production in plants (per cent)	9.1	6.1	7.9	10.8
Fuel Oil				
Consumption (1000 tons)	1137	959	582	511
Energy Consumption				
Total (millions of Gcal)	61.3	71.9	79.1	104.3
Per ton of crude steel produced (Gcal/ton)	5.7	5.1	5.1	5.1
Manganese Ore				
Consumption (1000 tons)	146	218	191	271
Ratio of exports to consumption	5.7	5.0	4.6	3.4
Zinc				
Consumption (1000 tons)	18	22	22	31
Purchases in foreign markets (per cent of consumption)	16.7	12.8	0	39.5
(a) Annual averages.				

Source: IBS [b, 1986, Tables 37-54].



Table A26 - The Structure of Employment and Average Wages in Metallurgy and Total Manufacturing Industries of Brazil, 1975 and 1980

	1975							1980 (a)						
	total employees (b)	managers (c)	productive staff			non-productive staff		total employees (b)	managers (d)	productive staff (e)			non-productive staff (e)	
			upper level (f)	medium level (g)	workers	upper level (f)	other			upper level (f)	medium level (h)	workers	upper level (f)	other
Metallurgy														
Employment														
1000	430.0	13.2	2.8	18.1	355.6	1.4	38.9	503.0	18.9	2.3	15.5	420.0	1.8	44.5
per cent	100.0	3.1	0.6	4.2	82.7	0.3	9.1	100.0	3.8	0.4	3.1	83.5	0.4	8.8
Salaries														
Cr \$ million	7963	740	271	841	5076	98	937	87733	11961	1424	5817	59357	945	8299
per cent	100.0	9.3	3.4	10.6	63.7	1.2	11.8	100.0	13.6	1.6	6.6	67.7	1.1	9.4
Average wages (i)														
Cr \$ thousand	18.52	55.86	98.04	46.52	14.27	71.04	24.07	174.4	632.1	630.8	375.5	141.3	522.9	184.9
total employees = 100	100.0	301.7	529.4	251.2	77.1	383.7	130.0	100.0	362.4	361.7	215.3	81.0	299.8	106.0
Total manufacturing														
Employment														
1000	3594.4	131.5	22.1	150.4	2897.6	12.1	380.6	4481.4	166.5	25.7	117.3	3746.5	16.4	409.0
per cent	100.0	3.7	0.6	4.2	80.6	0.3	10.6	100.0	3.7	0.6	2.6	83.6	0.4	9.1
Salaries														
Cr \$ million	58623	5772	2065	6219	35596	958	8014	682773	96764	16461	38875	455927	8392	66354
per cent	100.0	9.8	3.5	10.6	60.7	1.6	13.7	100.0	14.2	2.4	5.7	66.8	1.2	9.7
Average wages (i)														
Cr \$ thousand	16.31	43.89	93.44	41.35	12.28	79.17	21.06	152.4	581.2	640.5	331.4	121.7	511.7	162.2
total employees = 100	100.0	269.1	572.9	253.5	75.3	485.4	129.1	100.0	381.4	420.3	217.5	79.9	335.8	106.4
Average wages in metallurgy (total manufacturing = 1.00)	1.37	1.39	1.18	1.23	1.47	1.07	1.23	1.39	1.30	1.13	1.35	1.47	1.15	1.19
<p>(a) The employment structure of 1980 is not fully comparable to 1975, due to slightly changed definitions of some categories; see also the following notes. - (b) Total number of persons engaged minus proprietors and unpaid family members. - (c) "Presidentes", "diretores", and "gerentes". Probably, mainly managers receive the bulk of gratifications and profit shares not included in regular salaries, so that the latter are relatively low. - (d) "Chefes" and "supervisores" in productive and non-productive activities included (in addition to categories given in note (c)). - (e) Without "gerentes, chefes e supervisores". - (f) "Profissionais de nivel superior". - (g) "Técnicos de nivel medio", "mestres", and "construtores". - (h) "Mestres" and "construtores". - (i) Total salaries divided by number of employees, i.e., annual wage payments per employee in the respective category.</p>														

Source: IBGE [b, 1975; 1980, Part A, Table 25]; own calculations.

Table A27 - The Capacity of Coke-Based Blast Furnaces in Brazil and Japan, 1985

Inner volume (m <sup>3</sup> )	Brazil			Japan		
	number	per cent of total number	capacity (1000 tons of pig iron)	per cent of total capacity	number	per cent of total number
Under 2000	5	55.6	3846	28.4	18	33.3
2000 - 4000 exclusive	3	33.3	6395	47.3	21	38.9
4000 and over	1	11.1	3285	24.3	15	27.8
Total	9	100.0	13526	100.0	54	100.0

Source: Suma Económica [1985, p. 68]; Kawata [1986, p. 48].

