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MONITOR - SAST ACTIVITY
STRATEGIC ANALYSIS IN SCIENCE AND TECHNOLOGY

THE NEEDS AND POSSIBILITIES FOR COOPERATION BETWEEN SELECTED ADVANCED DEVELOPING COUNTRIES AND THE COMMUNITY IN THE FIELD OF SCIENCE AND TECHNOLOGY

(Sast Project N° 1)

COUNTRY REPORT ON BRAZIL

by
Constantine Vaitsos, Athens University

December 1990

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FOREWORD

This report has been prepared for the Strategic Analysis in Science and Technology Unit (SAST) of the Directorate-General for Science, Research and Development of the Commission of the European Communities. SAST activities are part of the MONITOR Programme which aims to identify new directions and priorities for Community research and technological development (RTD) policy and to help show more clearly the relationship between RTD policy and other Community policies.

For questions already identified as of interest for the development of Community policy, SAST projects provide an investigation of the perspectives opened up by science and technology. SAST projects thus serve as an input to the process of policy formulation. In the case of the SAST project to which this report contributes, "The needs and possibilities for cooperation between selected advanced developing countries and the Community in the field of science and technology", the context of policy questions includes the evolving economic relations between the Community and these countries, the interest to the Community of promoting international cooperation in science and technology with various types of countries, and the Community's role in European science and technology.

This report is one of a set of country studies carried out for the project. The set comprises the Republic of Korea, Thailand, other ASEAN countries, the People's Republic of China, India, Brazil and Mexico. An overall strategic review will also be available in 1992.

It should be borne in mind in reading the country studies that the fieldwork on which they are based was carried out almost entirely in the country concerned. The points of view of European industrialists/researchers/policy makers were not explicitly sought for this part of the project. (They will be sought as part of the work for the overall strategic review.)

SAST presents this report as a stimulus to reflection and debate within the European Community on the best strategies to adopt towards a group of increasingly important countries. It must be stressed, however, that the orientation and content of reports prepared for SAST cannot be taken as indicating the considered opinion of policy advisors within the Commission services.

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INTRODUCTION AND READERS' GUIDE

The main purpose of this report consists in providing a strategic review and a decision base about the main areas of possible cooperation in science and technology between the European Community and Brazil - one of the advanced developing countries having been selected for examination within the context of SAST Project N° 1. Such a cooperation is broadly defined to include diverse knowledge intensive economic activities (as in trade of machinery, technology embodying inputs and factoral flows, corresponding production operations, direct investment commitments, etc.), together with R&D and knowledge diffusion mechanisms, training, technological infrastructure and related initiatives on scientific and technical development.

The structure of this Report consists of two main parts, the Strategic Review and the Decision Base respectively, plus annexes, preceded by an Executive Summary.

The brief Executive Summary does not intend to present a synthesis of the diverse elements and analysis of the Report but, instead, to highlight some overriding considerations. The latter transcend the rest of the main conclusions and define the context within which the Brazilian S&T system can be understood. They also condition the possible initiatives for the promotion of an effective and knowledge intensive cooperation with the European Community.

Part I, under the title of Strategic Review, represents the core of the Report. It contains a comprehensive synthesis of the Brazilian S&T system as it has evolved within the process of the country's overall development performance and its broader socio-economic realities. Initially, attention is drawn to some key macroeconomic conditions which greatly affect the overall evolution of sectoral performance and the policy initiatives of distinct economic actors. Special reference is being made to the nature and severity of the economic disequilibria experienced by Brazil during the 1980's, and to the importance and structure of the country's achievements in industrial development over the last quarter of a century. Subsequently, the contents of government and business policy options are analyzed and particular reference is made to the main characteristics of the country's external sector transactions. Also, each of the principal components of the science and technology system of Brazil is being addressed and succinctly evaluated.
Finally, a set of priority proposals are being presented in what appear to be the more promising areas for advancing a concerted effort on science and technology cooperation between Brazil and the European Community.

Part II, under the title of Decision Base, provides, in more detail, the supporting evidence of the Report. It is divided into four main sections.
The first covers the conditions and constraints of the Brazilian macroeconomic performance, the paramount importance of the debt burden and the strategic options presently confronting the industrial sector in the pursue of greater international competitiveness.
Section two focuses on the business and broader economic expressions of Brazil's external sector with the aim to identify the country's evolving position in the international economy

and the relative presence of European economic interests in meeting the needs and prospects of the Brazilian productive system.
Section three analyzes the main areas, characteristics and potentialities of the country's S&T system. In this case, emphasis is being placed on the identification of the country's knowledge specialization and on the representative aspects of the institutional, skill intensive and technological resource commitments and activities. Also, the analysis focuses on the key areas and on the deficiencies of the Brazilian S&T system, so as to conclude with the required changes within which a European cooperation will be of greater mutual value.
Finally, section four presents a more sectoral perspective in two fields (biotechnology, and electronics and informatics) by combining both business and strictly S&T references and analysis.

Statistical tables and background information are mainly provided in the Annexes of the Report. The sources of this information originate from published and unpublished official and business publications and from the interviews undertaken in the course of this SAST Project.

The country research and preparation of the main statistical supporting evidence were undertaken by Professor Fabio Erber of Brazil. Sectoral analysis in the field of biotechnology was prepared by Paolo Bifani of Italy and in electronics and informatics by Ricardo Soifer of Argentina.

I am particularly grateful to Bruno Schmitz and to the SAST staff for their efficient support and encouragement in executing this project. Also thanks are due to Kurt Hoffman for his overall co-ordinating guidance.

Constantine Vaitsos
Athens University
December 1990

EXECUTIVE SUMMARY

The overall context and major characteristics of the present process of development in Brazil can be addressed in the light of some key considerations. The latter are also crucial in defining the main venues for a concerted Brazilian-European Community cooperation on science and technology (S&T). These considerations include :

First, not only in geographic but also economic terms, Brazil is a country of continental proportions with a major potential in the world economy. Its present level of GDP of around U.S. $ 350 billion is between two and a half to three times larger than that of Mexico's and it far exceeds the combined equivalent of the rest of South America. Also, over the last two decades or so, Brazil has developed a particular international presence which, in its export activities, is strongly oriented -- close to or more than one third of total exports -- towards the markets of lesser advanced economies. Such a performance is directly linked to an increasingly sophisticated domestic industrial and managerial base. Furthermore, Brazil has very significant prospects for future growth which could originate from the still untapped opportunities of its internal market. The latter confronts the socio-economic realities of an income distribution which is one of the worst among the developing countries, with the vast majority of its large and growing population (presently approaching 150 million inhabitants) still living at low income or poverty and sub-poverty levels.

With respect to such an overall economic performance and its potential, the European Community represents today Brazil's larger foreign partner. In all major categories of external economic transactions (trade, foreign direct investments, technology and services), the European productive and broader economic system surpasses in its activities/relations with Brazil the equivalent of the U.S. and constitutes a multiple of the corresponding Japanese presence.

The combined implications of all of the above make Brazil the most interesting Latin America case as far as the European economic interests are concerned. They also project Brazil as one of the more promising economies among developing countries with which the Community has long standing and active economic relations. Consequently, Europe's approach on S&T and overall economic cooperation with Brazil needs to be structured with a long term perspective and with an as comprehensive as possible orientation. The latter should not be restricted by either immediate differences over specific negotiations (e.g. the intellectual property provisions, TRIPs, in the Uruguay Round) nor by approaches which mainly focus on legitimate yet narrow distributional concerns. Instead, an effort should be made to address areas and issues which offer opportunities for significant mutual benefits and for advancing longer term strategic economic alliances between Brazil and the Community.
Second, the country presently faces a crisis with two main macroeconomic expressions :

(a) It is a crisis of its finance structure, where the external and internal indebtedness of the public sector became enmeshed with high inflation and major resource demands posed by the servicing of the foreign debt. Although the internal side of this vicious and cumulative spiral of financial disequilibria may be broken by measures taken recently by the Brazilian government, without a renegotiation of the country's foreign

debt with a primary objective to reduce its macroeconomic burden, sustainable economic recovery cannot be expected to be achieved. Instead, resource commitments and activities which advance Brazil's S&T system and induce technology intensive trade and investments inflows from abroad will continue to be seriously hampered.

As far as European interests are concerned in this area of relations with Brazil, the relevant direct trade-offs are between, on the one hand, a continuing stalemate and decreasing economic prospects with mounting debt servicing claims and, on the other, an expansion of trade and investment relations with a relatively high technological intensity in which Europe could be a primary source of supply. Thus, the re-evaluation of the debt issues from a developmental point of view constitutes a strategic choice for the Community's interests, including those on science and technology cooperation, with the Brazilian economy. For such a change of policy orientation, the longer term prospects of Europe's relations with Brazil appear to be better served through a more assertive presence in matters which take explicitly into account the implications of the debt burden on the broader development horizon, instead of continuing to largely follow or respond to periodic U.S. initiatives in this area.

(b) The second expression of the Brazilian macroeconomic crisis concerns the exhaustion of the dynamism of past development strategies which have led Brazil to become one of the more "closed" economies (e.g. the import coefficient in manufactures generally ranges between below 5 % and 10 %). Such levels of "self-sufficiency" have also meant that access to the local production base is central to the promotion of effective international cooperation initiatives.

The political acceptance for a gradual and consistent opening-up of the economy presently constitutes a major government and business realization. This has been brought about, as a key policy watershed, by the depth and intensity of the crisis of the 1980's. The advancing liberalization of the Brazilian economy needs, though, to take into account some central strategic issues :

- The opening-up of the Brazilian economy will tend to be much more cautious and selective than others in Latin America.
- The industrialization options, which will prove again to constitute a key engine for overall growth, need not be caught within crude policy choices of import substitution versus export promotion. Instead, much more complex realities exist and eclectic policies are likely to be followed which combine export promotion with a fuller understanding of the growth potential of the internal market.
- The promotion of a more open and competitive economy requires -- at both government and business decision making levels -- a closer linkage between industrial (or agricultural) sectoral/corporate policies and S&T resource commitments and initiatives. In the latter case, Brazil, despite its advances, still falls far short of its relative economic and industrial presence within the world economy.

Overall, in the course of the last two-three decades, Brazil has developed a level of institutional and productive sophistication which calls for a more complex and in depth understanding by European economic actors. It is only through such upgraded and more demanding relations that successful initiatives of cooperation in S&T can be advanced, thus fostering broader and longer term economic ties.

PART I : STRATEGIC REVIEW

I.1. - MAIN ISSUES

I.2. - EXTERNAL SECTOR TECHNOLOGY INTENSIVE ACTIVITIES

I.3. - THE S&T SYSTEM : COMPLETE BUT WEAK AND HETEROGENEOUS

I.4. - PROPOSALS FOR S&T COOPERATION INITIATIVES BETWEEN BRAZIL AND THE EUROPEAN COMMUNITY

I.1. MAIN ISSUES

I.1.1. BRAZIL'S ECONOMIC SIZE AND EC'S RELATIVE PRESENCE IN EXTERNAL SECTOR TRANSANCTIONS

In both geographic and economic terms, Brazil is a country of continental proportions. Its territory covers an area of more than 8.5 million sq.km. In the end of the 1980's, its net domestic product was in the range of U.S. $ 350 billion, a figure which was between two and a half to three times that of Mexico's, and far exceeded the combined equivalent of the rest of the South American economies. Also, at that time, its employment level surpassed fifty million, while in its industrial activities Brazil occupies the ninth position in the world production of manufactures. The country's annual merchandise exports averaged in excess of U.S. $ 26 billion in the 1983-88 period with a total outstanding external debt of about U.S. $ 115 at the end of 1988. Its net debt service ratio approached 45 % by the end of the previous decade.

After a period of impressive growth (average 8 % per year for the three decades 1950-80) leading to a per capita GDP increase of 66.4 % in the '70's, Brazil entered into a long period of stagflation and of overall and acute economic crisis with severe macro-economic disequilibria in both its external and internal sectors. At the same time, the dark side of the Brazilian economic growth, its profound inequalities, accentuated seriously. (The Gini concentration index of personal income distribution continued to deteriorate reaching 0.60 in 1987). Poverty deepened, with half of the population of the Brazilian Northeast living today at per capita income levels below 25 % of the real minimum wage indexed at 1980 prices. Also, large poverty pockets exist throughout the urban centres and elsewhere in Brazil portraying severe conditions of economic misery.

In the economic sphere, the aggregate participation of EC business interests in Brazil is portrayed by the following key indicators : in 1988, out of a total merchandise volume of imports amounting to U.S. $ 14.6 billion (they were close to U.S. $ 23 billion in 1980), the European Community accounted for more than 22 %, most of them in mature technology intensive goods. Additional exports to Brazil reported as originating from other European countries, especially from Switzerland, were often linked to EC business interests, for fiscal and other reasons. The U.S. share ranged between 18 % - 21.4 % during the decade and the Japanese between 4.2 % - 6.6 %. On the export side, the EC accounted for close to 28 % of the total, the U.S. for 26 % and Japan for less than 7 % in 1988.

As far as foreign direct investments are concerned, from the 1988 registered total stock, the EC share was around 36 %. If we include FIAT's and other W.European companies' investments in Brazil, which in the official statistics are reported as originating from Switzerland, then the EC's share should exceed the 40 % level. In comparison, registered U.S. investments are less than 29 % and Japan's less than 10 %. Taking into account the relatively high presence of European investments in joint ventures, as compared to the strong preference for wholly owned subsidiaries by U.S. and Japanese firms, the effective business dimensions of the EC relative presence in Brazil is even higher than the figures given above.

The extent of EC industrial interests in Brazil sharply distinguishes this case from the equivalent of Mexico or from other Latin American countries. Furthermore, the relative magnitude of the European presence makes it highly succeptible to sector wide and

macroeconomic considerations, especially with respect to the resolution of the foreign debt crisis, to which we will return in subsequent pages and in our proposals. The macro environment of Brazil's economy is therefore central to the broader EC business interests, especially as far as technology intensive goods and services are concerned in all categories of productive activities. Consequently, proposals by the Commission on S&T cooperation with Brazil should, in addition to specific project and activity initiatives, bear in mind explicitly the wider dimensions of such concerns.

I.1.2. THE NATURE AND DEPTH OF THE BRAZILIAN ECONOMIC DISEQUILIBRIA AND THE RELATED ECONOMIC CRISIS

The seventies are important in understanding the present crisis in Brazil not only for reasons of historical proximity. In fact, it was during that decade, especially in its second half, that the seeds of the crisis were sown and, at the same time, the productive conditions were established which may support an exit from the present plight of the Brazilian economy.

What distinguishes the case of the Brazilian macroeconomic disequilibria and related financial crisis from other experiences like those of Argentina, Mexico, etc..., is that in Brazil the heavy indebtedness is very much related to an ambitious, even if not very efficient in shorter term competitive market conditions, industrial development program (II PND), together with a number of highly adverse external sector parameters also present in other country experiences. Thus, although Brazil got mired, during the 1980's, in its worst economic crisis -- worse than the depression of the 1930's, according to several observers -- the productive and institutional base already developed could provide opportunities for a recovery, given some key and appropriate policy reorientations.

The crisis was indeed very profound and the resulting stagflation took extreme forms. Inflation rates increased from an average of 33 % per year in the '70's to more than 1700 % in 1989. The inflationary spiral was the complex result of a number of factors involving exogenous shocks, public debt, stabilization policies, indexation and expectations. Also, accustomed to very high rates of growth, which as noted above averaged about 8 % per year over a 30-year period after 1950, per capita GDP declined during the decade of the 1980's. Even more important, gross capital formation fell from an average 23 % of GDP to 18 % in 1981-88.

The expansionary policies of the 1970's were partly financed by a massive and unequal transfer of internal resources of a mainly indirect redistributive nature. At the same time, the net tax rate fell from 14 % of GDP in 1975 to 5.7 in 1987 leading to serious fiscal imbalances. Nonetheless, the major characteristic of the finance strategy adopted for growth-cum-debt was the reliance on foreign credits. The gross external medium and long term debt increased from U.S. $ 17 billion in 1974 to U.S. $ 50 billion in 1979.

During the 1980-88 period, Brazil paid U.S. $ 84 billion for servicing its external debt, equivalent to 131 % of the total such debt in 1980. It still ended up with a total outstanding external debt in December 31, 1988, of U.S. $ 114.9, of which only $ 11.5 billion referred to non-guaranteed private debts. In 1989, the government stopped payments on the foreign debt, in a "tacit moratorium". The full scope of its strategy for renegotiating the external debt is still evolving after some recent government initiatives made public in late 1990.

The debt related payments amounted annually to almost 5 % of GDP between 1984-88. This figure is about equivalent to the drop in the country's gross fixed capital formation. Such a sustained and major internal resource drainage and its foreign exchange counterpart required corresponding adjustments in the functioning of the economy not only directly but also through crucial indirect effects. Successive Brazilian government policies from 1979 onward, put the main burden of adjustment on the shoulders of the wage earners, the poor and on the State itself.

The main immediate target for expenditure cuts involved the program of public sector investments, including the R&D and educational budgets, and, more importantly in quantitative terms, the investments of state enterprises. They were jointly reduced by three percentage GDP points, or about 60 % of the equivalent required for resource transfers abroad. Furthermore, the mounting interrelationship between external and internal debt (so as to control the liquidity effects from the surge in exports needed to pay the debt requirements) and the combined functioning of the financial and price systems, had serious impacts on the expectations and performance of the private productive sector : purely financial returns and speculative resource commitments became more attractive for private profitability purposes than investments in real productivity increases and competitive cost effective reductions.

The whole process is, thus, directly and indirectly mortgaging Brazil's future performance and fundamentally influencing the country's S&T system. It also has a major and immediate impact on Brazil's technology intensive imports, which originate significantly from the EC and which, in total, amounted to almost a quarter of Brazil's overall import bill (including petroleum) in 1983.

I.1.3. INDUSTRY STRUCTURE AND ITS IMPORTANCE

The development of the Brazilian productive base since the Second World War has been led by the manufacturing sector. Industry played the role of the engine to Brazil's growth, increasing its share in GDP from a fifth in 1950 to a third in 1980, while the overall economy was experiencing a high growth performance. Industry's relative share fell somewhat during the subsequent years of economic crisis to 30 % by 1987.

The importance of this process was not only quantitative. It also created significant productive structures and key economic actors and institutions. Furthermore, local industrial production presently supplies most, if not practically all, of the internal demand. Brazil's overall import co-efficient in manufactures is less than 5 % with some categories of technology intensive products (e.g. mechanical, transport, electrical and electronic goods going up to 10 % or higher of local demand). This makes Brazil one of the most "self-sufficient" and "closed" economies, in which access to the local production base is central for the promotion of international cooperation initiatives. Yet, important considerations are presently advanced about the need to open-up the economy so as to benefit from the diffusion of embodied and disembodied technology inputs, and to increase the competitiveness of the Brazilian productive base.

Two important structural aspects need to be highlighted in reviewing Brazil's industrial development path. They are of special interest in view of their direct relevance to the potential initiatives on S&T cooperation between this Latin American country and the European Community.

First, Brazil's sustained industrial development over three decades after WWII, led to a highly integrated production structure with local intra-industrial sales accounting for over 40 % of total industrial production in 1980. This is a pattern more akin to industrially developed economies than to other LDCs. Yet, the deepening of such a national domestic integration process took place under a comprehensive system of import protection and market "closedness" leading to various degrees of relative inefficiency.

The gradual opening-up of the Brazilian market and the need to attain international competitiveness has already created pressures to expand investments, when the macroeconomic conditions permit it on an industry-wide level. The aim is to promote new forms of organization of production with emphasis on total quality and cost reduction, and various levels of automation. The needs for productivity increases and industrial restructuring cut across all industrial complexes. The market opportunities for foreign exporters in a possible surge of such a change in investment patterns in Brazil are significant and require closer monitoring.

Second, the share of technologically dynamic sub-sectors in the overall manufacturing value added increased from 23 % in 1970, to 31 % in 1980 and it reached 33 % in 1987 even under the prevailing crisis conditions of the last decade. This trend suggests, again, a pattern of convergence with industrially advanced countries. Yet, serious differences exist stemming from the realization that, in Brazil, chemicals (especially geared to basic products) tend to be more important, in relative terms, than in the industrially advanced countries. In contrast, electrical, electronic and mechanical products lag far behind, especially in the machinery sector and generally in the product categories more responsive to technical progress and its diffusion. Similarly, in the chemical sector the technologically more relevant inputs are imported and serious gaps exist in the promising and dynamic areas of fine chemicals, biotechnological processes and products, new materials, etc...

Such a differentiated analysis of Brazil's present industrial structure and its future needs could assist in focusing on major opportunities for European technology intensive producers of goods and services. An overall investment and industrial production increase in Brazil is certain to include new foreign entries with serious resource commitments in its economy in a number of product and subsectoral categories. Here, a targeted presence from the European Community will assure a continued strong participation in the emerging new cycle of Brazil's industrialization process while it moves from more traditional and technologically mature import substituting activities to more competitive and new product groups. In conclusion, S&T cooperation by the EC needs to be more intimately interwoven with industrial strategy, as Brazil is also moving in a similar marriage of policy instruments within the management of its own economy and future growth.

I.2. EXTERNAL SECTOR TECHNOLOGY INTENSIVE ACTIVITIES

I.2.1. FOREIGN TRADE PATTERNS IN PRODUCTS AND IN KNOW-HOW

With the exception of India, all relevant quantitative indicators on the degree of "openness" to foreign trade (e.g. imports and/or exports as a percentage of GDP) put Brazil at the bottom of the list. Restrictions on imports, which constituted a strategic feature of the industrialization policies followed in the past, included not only high nominal tariffs in various product categories, but mainly a wide variety of imports regimes, special permit requirements and prohibitions. These were managed primarily by a specialized organization (CACEX), the Central Bank and, in some sectoral cases, by other government agencies, like the Informatics Secretariat (SEI). The foreign debt servicing requirements of the 1980's placed an added pressure for import reductions. Thus, the 1980 import bill was 57 % higher than the equivalent reported for 1988. This was mainly achieved through a process of rationing foreign exchange resources on the basis of priority lists.

With a number of trade reforms introduced since 1987, an emerging consensus has evolved during the last two-three years which is affecting the policy orientation of the new government. It is based on the general conclusion that it is necessary to reduce both the level and the nature of import controls in Brazil for two main policy objectives : (i) to exert pressures on local producers to reduce prices and (ii) to foster the technological and productivity capacity of Brazil through embodied and advanced know-how imports. It is also, though, a matter of general consensus in Brazil (regardless of the rhetoric and occasional polemics) that import liberalization must be selective in order to avoid disruptions in the productive tissue of the country of the type which characterized Argentina and, more recently, Mexico. The close and comprehensive monitoring of such selective liberalization policies complemented by a targeted approach of credit facilities could prove to be crucial in fostering technology intensive exports from the EC to Brazil during the coming years. It could also assist in countering corresponding entry strategies by US and Japanese firms.