Table A28 - Steel Making Capacity by Sector and Process in Brazil, 1984

Sector/plant	Crude steel capacity (1000 tons per year)		
	basic oxygen furnaces (a)	electric furnaces (a)	SIEMENS MARTIN furnaces (a)
Flat products sector			
CST	3370	-	-
CSN	2900	-	-
COSIPA	3000	-	-
USIMINAS	3600	-	-
Subtotal	12870	-	-
Non-flat products sector			
8 plants with a capacity of less than 100000 tons per year	46 (1)	353 (7)	-
16 plants (b) with a capacity of between 100000 and 400000 tons per year	270 (2)	2692 (12)	854 (4)
2 plants with a capacity of more than 400000 tons per year	620 (1)	950 (1)	-
Subtotal	936 (4)	3995 (20)	854 (4)
Special steel sector (c)			
ACESITA	500	.	-
MANNESMANN	730	.	-
8 firms including ACESITA and MANNESMANN	.	1518 (d)	-
Subtotal	1230	1518	-
Grand total	15036	5513	854

(a) Number of plants in parentheses. - (b) Some plants utilize more than one process. - (c) ACESITA produces flat and non-flat products; all other firms only make non-flats. - (d) Electric steel-making capacity is between 100000 and 400000 tons per year for 7 firms, and below 100000 tons for one firm.

Source: Suma Económica [1985, pp. 52-79].

Table A29 - Real Exchange Rate (a) and Price Indices for Steel Exports, 1970-1985 (1977 = 100)

	Real exchange rates			Export unit values			Wholesale export price index, all iron and steel products	Nominal exchange rate index
	total rolled exports	flat rolled exports	non-flat rolled exports	total rolled exports	flat rolled exports	non-flat rolled exports		
1970	96	69	96	61	44	61	21	33
1971	91	66	91	62	45	61	24	36
1972	93	70	89	61	46	59	28	42
1973	98	69	99	73	51	73	32	44
1974	163	106	171	150	98	158	45	48
1975	144	94	156	148	97	160	59	58
1976	120	98	116	116	95	112	74	76
1977	100	100	100	100	100	100	100	100
1978	113	86	112	115	88	114	132	128
1979	159	99	181	157	98	178	188	191
1980	196	117	281	169	101	242	322	374
1981	164	102	186	156	97	177	632	664
1982	146	95	168	135	88	155	1173	1272
1983	190	133	190	107	75	107	2308	4087
1984	228	157	236	120	82	124	6882	13087
1985	240	165	248	114	78	117	20824	44005

(a) Calculated by multiplying an index of the nominal exchange rate (Cr \$/US \$) by an index of export unit values for each category of exports, and dividing by the Brazilian wholesale price index for all iron and steel products. Separate price series for flat and non-flat rolled products in the domestic market have not been available.

Source: Own calculations based on data from Conjuntura Económica [various issues], and CONSIDER [1986].

Table A30 - Steel Consumption and GDP Growth 1950-1984 - Summary of Regression Results (a) for Selected Countries

	Secular rate of growth or decline	Income elasticity	Growth rate of GDP at which	
			steel consumption remains constant	steel intensity remains constant (b)
Industrialized market economies				
Sweden	-11.6	4.0	2.9	3.9
West Germany	- 4.4	1.7	2.6	6.4
United States	-11.2	3.8	3.0	4.0
France	- 9.6	2.7	3.5	5.6
Netherlands	- 6.4	2.2	2.9	5.5
Canada	-10.3	3.1	3.3	4.8
Australia	-10.3	3.2	3.2	4.7
Japan	-12.3	2.7	4.5	7.2
United Kingdom	- 8.9	3.6	2.5	3.4
Italy	- 5.2	2.5	2.1	3.5
NICs				
Spain	-10.7	3.6	3.0	4.1
Singapore	-22.0	3.8	5.9	8.0
Greece	- 2.0	1.8	1.1	2.6
Yugoslavia	- 4.7	1.8	2.6	5.9
South Africa	- 7.6	2.8	2.7	4.2
Argentina	- 3.6	2.6	1.4	2.3
Mexico	-13.2	3.4	3.9	5.5
Brazil	-10.3	2.4	4.3	7.3
Malaysia	-24.4	5.3	4.6	5.7
South Korea	- 1.4	2.1	0.7	1.3
Turkey	- 8.0	3.2	2.5	3.7
Developing countries				
Nigeria	4.6	1.7	-2.6	-
Thailand	- 6.0	2.4	2.6	4.4
Indonesia	-14.4	4.6	3.1	4.0
India	3.9	0.0	-	-
High-income oil exporter				
Saudi Arabia	18.6	0.7	-	-
Centrally planned economies				
GDR	-16.4	4.4	3.7	4.9
CSSR	- 0.4	0.9	0.4	-
Poland	- 0.4	1.0	0.4	-
Soviet Union	- 4.2	1.5	2.8	8.1
Rumania	- 0.2	1.0	0.2	-