Few items accounted for almost two thirds of total imports during the last decade and a half (ranging from about US $ 12 billion to $ 23 billion depending on the year, with a peak in 1980/81). These items include oil (varying significantly according to oil price levels and substitution capabilities of PETROBRAS and the Pro-Alcohol Programme), cereals, electrical and non-electrical machinery (the latter being highly procyclical and greatly affected by the debt crisis) and chemicals (mainly fine chemicals and intermediary products which often reflect related party transactions).

Among Community countries, the F.R. of Germany concentrates about 40 % of EEC exports to Brazil, France and Italy share 16 % each, with the U.K. closing the rank of major suppliers with about 11 %. These four represent more than 80 % of Brazilian imports from the EEC or about three times the equivalent from Japan in 1988.

Non-factoral service (NFS) imports have been maintained at 0.5 % of GDP or, on the average with respect to merchandise imports, 16 % in the period 1977/81 and 20 % thereafter. Almost half of such service imports concern transport payments. Other services include technology related payments or 15 % of NFS imports, most of which (70 %) concern equipment leasing, largely for oil exploration, and related specialized technical assistance inputs.

On the whole, total registered payments for disembodied know-how imports peaked in 1980 with US $ 321 million. During the following decade, the economic crisis and the severe balance of payments constraints brought down progressively and steadily such payments to US $ 135 million by 1988. Of the total foreign exchange expenditures for imported technology during the ten-year period 1979-88, amounting to US $ 2,238 million, the following break-down was reported :

- for patents and trademarks : 3.2 %, explicitly restricted by legislation limiting inter-affiliate payments;
- technical services : 80.4 %, most of which were for equipment leasing as noted above;
- licensed technology : 9.2 %, mainly concentrated in custom-built machinery and equipment, metallurgy (steel), chemicals and informatics;
- others : 7.2 %, mainly diverse consulting services.

Total Brazilian exports jumped from less than US $ 10 billion in the pre-1976 period, to $ 20 billion in 1980, reaching $ 33.8 billion by 1988. Notwithstanding this spectacular performance in the export drive and a number of specific new success cases (e.g. aircraft, machine tools, armaments), there is a growing concern in Brazil about the international competitiveness of its exports. Although Brazil ranks ninth in the world as a producer of manufactures, it is only nineteenth in terms of such exports. Some commentators have noted the "spurious nature" of Brazil's export growth. In particular, detailed sector and product specific analyses indicate that, in what are referred to as "technology intensive" cases, their corresponding Brazilian export share represents less than half of the country's overall equivalent share in total world exports. Thus, despite the very high absolute surge of Brazil's exports, there is a lack in the relative dynamism of leading products. As a consequence, although Brazilian exports increased their share in the world total from 1.3 % in 1976 to 2.3 % in 1984, they dropped to 1.5 % by 1987.

Two significant observations merit particular reference in the case of the Brazilian exports: first, the country demonstrates a "revealed comparative advantage" in resource-intensive products, both of mineral and agricultural origin. Yet, the intensity of use of natural resources and of the corresponding export performance have often required the deployment of considerable technical inputs, as in the case of the soya complex (grain, oil, cake, etc.).

Second, a major change has taken place in the comparative destination of Brazilian exports: developing countries accounted for only 10.4 % of Brazil's exports in 1960 and they jumped to 28.2 % by 1988. This took place despite the economic crisis affecting many importers, especially in the rest of Latin America. Several of the latter are also recipient of Brazil's factoral service exports (specially technical services in construction and engineering) and some non-factor service exports. Thus, Brazil's industrial development, based on long term and sustained import substitution policies, is presently placing her economy at an intermediate level of exporting capabilities to other lesser developing countries. It is in this direction that a number of initiatives have recently been undertaken to foster special co-operation/integration mechanisms with neighboring countries, like the Capital Goods Agreement signed with Argentina in 1986.

With respect to the European Community (of whose imports Brazil accounts for only 1 %), various agricultural products (including food, beverages and tobacco) account for 60 % of total such trade. More technology-intensive Brazilian exports to the Community account for 13.6 % of the total, mainly in chemicals (4.7 %), machinery (5.3 %) and transport equipment (3.6 %). A significant part of these depend on intra-firm trade within the global

strategies of European based transnationals (e.g. FIAT and some German firms in chemicals).

There is a widely diffused opinion in Brazil that protectionist barriers will be strengthened by the closer integration of Europe, involving both EC-1992 and its relations with Eastern Europe. (Corresponding concerns exist with respect to the initiatives for a North American Free Trade Agreement between the U.S., Canada and Mexico). Also, special preference agreements of the EC with third countries in temperate-zone and other products will adversely affect Brazilian export prospects. It is, thus, generally believed that, notwithstanding the positive global trade effects that wider markets may have and despite the liberal rhetoric of the governments and of specific institutions involved, Brazil perceives that, as an outsider to such integrated markets, she stands to loose market shares.

I.2.2. FOREIGN DIRECT INVESTMENTS

Brazil figures among the very top host countries for foreign direct investments among the ldc's. According to Central Bank data on direct investments and reinvestments by foreign enterprises, the total accumulated stock exceeded the figure of U.S. $ 30 billion in 1988. Of these, agriculture related activities represented only 0.73 %, mining 1.92 %, manufacturing 65.75 % (with the larger shares in the automotive, electrical and communication, basic chemicals and mechanical subsectors), services 15.93 % (with a major presence in financial related activities), and the rest were non-specified cases. By far, the main EC presence was that of the F.R. of Germany with 15.35 % of the world total (more than half of the equivalent for the U.S. and more than one and a half of Japan's), followed by the U.K. (6.24 %), France (4.27 %) and Italy (3.54 %).

The law which regulates foreign investments in Brazil (Law 4131) dates back to 1962, a case of exemplary stability in the Brazilian legal-institutional context. The guarantees on property and other matters, the rights of foreign investors and the regulatory provisions affecting their operations and relations with parent firms (e.g. dividend remittances, royalty payments, etc.) are clearly spelled out in the text of the law which, as a general principle, also establishes equal treatment between all types of investors. Four subsectoral cases, though, exist in which differential treatments on market access and ownership restrictions are being followed : (i) national security activities including public media, (ii) mineral resource exploitation, (iii) selected service operations in transport and some finances, and (iv) specific high technology cases (such as informatics and telecommunications' equipment and some engineering services).

In addition to the overall legal and procedural treatment provided by Law 4131, most of the basic institutional conditions affecting the activities of foreign firms need to be found elsewhere. They have to do with the content of economic policies concerning protective external trade practices and export subsidies, tax and other incentives, special financing arrangements and broader sectoral development promotion packages. In the past two-three decades, these provided an overall attractive environment for business oportunities in a relatively large market, resulting in highly significant foreign direct investment flows. Policy changes in the future have to be seen in the process of selective liberalization, market reserve changes and privatization initiatives.

The annual flows of net foreign direct investments increased steadily from a range of about U.S. $ 100-200 in the 1960-72 period, to US $ 898 in 1973-77, to more than 1,300 million up to 1981. With the macroeconomic crisis of the '80's the trend was reversed and

in one year, 1986, it reached negative figures, being offset afterwards mainly by debt-equity swaps and reinvestments. The latter case of reinvestments accounted for 70 % of the registered foreign direct investments in the 1985-88 period with "outside" foreign investments falling to 30 % of the registered total.

In financial terms (excluding trade transactions), contrary to the results obtained in all previous years up to 1982, Brazil entered into a new phase and became a net capital exporter in the registered accounts of foreign owned enterprises during the second half of the 1980's : profit and related remittances exceeded net foreign direct investments by about U.S. $ 1,414 billion in the period 1983-88, without counting the interaffiliate loans which also showed significant negative performances. Profit and dividend remittances from Brazil in the 1983-88 period exceeded, on the average, the one billion U.S. dollar level per year while the economy stagnated in a context of a financial crisis and the related macro-economic disequilibria. In contrast, during the early '80's, the equivalent yearly payments averaged around U.S. $ 500 million and, in the decade of the '70's, they were reported to be less than U.S. $ 250 million.

In conclusion, the severe macroeconomic disequilibria of the 1980's gravely affected market opportunities for foreign investors who, in financial terms and as a whole, aggravated the resource drainage of and the balance of payments pressures placed on the Brazilian economy by the foreign debt crisis. As far as such indebtedness is concerned, official sources report that, in the late 1980's, a fourth of the total Brazilian gross external debt was held by U.S. banks, another fourth by eight Western European countries and 8 % by the Japanese financial system.

On the trade account (excluding oil), foreign enterprises accounted for 27 % of total Brazilian exports, 32 % of total imports and 24 % of total trade surplus in the period 1978-86. A dominant part of this trade took the form of related party transactions which, in the case of U.S. subsidiaries located in Brazil, represented more than 70 % of their trade operations in 1977. More recent data for the mid-'80's indicate even higher shares of intra-firm trade, reaching in the case of the automotive sector above 75 % and in informatics over 90 %. Consequently, the scope and interests of foreign investors in the case of Brazil (as often happens elsewhere) is very highly intermingled with the promotion of specific trade operations.

The sectoral breakdown of foreign direct investments presents a quite differentiated interest in Brazil depending on the country of origin of the investors. The overall preferences reveal the following foreign investor product specialization :

- U.S. - mechanical, electrical and communications subsectors plus chemical industries;
- Japan - mainly in steel, electrical and communications;
- FRG - the metal-mechanic complex accounts for 57 % of German investments (with the automotive subsector representing 33.2 %), plus diverse chemical activities;
- U.K. - heavily concentrated in petroleum derivatives;
- France - chemicals;
- Italy - automotive and steel;
- NL - electrical, electronics and communications, plus some chemicals.

I.3. THE S&T SYSTEM : COMPLETE BUT WEAK AND HETEROGENEOUS

I.3.1. A GENERAL OVERVIEW

The relative size of the present Brazilian commitment in scientific and technological production seems to be quite below the level of the country's relative economic performance and extent of international economic transactions. This is clearly reflected by the low level of R&D expenditures in Brazil which is around 0.7 % of its GDP, less than half of the equivalent share allocated by other NICs, such as South Korea, and around one third of the level of expenditure by the advanced industrialized countries [1] . Out of a sample of 66 countries among market economies, Brazil's relative share in R&D expenditure was less than 1 %. This contrasts with the much higher shares in total manufacturing production, foreign investment, trade, etc., covered in previous sections.

By the mid 1980's, there were about 465 diverse non-enterprise institutions (a quarter of which were higher education related) performing S&T projects and programs in Brazil (excluding purely educational activities and other training), plus 1288 industrial enterprises which registered R&D activities. The gross estimates for 1985 indicate that the total national resource commitments on S&T within Brazil exceeded the level of U.S. $ 1.8 billion.

Two important distributional characteristics require special mentioning : first, the enterprise sector represented only 17 % of the total resource use for S&T activities, while diverse institutions accounted for 83 %, with the vast majority of finances depending on the Federal Government Treasury (69.4 % of the total national resources on S&T). Second, within the enterprise sector, state enterprises accounted for 55 % of resource commitments and private ones for 45 % (or 7.7 % of the national total). With respect to ownership patterns, more than 90 % of R&D expenditures, by the enterprise sector, originated from commitments by nationally owned enterprises and less than 10 % from foreign ones. Also, enterprise related expenditures on R&D in Brazil, amounting to about U.S. $ 300 million in 1985, do not differ very much from the equivalent in the balance of payments "accounting category" of royalties and fees for imported know-how. In 1980, the latter category which, by definition, does not include effective payments for technology through dividend remittances, transfer pricing and overall trade of technology embodying goods, amounted to U.S. $ 320 million falling to U.S. $ 200 million by 1985 in view of the economic crisis impact.

The evidence of limited S&T performance is widespread. Among the 65 main institutions in Brazil involved in S&T activities, the corresponding services they provide refer only by one third to R&D related activities, while the remaining involve tests and analyses, quality certificates, standards and norms and informational services. Some institutes, though, like the Aeronautics Technological Center, perform high quality tasks and have acted -- like some research centres at the Universities of Campinas and Sao Carlos, the CPqD, etc. -- as spin-off nuclei for several high-tech firms. Also, research parks, based on federal

[1] It is also important to note that Brazilian statistics on R&D encompass a much wider range of activities than those included by OECD countries. For example, out of the Brazilian Federal Treasure expenditures on S&T, which constitutes the main source for such funds in the country, only about half of the corresponding budget was for R&D strictu sensu.

universities, like the biotechnology pole of the State of Rio de Janeiro, and some key R&D Centres of state enterprises (like those of Petrobas, Telebras and Electrobras) serve as important catalysts for bringing together the R&D system with the enterprise sector. In conclusion, the institutional S&T base of Brazil is highly diversified yet quite uneven in terms of resource commitments and degrees of excellence. Also, high concentration indices exist and the main actors are, in relative terms, limited in number and constrained by the funds they command.

At the enterprise level, the most recent industrial census for the 1980's indicated that those firms which undertake R&D expenditures (less than 2 % of the enterprises covered) spend for such activities the equivalent of less than half of one percent of their total earnings. A special association (ANPEI) of large enterprises undertaking R&D activities (with average sales of more than half a billion U.S. dollars and average employment in excess of 5400 employees) reported among its members an average R&D/sales ratio of 1.6 % for 1987.

From a large intersectoral sample of firms, whose aggregate R&D activities accounted for 78 % of the whole Brazilian industry, it was reported that 209 enterprises performed pratically the totality of such research. Most of them were based on in-house R&D centres. Such high concentration indices are quite characteristic of the Brazilian S&T system as a whole.

The overall content of Brazilian R&D efforts concentrates in the processing of natural resources, a pattern which is coherent with the country's "revealed comparative advantage" in its exports. Four such subsectors (metallic minerals, non-ferrous metallurgy, basic chemicals, and petrochemicals and oil refineries) account for close to half of the total R&D spending by industry in Brazil. Another subsector, which is not, though, resource intensive and which reports the highest absolute and relative expenditures on R&D, is that of electronics. This is the result of the informatics policy pursued by the Brazilian government linking, among other instruments, a high R&D/sales ratio requirement of 8-10 % to reserved market opportunities and ownership special treatment practices.

I.3.2. THE ROLE OF THE GOVERNMENT

Both failures and successes of the Brazilian S&T system are heavily influenced by the actions of the public sector and, in selected key areas, by the state enterprises. Public resources account for more than 90 % of R&D expenditures in Brazil and for a major part of the educational budget (see next section). Also, public sectoral development efforts, notably in high technology areas like electronics and biotechnology, as well as in more mature industries, constitute determining factors of Brazil's S&T and industrial evolutions.

Although many of the Brazilian research institutions have a history of several decades, the S&T system was structured mainly during the seventies, especially during the second half of the decade. Also, during that period the private sector was offered subsidized loans for technological activities through the special development bank for S&T (FINEP). The latter acted also as the coordinating agency for promoting linkages between public enterprises and their technology suppliers.

This important effort, which succeeded in establishing promising structures in the S&T system, was drastically altered during the crisis years of the 1980's. The Government's

attempts to curtail its overall spending affected seriously the resource allocations on S&T and introduced an erratic performance which inhibited the long term horizons demanded by R&D activities. The reduction of funds was more profound in the support of new projects and in the upgrading of the technological infrastructure. For example, in real terms the yearly average resources of the National Fund for Scientific and Technological Development during the 1980's were at levels of only 60 % of the equivalent for the preceeding decade. Also, FINEP's loans to enterprises for technological activities declined from a yearly average of U.S. $ 84.4 during 1976/79 to U.S. 50.2 in the 1980/86 period.

In conclusion, the capacity of Brazil's S&T system (both public and private), created mainly in the pre-1980's years, is presently confronting a major disruptive threat if the resource scarcity of the recent "lost decade" continues to persist in the future. In this context, it is highly relevant to turn to some positive evolutions in the perceptions of the country's productive base as far as the crucial importance of S&T is concerned in Brazil's emerging challenges for the coming years.

I.3.3. SIGNS OF CHANGE IN THE PRODUCTIVE SECTOR

In the recent past and despite the general malaise in Brazil's real economy created by the debt burden and its severe corollary macroeconomic disequilibria, some important changes are taking place in the perceptions and actions of the productive sector with respect to the role of technical progress. This transformation involves a dual realization :

First, there is the recognition that higher levels of productivity must be sought, spurred in part by the combination of external and internal pressures to reduce the levels of protectionism. Such a process of selective import liberalization is considered warranted in view of the relative maturity of the Brazilian industrial structure in a number of subsectoral activities. The productivity improvements will, in turn, require and induce new investments with significant imports of technology embodying production inputs and capital goods.

Second, an increase in productivity and international competitiveness require the support of an enhanced endogenous technological capability. The latter must involve R&D skills which go beyond the production and detail engineering skills which were prevalent in the import-substitution stage of industrialization. Instead, deeper product and process innovation requirements need to be advanced linked to commercially viable productive activities. They will also demand closer links and coordination between policies on industrialization and those on S&T, together with the promotion of closer contacts between the productive and technological infrastructures of the country.

Concrete organizational initiatives have already been promoted in accordance with the above noted transformation of perceptions. In the private sector, a series of technology related actions have been advanced on a collective basis, such as those by the powerful Industry Federation of the State of Sao Paolo (encompassing more than half of the Brazilian industrial output). Furthermore, it is important to note that demand for loans for technological development from FINEP has been highly responsive to resource availability and to the promotional policy instruments of industrial development targeting.

One of the main conclusions reached in the context of diverse interviews undertaken for this project with entrepreneurs, government officials and researchers, can be summarized as follows : "Given a greater degree of macroeconomic stability with appropriate expectations as to the time horizon of concerted government policies, the Brazilian industry

would be ready for a major expansion of its internal research and development. This will be complemented by an enhanced need to import technology intensive goods and services linked to the promotion of new investments".

I.3.4. HUMAN RESOURCES FOR SCIENCE AND TECHNOLOGY

I.3.4.1. The stock of human capital formation in Brazil

In industrially advanced economies the density of scientists and other professionals with Masters and PhD degrees often ranges between 1/400 to 1/100 per inhabitant. In Brazil, this density is approximately 1/4000 professional/inhabitant. Considering the rate of population growth, the country would need to train half a million new scientists in the next decade in order to reach a density of 1/400. This is clearly a quite improbable task, given resource availabilities and the capacity of the existing educational system. The challenges ahead are, therefore, formidable in the multiple tasks of human capital formation in Brazil.

The total enrolment in graduate programs in Brazilian academic institutions more than tripled between 1973-79, stagnated in the first half of the 1980's and experienced a further surge afterwards to reach about 65,000 by 1986. Of these, less than 10,000 were at PhD level. The number of graduate programs in Brazilian academic institutions more than doubled in the early '70's to reach 950 by 1979, stagnated in the early 1980's and reached 1175 by 1986.

In terms of categories of knowledge areas, the present distribution of graduate and post-graduate students in Brazil presents the following picture, in descending order. This points to important differences in comparison to a number of industrially advanced countries :

- Social sciences and humanities 33 %
- Biological sciences 16 %
- Exact and geological sciences 15 %
- Engineering 15 %
- Agricultural sciences 10 %
- Health sciences 10 %

In 1987, the Brazilian government established the following criteria to direct its human resource training policies :

- to increase significantly the participation of several branches of engineering;
- to give special emphasis to the training in priority areas, especially in biotechnology, material sciences, fine chemistry, informatics and precision mechanics; and
- to complement training, including the pursuit of education abroad,in the areas where there is a low internal capacity for graduate programs.

I.3.4.2. Training of human resources abroad

A major bottleneck in the Brazilian educational system for advancing the country's S&T system, is focused on the availability of academic staff holding doctoral degrees or the equivalent and working in graduate programs in Brazil. The most recent comprehensive data indicate that most of the growth for such qualified staff took place in the 1975-80 period - (almost tripling the corresponding numbers) and reaching 4630 by 1986. Yet, more than 40 % of the latter were in social sciences (excluding economics), the arts and the medical professions. Another 6 % were in economics, law and social service specializations. In contrast, the lowest participation among the remaining concerned the engineering profession (10.4 %) and agriculture (12.6 %). Biology alone had a relatively high participation (12.7 %) and exact sciences the remaining 17.5 %.

It appears that an important and targeted program could involve, among other initiatives, a concerted effort to train abroad, in priority fields, academic staff who could subsequently return to the Brazilian educational system to meet its growing demands.

Thirty or so years ago, fewer than 1200 Brazilians obtained their graduate training abroad and of these almost 1000 were being covered by scholarships granted by foreign institutions and by international organizations. By the mid 1980's, the number of scholarships for training abroad had exceeded 5000 of which more than 90 % were being partly or totally covered by two Brazilian Federal institutions (CAPES and CNPg). Another program on Agricultural Sciences, implemented by EMBRAPA from 1978-87, trained about 1000 students during the whole period and has recently been discontinued.

Four years (1975, 1979, 1987 and 1989) mark important initiatives with explicit Brazilian government policies towards an increase in the training of highly skilled human resources in foreign countries. They demonstrate a continued and long term preoccupation of the Brazilian authorities for the need to foster foreign educational support. As far as the European Community is concerned, its comparative involvement through scholarships in this area presents the following picture for 1986 :

- Federal Republic of Germany : 90
- United Kingdom : 465 of which about a quarter were in engineering and another quarter in humanities and social studies, while 81 were in informatics and 60 in biotechnology
- France : 468 of which almost half were in social studies and the humanities, 62 in engineering and 33 in biotechnology
- U.S. : 759 of which almost half were in engineering, biotechnology and informatics and one third in social sciences and the humanities.

What is noted from the above is the complete dissimilarity in the distribution of specializations concerning the corresponding scholarships programs, the relatively high participation of social sciences and humanities (especially in France), and the relatively low overall participation of the Federal Republic of Germany contrasting sharply with that country's business presence in the Brazilian economy.

I.4. PROPOSALS FOR S&T COOPERATION INITIATIVES BETWEEN BRAZIL AND THE EUROPEAN COMMUNITY

I.4.1. BRAZIL'S MACROECONOMIC CONTEXT AND EUROPEAN BUSINESS INTERESTS

As far as EC economic interests are concerned, the case of Brazil presents, as noted above, a unique combination : first, this is a country of continental proportions with an immense potential and with a characteristic level of intermediate yet highly integrated and broad industrial development focused on its large domestic productive base and market, complemented by specific export opportunities. Second, the magnitude of the European business presence in Brazil and of the related overall economic interests from the Community are very sizable both in absolute terms and relative to the U.S. and Japanese corresponding commitments.