(a) Coefficients of determination between 0.74 and 0.99. - (b) I.e., apparent steel consumption grows as fast as GDP.

Source: Wienert [1985, pp. 150-1]; own compilations.

Table A31 - The Income Elasticity of Apparent Steel Consumption - Cross-Country Regression Results, 1985

Country sample	Apparent steel consumption as a function of gross domestic product (double log form)		
	income elasticity of steel consumption(a)	adjusted R <sup>2</sup>	standard error of the regression
All countries (70)	1.13	0.86	0.72
Lower-middle-income (22)	1.15	0.77	0.67
Upper-middle-income (18)	1.36	0.67	0.81
Industrial market economies (19)	1.08	0.97	0.26
	Apparent steel consumption per head as a function of gross national product per head (double log form)		
	income elasticity of steel consumption(a)	adjusted R <sup>2</sup>	standard error of the regression
All countries (70)	0.99	0.75	0.73
Lower-middle-income (22)	1.26	0.57	0.63
Upper-middle-income (18)	0.11 (b)	-0.06	0.74
Industrial market economies (19)	0.80	0.53	0.27
(a) All coefficients are significant at the 1 per cent level except otherwise indicated. - (b) Insignificant.			

Source: IISI [f, 1986]; World Bank [1987]; own calculations.

Table A32 - Trade Measures Imposed by Industrialized Countries Against Steel Imports (Except Steel Pact Agreements), 1979-1984

Products affected	United States	EC	Canada
Carbon steel sheets (steel sheets for EC)	1982: countervailing duties, voluntary export restraints, antidumping duties, global quota	1979: antidumping duties for all steel sheets	1982: antidumping duties
Laminated steel wire	1983: antidumping duties, global quota		
Carbon steel wire (steel wire for EC)	1982: countervailing duties, antidumping duties, voluntary export restraints	1982: antidumping duties for all steel wire	
Steel tubing	1983: countervailing duties, antidumping duties, voluntary export restraints		
Stainless steel bars and wires	1983: countervailing duties, bilateral voluntary export quota restraints		1984: antidumping duties
Alloy steel bars	1982: countervailing duties, bilateral quotas, voluntary export restraint		1984: antidumping duties
Pig iron	1979: countervailing duties		
Steel pipes	1984: countervailing duties, antidumping duties		
Cast-iron connections	1984: countervailing duties		
Alloy steel sheets			1984: antidumping duties
Chrome steel wheels			1981: antidumping duties

Source: Amelung [1988, Table 3].

Table A33 - Released Subsidies in the EC, 1980-1985 (million Ecu)

	Subsidies for interest payments			Venture capital paid in as shares or loans			Debt/equity conversion					
	1984	1985	1980-1985	1984	1985	1980-1985	1984	1985	1980-1985			
Belgium	83	50	166	390	203	1216	1425	37	1740			
West Germany	1960	279	2811	-	-	-	-	-	-			
France	-	-	150	805	2835	8298	-	-	-			
Italy	388	1931	3354	2085	4552	9902	-	-	-			
United Kingdom	168	80	294	1153	1003	5346	-	-	-			
Ireland	129	-	44	-	33	162	-	-	-			
Netherlands	19	-	97	222	-	222	-	-	-			
Luxembourg	141	-	211	59	104	165	-	-	-			
EC total	2888	2340	7127	4714	8730	22350	1425	37	1740			
	Loans with preferential interest rates			Securities, guarantees and loans on market terms			Other subsidies			Total subsidies		
	1984	1985	1980-1985	1984	1985	1980-1985	1984	1985	1980-1985	1984	1985	1980-1985
Belgium	110	-	187	499	27	947	-	-	-	2507	317	4256
West Germany	-	-	68	704	42	935	-	-	29	2664	321	3844
France	-	-	-	-	-	693	-	-	-	805	2835	9141
Italy	1512	1727	3600	-	-	-	-	-	-	3985	8210	13856
United Kingdom	-	-	-	-	-	-	-	-	-	1321	1083	5640
Ireland	-	-	-	6	-	58	-	-	-	135	33	264
Netherlands	-	-	-	-	-	137	-	-	-	241	-	456
Luxembourg	1	-	27	182	-	226	-	-	2	383	104	631
EC total	1623	1727	3882	1391	69	2996	-	-	73	12041	12903	38169
Note: These figures reflect only those subsidies that appear in the budgets of the respective countries.												