Consequently, the economic affairs of the European Community with and in Brazil -- largely concentrated in technology intensive goods, services and factoral flows -- are highly succeptible to macro-economic and sector-wide considerations. This was amply demonstrated during the crisis period of the "lost decade" of the 1980's, with massive (multi-billion ECU) cuts of imports from Europe and the equally significant loss of dynamism in investment and technology flows. Such a turn affected, in accordance with Brazil's relative economic size and potential, the levels of and opportunities for employment, profits, government revenues and overall economic activities in the Community members. The determining factor in these recent evolutions has been the accumulated debt burden of Brazil and its servicing requirements.

Up to the present, the approach followed by the Community on issues of third country foreign debt has been such that corresponding policy initiatives are under the separate responsibility of each individual member country and of the participating financial institutions and not so much a concern for the Community as a group. Proposals, such as the European Guarantee Fund, put forward by Spain to reduce the debt of countries of medium-level of income, were not pursued.

At the same time, Community governments are actively involved in the negotiations of the Paris Club and constitute important board members of international financial institutions directly participating in the management of the foreign debt issues of Brazil. Also, a number of large European commercial banks participate as major creditors to Brazil.

All of the above and their implications on broader Community interests and concerns call for a serious reconsideration of existing practices with the aim to advance a comprehensive Community initiative on key aspects of the Brazilian foreign debt burden.

It is noteworthy that in a speech closing a conference on Eastern Europe's economies on July 7, 1990, the President of EC Commission, Mr. Jacques Delors, urged a radical overhaul of the international financial system. His recommendations included debt relief measures not only for Eastern Europe, but also for other debtor countries. With respect to Latin America in general and to Brazil in particular, such an initiative is likely to turn out to be one of the most important leverages for promoting European technology intensive exports of goods and services and in enhancing corresponding investment opportunities to that country.

As far as European interests are concerned in this area of relations with Brazil, the relevant direct trade-offs are between, on the one hand, a continuing stalemate and decreasing economic prospects with mounting debt servicing claims and, on the other, an expansion of trade and investment relations with a relatively high technological intensity induced by the alleviation of the debt burden. Thus, the re-evaluation of the debt issues from a developmental point of view could constitute a strategic choice for the Community's interests -- including those on science and technology cooperation -- with the Brazilian economy.

Complementing a radically re-evaluated approach on debt, the Community could seriously consider a targeted strategy for increased new financial resources which could support a restructuring of Brazil's infrastructural, productive and technological base. The serious reduction of aggregate investment undertakings over the last decade in Brazil, its declining imports of technology and the drying up of certain foreign credit facilities (in view of the debt generated problems) have accumulated a significant and suppressed demand involving a number of major and much needed and identifiable projects, especially in areas of technology intensive infrastructural investments.

Bold initiatives on resource availabilities through the European Development Bank, the European Development Fund and the other development financing mechanisms of European origin could give an advantage to Community interests over comparable U.S. or Japanese measures. Such initiatives from Europe could build on already heavy commitments by the continent's business interests in that country, the latter's high propensity for technology intensive imports and a renewed strategy for improving its competitiveness by opening up the local economy.

If considered appropriate for effective implementation, such a strategy calls for corresponding initiatives at the highest decision making levels directly linked to specific and complementary policy mechanisms and business actions.

I.4.2. COOPERATION IN HIGH TECHNOLOGY AREAS

I.4.2.1. Electronic and informatics

The current level of sectoral demand for electronics and informatics products in Brazil reaches the range of U.S. $ 8 billion annually. Excluding the cases of the U.S., Japan and Europe, this Brazilian market accounts for about one fifth of the remaining global market-economies demand and is roughly equivalent to the corresponding size reported for South Korea. Contrary, though, to the latter's manifested international role as an exporter and international competitor, Brazil's situation is totally different. Its internal size (in terms of population, industrial and service activities and its special communication needs in view of its geographic dimensions), projects this country's outlook for electronics, in general, and for informatics, in particular, as one of the more promising local markets, outside the main industrially developed economies.

Furthermore, the new Brazilian government has already promoted preparatory institutional initiatives to review and revise, on a selective yet fundamental basis, its practices on "market reserve" and related non-tariff barriers. This constitutes an important evolution

especially in the professional informatics subsector involving a number of product categories in the computer's family, peripherals, software, etc.

In view of the above it is proposed that the Commission, in cooperation with a number of European based interested business and technology concerns, should consider the promotion of a sector-wide policy strategy with the following purposes :

- to monitor and interpret, on a concrete product level, the business opportunities arising from policy shifts that appear to be forthcoming in the economic and technological management of Brazil's professional informatics subsector, and to follow more closely the different approaches pursued in the area of telecommunications;

- to propose a sector-wide policy strategy for the identification of specific areas of comprehensive cooperation involving industrial/technological/human resource institutional initiatives which will cover a number of years of action oriented programs.

In the past, European firms often appeared (with the exception of telecommunications related activities) as passive by-standers to concrete opportunities offered by the Brazilians, especially during the years of the US-Brazil conflict in the informatics sector. They also lost significant market shares, which were attained during the 1970's, due to more recent and aggressive initiatives of US and Japanese private and public interests. The above proposals could reverse this trend of relative loss of European presence in the informatics sector of Brazil compared to other foreign participations.

I.4.2.2. Biotechnology

Biotechnology constitutes one of the more promising areas for S&T cooperation between Brazil and the European Community leading to very important economic effects and key social considerations. Brazil has a long history in biotechnology activities. Industrial sales in new biotechnology related activities reached in 1988 around U.S. $ 10 billion. Of these, though, more than 90 % were dominated by energy related operations in the Brazilian Pro-alcohol programme. Of the remaining or about U.S. $ 860 million, the agricultural market share in new biotechnology industrial sales represented 37.5 %, human health 37.0 %, food production 17.7 %, animal related activities 3.5 % and environment with only 2.2 %.

In addition, important resource commitments have been allocated in biotechnology R&D amounting to more than U.S. $ 262 million during the 1985-88 period. Of these, more than 98 % were from Brazilian sources (two thirds by the public sector and one third by private industry). The productive sector developed and diversified its activities with new enterprises advancing in specific product lines. Some of these firms obtain valuable knowledge intensive inputs from the promising biotechnology parks (e.g. the BIO-RIO Park) established around main university campuses. Finally, educational efforts in the diverse disciplines involved in new biotechnology have been signaled out as top priorities in specific training initiatives and scholarships programs in Brazil during the latter years of the 1980's.

The proposed areas for Brazilian-EC S&T cooperation in new biotechnology include the following main fields :

(a) Fertilization and biological fixation of nitrogenous

The development of capabilities so as to make optimal use of a natural system of fertilization through coordinated technological activities in soil biology in order to increase energy efficiency and to protect the natural environment, is of paramount importance both in Brazil and in Europe. In the latter case, nitrogenous fertilizers are used extensively and are associated with increasing nitric contamination.

Brazil has already made important advances in this area and promoted a number of specialized institutions and an emerging and strong technological infrastructure. These include : the EMBRAPA:GENARGEN work in the rhizobium inoculation of the soybean; the Servicio Nacional de Resquisas Agronomica (SNPA) which is dependent on EMBRAPA and specializes in training and basic research on biological fixation of nitrogen for the tropics; the Programa Nacional de Pesquisa em Biologia do Solo (soil biology) with 24 projects and presently coordinating 53 other in several States and cooperating with agreements with EC institutions and the World Bank; the Fundacao de Estudos Agrarios Luis de Queizoz; CENA, etc.

Areas of cooperation with Brazil include not only promising joint research initiatives but also important manufacturing undertakings. The latter concern especially the industrial scaling-up of research results, productivity and quality improvements in cases such as the production of inoculous of thizobium and in the broader concerns of fermentation processes.

(b) Seed production and tissue culture

The micropropagation of diverse tropical and temperate fruits, tubers and ornamental plants and of forest species, can have a major impact on the diversification of the Brazilian agriculture. It also constitutes a crucial element in needed reforestation programs (like in the case of eucalyptus where technological work has already been promoted in the country). Finally important potentialities exist in tissue culture in a number of crops.

Presently, Brazil combines a number of basic and applied research efforts, under the leadership of EMBRAPA, with a number of private firms involved in industrial and commercial activities. Such firms have undertaken important cooperation initiatives with European business firms and public sector institutions from France, the U.K., the Netherlands, etc. [2]

(c) Biotechnological cooperation for disease and pest control

The increasing debate on the use of chemical pesticides and the corresponding efforts made in this respect by Brazil and some European Community countries indicate that the overall area of agricultural protection is a potentially major field for S&T and industrial cooperation. Also, market research estimates indicate that local demand for pest control

[2] A list and business characteristics of these firms appear in the corresponding special report prepared for the Commission in the context of the MONITOR program.

products (herbicides and insecticides) amounts to several hundred million US dollars annually just for plantation agriculture. Potentially serious additional possibilities exist for corresponding protection in food crops, vegetables, etc.

Brazil has already successfully initiated the development of biopesticides in a number of institutions such as CNPS/EMBRAPA, UNICAMP/PLANALSUCAR, FIOCRUZ. Important additional projects have been identified at the R&D, pilot plant and industrial production levels on biological insecticides of bacterial origin and on viral insecticides for the protection of sugar cane and soybean (replacing traditional agrotoxic pesticides).

(d) Food and feed production

CENERGEN has already initiated R&D cooperation with European (Belgian) institutes for the improvement of the protein content of some crops (particularly beans). This area of cooperation can be significantly enhanced and extended to other crops and R&D institutes in Brazil with the active involvement of European institutes and firms working on such issues.

Furthermore, the key objective to improve the nutritional level of the large population of Brazil, particularly in the intake of protein, suggests that concerted efforts need to be undertaken in the areas of animal growth and feed. The enormous amounts of residues from plantation crops (especially sugar and coffee) suggest the great possibilities of production of single cell protein for animal feed using such plantation residues as feed stocks. This opens an important area of cooperation in the overall area of fermentation. AGROCERES, being directly involved in the production of animal feed, constitutes a serious potential partner for European initiatives in this area.

In addition, Community countries have already advanced with significant experiences in animal agriculture, artificial insemination and animal food. Contacts already exist in certain areas with Brazil (e.g. U.K. cooperation in swine production) and need to be extended including the area of milk production.

(e) Health matters cooperation

Like many other countries with tropical climates, Brazil faces severe problems of endemic tropical diseases. New biotechnology, particularly recombinant DNA and genetic manipulation, now permits the understanding of the unique biology of parasitic organisms that cause malaria, schistosomiasis, leishmaniasis and other tropical infectious diseases. It also provides methods to produce vaccines more specific and safer than traditional ones.

The responsibility of the public health authorities in the control requirements of endemic diseases have brought public sector institutions at the centre of managing immunological products. Thus, contrary to other important cases in the pharmaceutical sector, where foreign private firms dominate the production and commercialization of key products (e.g. in antibiotics), in the field of endemic tropical diseases, European cooperation with public authorities is essential for the formers' market entry into Brazil in these product categories.

(f) Cooperation in the infrastructure of biotechnology advancement

A concerted European cooperative program could be promoted for the coordination and advancement of activities in three major areas concerning the infrastructural base of the whole field of biotechnology in Brazil. They concern :

- the availability and maintenance of hardware and of related inputs for biotechnology;
- specialized training for expertise in biotechnology; and
- institutional building, policy formulation and informational networks in biotechnology advancement in Brazil.