Source: Krägenau [1986, p. 80-82]; own calculations.

#### 4. Glossary of Technical Terms (Steel Industry)

Alloy steelmakers	produce special steel products of different types. May or - more often - may not be engaged in reduction of iron from raw materials.
Basic oxygen furnace	major and widely used post-World War II process to produce crude steel, in which oxygen is injected into the steelmaking furnace. Needs at least a 60 per cent hot metal (molten pig iron) charge. Heavy user of coal.
Blast furnaces	furnaces for the reduction of iron ore into pig iron, using mainly coke (or charcoal), iron ore, and fluxes.
Blooms and billets	semi-finished product used in the rolling of non-flat products. Blooms are used for heavy shapes such as beams for bridges and buildings, and billets are used for light shapes, reinforcing bars, and wire rod.
Cold-rolled sheets	sheets of reduced thickness, used to make automobile bodies, appliances, furniture; also reprocessed to be sold as tempered sheet, or coated with tin or zinc.
Continuous casting	a process for solidifying steel of a continuous strand rather than individual ingots. More energy-efficient than ingot casting, as the liquid steel is not allowed to cool until formed into semi-finished products.
Direct reduction technology	processes for reducing iron ore to sponge iron without exceeding the melting temperature of the metal. Alternative to the blast furnace, using natural gas or low-quality coke as a reducing agent.
Electric arc furnace	technology for the production of crude steel which can take a 100 per cent cold metal charge (sponge iron or scrap).
Flat products	include plates, hot-rolled and cold-rolled sheets and coils, galvanized and coated sheets. Welded tubes and steel strips are transformed flat products.



Hot-rolled sheets	sheets less than one eighth of an inch thick, and three to five feet wide, sold as such or reprocessed for the preparation of cold-rolled sheets.
Ingot casting	process whereby liquid crude steel is poured into ingot moulds and allowed to cool, before being reheated and rolled into semi-finished products.
Integration/Integrated steelmaking	an indication of the extent to which a given firm produces the materials, components, etc. that constitute inputs to its final products. An integrated steel firm first reduces iron ore to iron, then converts iron into crude steel, and lastly transforms crude steel into the final products through rolling, drawing, or casting.
Linz-Donawitz technology	See Basic oxygen furnace.
Mini mill	typically a small semi-integrated steel mill, scrap-based and using electric furnaces to produce a limited range of non-flat products. Production between 0.2 and 1.0 million tons. May also be integrated, using direct reduction technology to produce the sponge iron needed to feed the electrical furnace.
Non-flat products (or shapes)	include rails and track accessories, structural shapes, bars, concrete reinforcing bars, wire rod, and seamless tubes. Drawn products such as smooth wire and barbed wire are usually classified as a separate group.
Open Hearth furnaces	(Siemens-Martin technology) an obsolete steel-making technology. Furnaces accept both pig iron and cold metal charge (scrap or sponge iron). Relatively intensive use of fuel oil and coke.
Ordinary steel products	general classification, including both carbon and low-alloy steels with less rigid quality and form specifications.
Pellets	refined iron ore.
Quality of steel products	may be expressed in terms of surface characteristics, physical properties, or chemical composition.

Semi-finished products	intermediate products before the final rolling stage (slabs, blooms and billets).
Semi-integrated plants	steel plants which do not reduce iron ore to iron but operate with already processed raw materials, such as scrap, pig iron, or sponge iron. They use mainly electric arc furnaces and specialize in the production of certain non-flat products.
Siemens-Martin technology	see Open Hearth furnaces.
Sinter	refined iron ore.
Slabs	semi-finished product used in the rolling of flat products.
Special steel products	general classification of carbon and alloy steel products with high purity requirements and very rigid quality and form specifications; include stainless, high-carbon, and silicon steel.
Steel plate	flat product made from slabs through the plate mill, used to build storage tanks, ships or other steel vessels.

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