I.4.2.3. New materials and fine chemicals

These two very promising areas were not covered by detailed sectoral analysis in the course of this project. In view of their major significance for Brazil, both with respect to resource availabilities (in the case of new materials) and industrial activities linked to imports (in fine chemicals), they merit special attention in developing Community-Brazil S&T cooperation initiatives.

I.4.3. S&T AREAS OF DIRECT CONCERN TO THE BUSINESS SECTOR

Presently Brazil reports a ratio of R&D expenditures to its GNP and an overall research performance which lags far behind its world share in industrial output and is below that of several competing newly industrializing economies. Furthermore, the productive sector of Brazil is showing important signs of change in orientation and attitude : it presently begins to consider investments in research and development and in overall technological advancements (including imported know-how) as key and practical business concerns for improving international competitiveness. Of particular and crucial relevance is the emerging joint and coordinated management of industrial and S&T policies both in Brazil and in its relations with foreign partners.The following two major initiatives are recommended on R&D policy matters :

I.4.3.1. EC special programs on science and technology

Some of Community's special programs -- like EUREKA, RACE, ESPRIT, etc. -- offer a promising scope for joint-ventures between European and Brazilian firms based on science and technology cooperation. However, presently there are several obstacles for the establishment of such joint ventures, some of which stem from the rules governing these programmes and others from lack of mechanisms for establishing the necessary rapport between European and Brazilian enterprises. It is, therefore, proposed :

- to consider establishing a joint task-force to study ways for improving the participation of Brazilian firms in the special Community programs on technology and economic cooperation.

- to improve information channels between Brazilian and EC enterprises on opportunities for joint ventures based on technological activities through, among others, a directed activation of specialized business information centres in Brazil, the Business Council of Brazilian EC Enterprises, etc., as well as corresponding initiatives in Europe for the promotion of Brazilian firms.

- to create through the development banking sector of Brazil and the technology specialized financial institution of FINEP, a special risk capital fund to support feasibility studies and technological activities partaking to Brazilian participation in Community special programmes (the World Bank has already expressed interest in this area). Debt conversion could constitute a mechanism for creating such a fund coupled with fresh European and Brazilian commitments.

I.4.3.2. R&D financing

As noted above, the resource claims of debt repayments and the resulting fiscal crisis in Brazil has led to a much reduced and erratic public financing of R&D activities in the country. Such financing presently constitutes the overwhelmingly dominant source of research funding activities in Brazil. Part of the vacuum has been filled, under their own policy criteria, by IBRD and IDB. They are presently advancing negociations for the allocation of around one billion U.S. dollars on research and development activities in Brazil over the coming five years.

In view of the extent of the EC-Brazilian economic interests and the concern for further advancing S&T co-operation between the two regions, it is proposed that a special financial scheme is evaluated for promoting selected R&D activities in Brazil with European support. The sources of such financing could be "tripartite" : European, Brazilian Treasury contributions and debt conversion.

I.4.4. COOPERATION IN THE EDUCATION OF HIGHLY SKILLED PERSONNEL

Brazil's training requirements are staggering : during the next decade it will need to train half a million new professional scientists if it is to approximate the relative education level portrayed by some of the lesser advanced developed market economies.

A major conclusion drawn from the Report is that, in selected areas, Brazil will have to depend heavily on specialized training abroad in order to attain the necessary scientific and technological base and to increase the quality of its own graduate university programs. In view of the high complexity -- in terms of economic, social, linguistic and brain drain reasons -- of the whole issue of education abroad, a concrete and high priority area has been selected in proposing concerted cooperation with the Community. It involves a targeted and long term program, based on a special Brazilian-EC-Educational Fund, to help train in Europe Brazilian academic staff who will subsequently return to their country to support the local educational system. It is considered that such an approach will have, in the light of scarce resources, the highest multiplying effects for the benefit of the rest of the Brazilian education system.

PART II : DECISION BASE

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II.2. - TECHNOLOGY INTENSIVE EXTERNAL SECTOR TRANSACTIONS

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II.4. - HIGH TECHNOLOGY SECTORS : TWO CASE STUDIES

II.1. A GENERAL OVERVIEW OF THE BRAZILIAN ECONOMY

II.1.1. MACROECONOMIC CONDITIONS AND CONSTRAINTS

Brazil is a country of continental proportions. The area it covers extends over more than 8.5 million sq. km. Its population stands at more than 144 million inhabitants and its net domestic product was reported, at the beginning of its recent economic crisis, at around U.S. $ 350 billion. (Some of Brazil's macroeconomic and social indicators at the end of the 1980's are summarized in Tables I.1 to I.4 of the annex).

In the Brazilian economic history the decade that now ended contrasts sharply with the rest of the period from the Second World War. Accustomed to very high rates of growth (an average of 8 % per year from 1950 to 1980) the Brazilian economy in the eighties got mired in its worst economic crisis (worse than the depression of the 1930's, as argued by Reis, et al., 1989), of which no end is on sight.

The depth of the present crisis can be better gauged by comparing the eighties with the preceding decade. In the period 1971/80 the per capita gross domestic product increased by 66.4 %. In contrast, in the years 1981/88 it declined by 1.3 %. Gross capital formation during the seventies was on average 23 % of GDP and it fell to an average of 18 % in the period 1981/88. Inflation rates which averaged 33 % per year during the seventies, reached an astounding level of more than 1700 % in 1989. The process of inflation in Brazil is complex and cannot be entirely explained by a single factor or model. Foreign debt, exogenous shocks, public debt, packages of stabilization policies, indexation and expectations have all fueled in various degrees and years the inflationary spiral. Since the end of 1985 the rate of inflationary pressures have accelerated and its pattern has changed with deep cyclical movements, obviously related to the three stabilization plans. (For a description of the inflationary process see World Bank, 1990).

At the same time, inequality, the dark side of the Brazilian economic growth, has increased being among the worst in the developing world. The Gini concentration index of personal income distribution increased from 0.56 in 1982 to 0.6. in 1987 (Silva, 1989). Poverty is wide spread, especially in Northeast where about half of the population lives at per capita income levels below 25 % of the real minimum wage indexed at 1980 prices.

The seventies are important for understanding the present crisis not only for reasons of historical proximity. In fact, it was during that decade, especially its second half, that the seeds of the crisis were sown in and, at the same time, the productive conditions were established which may support an exit from the present plight of the Brazilian economy. After the first oil shock and with the petering out of the "Brazilian miracle" of 1968/73, based on the internal market for durable consumer goods, the Brazilian government undertook an ambitious industrial development programme (II PND). It was geared to the substitution of imports of basic products (including substitution of oil for alcohol), intermediates and capital goods. As shown in more detail in a following section, the development of the scientific and technological infrastructure and the setting up of technology-intensive sectors were included in the programme.

The programme was financed, as far as internal funds are concerned, by massive transfers of resources and redistributive policies. Thus, the government mobilized a vast array of fiscal and credit incentives, kept low the rates and prices of basic inputs supplied by State

enterprises (steel, oil, etc.) and defined a wage policy which led to wage increases much below the growth of labor productivity. Nonetheless, the major characteristic of the finance strategy adopted was the reliance on foreign credits. Thus, gross external medium and long term debt increased from U.S. $ 17 billion in 1974 to U.S. $ 50 billion in 1979. Favorable lending conditions and incentives to exports (which grew 12 % per year from 1974 to 1979) seemed to justify such a path of growth-cum-debt. More importantly, though, such a strategy allowed postponing major changes in the finance structure of the Brazilian economy.

This approach was brusquely disrupted by external factors at the end of the seventies and beginning of the eighties. The price of oil imported by Brazil almost trebled between 1979 and 1981, terms of trade fell abruptly (in 1982 they were 62 % of the 1978 value), the US dollar (to which a number of Brazil's foreign obligations are pegged) appreciated, international lending rates increased steeply (the LIBOR which had averaged 7.8 % in 1974/78, shot up to 15.1 % in 1981/82) and, from 1982 onwards, the international sources of funds dried up (Horta 1989).

The policies followed by the Brazilian governments (1979/85 and 1985/90) put the burden of adjustment on the shoulders of wage earners, the poor and on the State itself. Although the Brazilian price system is highly indexed, wages have not kept up with other price increases. The minimum wage, for instance, has now reached, in real terms, its lowest point since it was established at the end of the thirties. Also, the share of labor (employees' earnings) in total product at factor prices fell to less than 40 % in the eighties. The ensuing decline of standards of living is exemplified by the reduction of 8.3 % of per capital consumption of family units between 1980 and 1987.

Another front, where the crisis of the 1980's manifested itself, has been in the sphere of the State finances. The growth of the public debt expresses clearly the picture : in 1988 the total debt was equivalent to 47 % of the GDP compared to 22 % in 1980. The debt to foreign creditors had increased from 12.7 % to 25.4 % of the GDP and the internal debt had risen from 9.3 % of the GDP to 21.3 % between 1980 and 1988 (Giambiagi 1989).

Such growing indebtedness of the public sector evidences a deep seated fiscal crisis which lies at the center of present economic policy debate. Compared to OECD countries, the gross tax burden in Brazil is low and has shown a downward trend. From 26 % of the GDP in 1970 it fell to 24.6 % in 1979/81 and further down to 22 % in 1987. The net tax rate fell more steeply - from 14 % of GDP in 1975 to 5.7 % in 1987. Such decline reflects not only the deterioration of taxes with growing inflation (the Tanzi effect) but also the fiscal incentives given by the government, of which a substantial part is directed to export activities needed to cover the transfers of foreign debt servicing. Furthermore, the government assumed the responsibility for covering the private sector's exchange rate risk on past loans. This increased its share of the external debt from 42.5 % in 1980 to 81.2 % in 1988.

During the same period Brazil paid U.S. $ 84 billion on interest for its external debt (equivalent to 131 % of the total debt in 1980) (Horta 1989). Such payments, which amounted to almost 5 % of GDP in the period 1984-88, relied mainly on a successful trade balance adjustment. Combining import restrictions with expport incentives, the trade deficit of 1980 (U.S. $ 2.8 billion) turned into a mega surplus in 1988 (U.S. $ 19 billion). Despite such adjustment, in 1989 the government stopped payments on the foreign debt, in a tacit moratorium.

However, the transformation of the foreign exchange proceedings earned by the private sector into local currency led the government to increase its internal debt in the spectacular rate shown above, in order to avoid major inflationary consequences. Thus, external and internal debts have become inextricably interwined. Also, in recent years, interest payments by the public sector account for practically all of the latter's deficit.

Since personnel expenditures and transfers for social security proved to be politically incompressible and given the snowball character of interest payments, the government opted to try reduce the deficit by cutting down its investments. Public administration investment, as defined by national accounts (excluding State enterprises) declined from an average of 3.1 % of GDP in the period 1976/80 to 2.7 % in 1987. State enterprises were even more seriously affected. In the period 1980/82, when the projects of the II PND were being completed, their investment was 5.2 % of the GIP. In 1988 such share dropped to 2.8 %.

Finally, it is important to stress that the characteristics of the Brazilian financial system, where long-term credit is provided by government sources only, contributes in no small way to financing strategies based on price increases. In the recent past, the combination of very high real interest rates, the laxness of government price controls and, in many sectors, the market power of few enterprises, have made price increases a much easier and safer financial strategy than investing to reduce costs and increase productivity. The performance of the financial system could be interpreted as showing a strong vested interest in high inflation rates and a soaring public debt, since such factors proved to be major determinants of the very high profit rates enjoyed during the recent past in corresponding financial transactions.

The government which took over in mid-March 1990 has taken some drastic measures in terms of reducing the liquidity of the economy and thus cutting down inflation rates from 90 % per month to about 3 % at the end of that year. Public debt payments were reduced accordingly and the government has announced that it intends to sell many of the State enterprises and reduce personnel expenditures by at least 30 %.

On the whole, the macroeconomic constraints now prevailing in Brazil with respect to needed industrial and technological developments, are quite severe. However, if such constraints are alleviated, the productive structure inherited from the seventies and further developed over the last decade provides substantial scope for such development, as the sections which follow endeavor to show.

II.1.2. INDUSTRIAL STRUCTURE AND STRATEGIC OPTIONS

The development of the Brazilian economy since the Second World War has been led by the manufacturing industry. The latter increased its share in GDP from a fifth in 1950 to a third in 1980. However, during the last decade this share fell to 30 % in 1987, practically the same level as in 1970 (29 %). As shown in Table II-1 manufacturing industry growth rates during the eighties were not only very small on average (0.5 % per year during the 1980/88 period), in sharp contrast with the previous decades, but they also fluctuated widely, ranging from an increase of 9 % in 1980 to a drop of more than 10 % the next year. Investments declined during the decade and in 1987 they were at the same level as in 1980.

Local production supplies practically all internal demand. As shown in Table II-2, the import coefficient of manufactures is less than 5 %, with mechanical products, electrical and electronic and transport equipment holding the highest import coefficients (around 10 % of final demand). This makes Brazil one of the more closed industrial economies of the world, thus limiting potential benefits from a fuller participation in the international division of labor once certain maturity levels have been achieved by the local industry. A consensus seems to have been reached internally that such a degree of closedness is harmful to the development of the country and a process of gradual import liberalization, started at the end of the last government, is being pursued by the present incumbent one. (For more details on this issue see the following section).

As evidenced (see Table II-2) by the low import coefficients throughout the industrial structure, local production is highly integrated. Thus, local intra-industrial sales accounted for over 40 % of total industrial output in 1980. This constitutes a pattern more akin to developed countries than to other LDCs. The information provided in Table II-3, also shows that the industrial structure is itself changing, especially among the more technologically dynamic sectors. The latter have continued to increase their share of manufacturing value added during the eighties (to 33 % in 1987 from 31 % in 1980 and 23 % in 1970) despite the poor industrial performance of the decade.

The share of such sectors in Brazil tends to be comparable to the share they hold in more advanced industrialized countries, as shown in Table II-4, suggesting a process of industrial convergence. The difference, though, rests on the fact that in Brazil chemicals tend to be more important than in the advanced countries, with the reverse holding for electrical and electronic and mechanical products. In fact, the differences run much deeper, especially if one looks at the segments of the above mentioned sectors which act as the sources of technical progress for industry and for the rest of the economic system.

Thus, comparing the structure of the electronics complex in Brazil and in more advanced countries (Tables II-5 and 6), we can see that in Brazil, in spite of the progress of the data-processing segment, based on the Informatics Policy, the production of consumer goods still predominates, while in the latter countries professional electronics is dominant. The small share of the Brazilian electronics complex held by the subsectors producing industrial automation equipment, instruments and components, is especially indicative in view of the role played by such activities in the diffusion of technical progress and increased productivity. Moreover, because the consumer goods' subsector benefits from a special import status, by virtue of its location in the Amazons region, it tends to massively import most of its components and equipment, thus constraining the options for developing the latter two lines of production.

More generally, the machinery sector (electrical and non-electrical) has been one of the worst affected by the crisis of the eighties, especially the firms which produce custom-built equipment. These were caught by the recession at a time they were completing the expansion of their capacity. Such an expansion was fostered by the industrial development plans of the seventies and the corresponding sales of machinery were mainly directed to satisfy the investment demand of state enterprises.

It is generally believed that a substantial part of the machinery sector, especially the small enterprises, have now lost ground in technological terms, increasing the heterogeneity of the sector and the gap between Brazil and other countries. The undevelopment of the machinery industry is especially noticeable for the segment producing equipment and components and from the lack of qualified manpower. As it is well-known, this subsector,

although small in size, is highly important in terms of embodiment and diffusion of technical progress.

Finally, with respect to the chemical complex, the Brazilian case is heavily geared towards the production of basic chemicals, especially oil refining, which accounted for 36 % of the overall output in 1984 (Haguenauer 1989). The integration of the complex is still partial, concentrated in petrochemical downstream chains of production. Other chemical industries (such as pharmaceuticals, pigments and pesticides) produce locally only the final products, importing the most technologically relevant inputs. Fine chemicals, which constitute the more dynamic segment of the complex in the world market, is also poorly developed (ibid).

Two other critical sectors, which could straddle many industrial complexes, biotechnology and new materials, are also in the first stages of broader industrial development in spite of favorable natural resources (e.g. in rare earths). Such sectors did not benefit from the boom of the seventies and their investment activities during the last decade (largely by private enterprises) have been limited, concentrated in agricultural uses for biotechnology and in ceramics in new materials. (For the case of new materials see Lasters et al., 1988. For the case of biotechnology see the last section below as well as Almeide et al., 1990).

Thus, the Brazilian industrial structure, in spite of its high level of integration, lacks precisely those segments which are most relevant in terms of technical progress, the segments which act as engines of innovation, providing the rest of the system with product and process innovations. This represents an important gap in the industrial-technological tissue of the country's economy.

Notwithstanding such structural problems, the Brazilian industry has shown signs of great vitality in the face of severe macro-economic constraints. New forms of automation have been incorporated by the Brazilian industry during this period. More generally, data (as computed from Araujo Jr. et al., 1989) show that 46 % of the industry has consistently increased its productivity from 1975 to 1984 and another 25 % between 1974 and 1982. Such increases in productivity cut across all industrial complexes, the main exception being the construction complex, one of the worst affected by the depression of the eighties.

Recent interviews with 134 leading industrial firms reported by Ferraz et al. (1990) show that enterprises in the manufacturing sector intend to expand their investment in new forms of automation and organization of production, with a strong emphasis on total quality control. As discussed in more detail below, there are also signs that the productive sector is increasing its spending on R&D. This evolution is following a generalized perception that the Brazilian industry must seek higher levels of productivity in order to compete internationally.

Such elements warrant a (guarded) optimism about the future of the Brazilian industry. However, before undertaking such a leap forward, the industry now stands at true crossroads. Until the end of the seventies, Brazilian industrialization was governed by import-substitution. In such a context imports provided clear sign-posts of the direction of industrial development. There is a consensus in Brazil that such process is largely exhausted, or, at least, it has been overextended, leading to an undesirable closedness of the economy with reduced competitiveness.

Given the present industrial structure, though, and the conditions characterizing international markets, traditional export practices cannot provide a sufficiently strong alternative source of growth. It is, thus, recognized that in order to increase exports at a time in which the fiscal incentives for export activities are contrained by boarder fiscal

imbalances, the technological content of the latter must be upgraded and their overall level of competitiveness needs to be significantly improved. Also, new product lines, which are more technologically intensive and which link their operations with more dynamic international market demand, must enter the fold of Brazilian exporters.

Yet, a number of Brazilian analysts also argue that industrial development in the country will continue to rely heavily on the growth of the internal market. Potentially, through this route, it is being argued, there is great scope for industrial development. The very low standards of living of the bulk of the population suggest that increases in real wages would lead to a great expansion of demand for consumer goods. Since wage-goods account for a very high share of industry (see Table II-3) and such industries have been the slowest to use the new forms of automation, their expansion would lead to heightened interindustrial transactions. Similarly, the deterioration of most State services, both in overall economic infrastructure (such as roads, energy and communications) and social (such as health and education) require substantial investments with intensive industrial linkages. Nevertheless, such an investment upsurge would require solving the fiscal crisis. In both cases, though, the integrated industrial structure is a powerful instrument for carrying the stimuli throughout the economic system.

II.2. TECHNOLOGY INTENSIVE EXTERNAL SECTOR TRANSACTIONS

II.2.1. FOREIGN TRADE

II.2.1.1. Foreign trade and domestic product

It has already been stressed that a major trait of the Brazilian economy is its relative "closedness" to international trade, especially if compared to other countries. As shown in Table III-1, except for India, all indicators of "openness" to foreign trade put Brazil at the bottom of the list. Moreover, the same indicators show that in the recent years, especially since 1984, the Brazilian economy reduced its foreign transactions as a proportion of its product.

To put this into a historical perspective Table III.2 shows the evolution of imports (M), exports (X) and of total trade [(M + X /2] as ratios to the gross domestic product over the period 1965/88. We can see that imports averaged 5 % of GDP over the second half of the sixties and increased during the seventies, when they averaged 7.8 % of the domestic product (with a peak of 11.5 % in 1974, after the first oil shock). This ratio was sustained during the first half of the eighties, but declined sharply from 1985 to 1988 to the same levels as in the sixties, reaching 4.1 % of the GDP in 1988, the lowest share in 24 years.

During the second half of the sixties exports accounted for a larger share of GDP (6.2 %) than imports, but during the seventies such a position was reversed, leading to large foreign trade deficits, especially during the mid-years of the decade. However, during the eighties, exports grew at very high rates, reaching a peak of 11.5 % of GDP in the period 1983/85, (see Table III-3) but lagged in the past three years, when their share was reduced to 7.2 % of the GDP. Nonetheless, because imports were curtailed more deeply, the trade surplus averaged 4 % of GDP during 1986/88, one of the highest in the world.

The trade adjustment of the eighties is also remarkable given the terms of trade. From the mid-1960's to 1977, the evolution of the terms of trade was, on balance, favorable to Brazil. Yet, from 1977 onwards, they declined abruptly and remained throughout the eighties, on average, 40 % lower than in 1977 (see Table III-4).

Some points of consensus have recently emerged about the Brazilian foreign trade : first, that the economy is too closed. Imports should be increased and diversified in order to use technical progress generated abroad and embodied in capital goods and inputs. Exports, for which there is a growing concern about their competitiveness, should also be diversified and technologically upgraded. Second, there is an agreement that the massive transfer of real resources abroad implicit in the mega trade surpluses is undesirable, not least because of its negative aspects in terms of expansion of the means of payment and on the indebtedness of the public sector, rendering more difficult the control of inflation, a key problem for the Brazilian economy (see Section II.1. above).

The first point can be dealt with mainly by internal policies but the second strongly depends on the decisions of Brazilian foreign creditors, since servicing the foreign debt has been the main reason behind the policy for obtaining huge trade surpluses.

II.2.1.2. Imports and foreign trade policies

Brazil is one of the economies which has carried further the process of import substitution, as evidenced by the very low import coefficients discussed above. The restrictions placed on imports, a strategic feature of the Brazilian industrialization policy, were considerably tightened during the past decade. However, differently from the previous decades, the recent restrictions were not imposed following an "industrialization logic" thus stimulating local production. Instead, they were established simply to attain the required trade surpluses so as to serve the foreign debt payments.

The import controls regime involves both tariff and non-tariff barriers, especially the latter. At the core of the non-tariff barriers mechanism lies the foreign exchange allocation system. Although it is presently being progressively dismantled, it is worthwile describing this system so as to signal out its main characteristics and effects.

Based on estimates of foreign exchange earnings, government authorities allocate such resources according to four priorities :

- servicing the foreign debt;
- priority imports for economic stabilization, mainly crude oil and wheat;
- imported inputs required for exports, especially drawback imports;
- all other imports.

The authority for the allocation of foreign exchange for all merchandise imports, except oil and wheat, was delegated to a special agency (CACEX) and to the Central Bank for all other non-factor services (about 20 % of merchandise imports).

In some cases, before CACEX could grant the import license, the importer had to obtain authorization from other Government agencies. Thus, electronic product imports must be approved by the Special Informatics Secretariat (SEI). Also imports of capital goods and intermediary products must fulfil certain external financing requirements established by the Central Bank.

As a consequence of the Law of Similars, importers were often led to establish some form of market-sharing agreement with domestic producers. In some cases such agreements were formalized, such as when there were pre-established import limits on import-competing goods, as applied to some steel and non-ferrous metal products, or when a "national participation agreement" was established between an importer and domestic producers, defining ex-ante what products would be imported. The latter was applied mainly to large investment projects, especially of State enterprises.

Under such a system of stringent direct import controls, the tariff barriers played a minor role. Although nominal tariff rates were very high, a wide variety of special import regimes allowed total or partial exemption of tariff duties and other import taxes, rendering the tariff system further inoperative.

Since late 1987 the Government introduced a number of trade reforms. These included a reduction of non-tariff barriers through the liberalization of the import programs by increasing their limits, by relaxing the external financing requirements, by reducing to a fourth the list of banned imports (about 10 % of total tariff lines), by limiting the number of preferential tariff regimes and by accelerating the process of issuing the import licenses. Moreover, in 1987 the Government introduced GATT-conforming regulations on

countervailing duties, a custom valuation code and an anti-dumping law to replace a system of surcharges levied against a list of products considered as being dumped in Brazil.

The evolution of the imports structure during the 1964/88 period is shown in Table III-5. Few items (oil, cereals, machinery and chemical products) account for almost two-thirds of imports. The reduction of oil imports reflects also the success of PETROBRAS, the State oil company, in finding and exploiting off-shore oil wells along the Brazilian coast. Investments for such purpose, which led to the mastery of complex technologies for deep-water exploration, have recently been reduced because of cash shortages, partly associated with the fuels price system, which penalizes the company. Therefore, should the international price of oil surge again, its impact on Brazilian imports would be significant, albeit considerably less than in the seventies.

Import of chemical products consist of a great variety of goods, mainly fine chemicals and intermediary products, reflecting the low level of integration of the chemical complex previously described. A considerable part of such imports is ascribed to intrafirm transactions and it is generally believed that there is considerable overinvoicing involved in such operations. It is also believed that this is an area in which import-substitution could be carried further, were it not for the preference of the leading firms, especially transnational companies, to continue importing such products.

Machinery imports (electrical and non-electrical) tend to be procyclical, increasing sharply at times of product and investment upsurge. This is shown (Table III-5) by their upturn during the seventies, especially during the second half of the decade, and their decline in the eighties, especially during the 1983/85 recession (see Table II-1). Such imports are also deeply affected by their financing especially in determining the source of supply. In the past, credits were decisive in circumventing the Law of Similars, referred to above.

It is widely accepted that, if the Brazilian economy resumes growth, imports of machinery are likely to increase considerably. This cyclical factor will probably be compounded by the lack of investments in technology by many capital goods producers in Brazil during the 1980's, thus increasing their technological gap.

A recent study by ECLAC (1989) on trade of technology-intensive products shows that Brazilian imports of such products (detailed in Table III-6) represent a smaller share of its total imports than in the rest of the world, especially in the Asian NICs (see Table III-7). This confirms not only the closedness of the Brazilian economy, but it also points out to the relatively reduced participation of Brazil in the international technological revolution, as the latter is being expressed in trade activities of specific capital goods and intermediary products which embody higher productivity and quality characteristics.

In contrast to the merchandise trade, the services and invisibles balance of Brazil shows a consistent deficit over time (see Table III-3). The bulk of such foreign payments is factor-related, especially interest payments, which take up almost 80 % of total expenditures. As shown in Table III-3, the net negative balance for factor services jumped from 1.6 % of GDP in 1977 to an average of 5.4 % in the years 1982/85, declining slightly thereafter but still composing one of the major constraints to Brazilian economic development. Factoral services are treated in more detail in other sections of this Report and we shall, thus, concentrate below on non-factor services (NFS).

As shown in Table III-3, NFS imports have maintained a stable relationship to GDP, around 0.5 %. Yet, they have increased their relationship to merchandise imports, from an average of 16 % in the period 1977/81 to the present 20 %. This is mainly due to the sharp

reduction of the latter imports. Table III-8 presents a break-down of NFS imports. Almost half of such expenditures are for transport services and some 5 % for insurance. Such expenditures are not covered by the Brazilian export incentives scheme, which operates at FOB level, limiting thus its efficacy (Carvalho 1990).

The other services signaled out in Table III-8 are directly related to technology. They account for 15 % of NFS imports. Most of such expenditures (70 % of the technology-related NFS) are for equipment leasing. A substantial part of such equipment is used for oil exploration, which, as we shall see below, also absorbs a large share of the payments for specialized technical services as well. The latter take up close to 20 % of technology-related NFS, and are discussed in more detail further below.

Payments for patents are almost negligible (U.S. $ 3 million), due to the fact that Brazilian legislation forbids such payments between affiliates and foreign parent-companies. Industrial technology licensing, which is used mainly by the capital goods industry, also plays a minor role in services imports and it is analyzed in more detail in Section II.3. below.

To sum up, there is now a consensus that it is necessary to reduce both the level and nature of import controls in Brazil, i.e. to cut down trade barriers and to use tariffs as the main policy instrument. However, there seems to be some disagreement about the main purpose of such an import liberalization. While some regard it primarily as a means for exerting pressures on local producers to lower price increases, others look at higher imports as a mean of fostering the technological and productive capacity of the economy. Nevertheless, another consensus seems to be emerging, namely that the liberalization must be selective, in order to avoid disruptions of the type which characterized the Argentinian experience and, more recently, that of Mexico.

As shown in Table III-9, Brazilian imports come mainly from the industrialized countries, especially the EEC, which, as a group, represents the main supplier to Brazil. Within the EEC, the Federal Republic of Germany (FRG) is the larger supplier of Brazil, concentrating about 40 % of Brazilian imports from the Community. In the recent past, France and Italy held approximately the same share of Brazilian imports (16 % each of the trade with the EC), with the U.K., closing the rank as a major supplier with about 11 % of the corresponding Community trade. Therefore, the four above-mentioned countries account for over 80 % of the Brazilian imports from the EEC. Except for the FRG, with which Brazil had a trade deficit in most of the years of the period 1970/1987, Brazil tends to run trade surpluses with all other major EEC suppliers.

II.2.1.3. Exports

As mentioned above, the role played by exports in the Brazilian economy has increased substantially (see Table III.3). Such an expansion was accompanied by a major diversification of trading partners and by dramatic changes in the composition of exports.

Table III-10 traces the changes of the relative weights of trading partners of Brazil during the 1960/88 period. An important evolution has been noted in the increase of the share of exports to developing countries. Such exports jumped from 10.4 % (1960) to 28.2 % (1988) of the corresponding total. Among developed countries, the main feature is the relative decline of the U.S. presence. The latter, although is still being the main individual trading partner of Brazil, now accounts for about 26 % of total exports, compared to 44 % in 1960. The importance of Eastern European countries has also declined while the relative

roles played by the Japanese and Canadian markets have increased substantially. The EEC countries have emerged as a key and sustainable market destination for Brazilian products, with a share equivalent to and surpassive that of the U.S.

As regards to the composition of exports, the changes have been also substantial. In broad categories, there was a sharp decline of the role played by primary products, especially coffee, and an increase in the relative weight of specific manufactured and semi-manufactured products. Using a simple computation to account for "revealed comparative advantage" in the export performance of Brazil (see Carvalho, 1990), we can see (Table III-11) that Brazil tends to have stronger comparative advantages in resource-intensive products, both of mineral (non-metallic minerals and metallurgy) and agricultural origin (leather goods, pulp and paper, rubber products, and food products). Although the Table shows an important comparative advantage in chemical products this is strongly influenced by the classification of vegetal oil and oil-cake, flour and other solid residues of oil seeds in the chemical industry. A more proper classification under the food products industry, would increase the latter's share of exports by approximately 60 %, reinforcing its role as the main Brazilian exporter as well as its "revealed comparative advantage". The sectors which show a relative comparative advantage account for over 60 % of total Brazilian non-primary exports and such share (see Table III-12) has remained relatively stable during the eighties, albeit with a slight decline from 1980 to 1987 (from 66 to 62 %).

As regards services exports, Table III-3 shows that they hold a small and stable relationship both to GDP and to merchandise exports (around 0.5 and 5.4 % on average, respectively). Two-thirds of such NFS exports are accounted by transport services, which are strengthened by regulations concerning the mandatory use of Brazilian ships under freight conferences (see Table III-5).

Technology-related services (mostly specialized technical services) account for only 4 % of NFS exports, according to Central Bank data. However, such figures probably grossly underestimate the earnings abroad from the sales of technical services. Gonçalves (1989) estimates that only 12 % of the net profits generated abroad by the firms exporting services of construction and engineering are sent back to Brazil.

Exports of the construction and consulting sector suggest that Brazilian comparative advantages lie in areas such as transport and energy, where the Brazilian market, especially public investment, offered scope for learning. The studies available refer mainly to the experience of the late seventies/early eighties and they show that other developing countries were the main market for Brazilian exports of services (see Gonçalves, op. cit. for a review of such studies). Nevertheless, Guimaraes (1990) reports that at least one of the main Brazilian construction firms has recently established a subsidiary in Portugal in order to profit from the entry of that country into the EEC.

The evidence about the linkages between exports of technology-related services and industrial goods in Brazil is mixed. A study of the early eighties (FUNCEX 1982) argues that such-exports are indeed linked with contracts for engineering services leading to exports of equipment and building materials such as steel, prefabricated construction modules, etc., and with contracts for construction and assembly including the supply of industrial goods. However, the same study reports the scepticism of industrial enterprises about the effectiveness of such linkages, which must be further researched.

The decline of Brazilian exports of specialized technical services, which had reached a peak of U.S. $ 141 million in 1981 and were reduced to U.S. $ 76 million in 1987, probably

reflects the crisis of other developing countries. It is also influenced by the lack of supportive Government policies, especially with respect to credit facilities for such services.

As concluded above, Brazilian exports seem to be based mainly on the use of the country's abundant natural resources. However, the intensity of use of natural resources for manufactured exports has often required the deployment of considerable technical inputs. This is evident in the case of the soya-complex (grain, oil, cake, etc.). In fact, the diffusion of soya throughout the Brazilian territory, which made possible the massive expansion of production and exports, was the result of local research and development efforts.

Notwithstanding the results of the recent export-drive, there is a growing concern in Brazil about the competitiveness of its exports. Part of the existing competitiveness is often considered to be of a "spurious nature", since it is predicated upon the low wages and overall proverty of its people. For specific products, though, such as aircraft, some types of simple machine-tools, armaments, etc., the capability of the local industry to design and manufacture goods targeted to specific markets has been recognized as an important source of export performance. The same applies to some technology-intensive but mature services such as engineering and construction.

Nevertheless, there is a widespread concern about the small share of technology-intensive products within the Brazilian exports. As shown in Tables III-11 and 12, the country's export share and its revealed comparative advantages in industries producing technology-intensive products, especially the electrical and electronic industry and the non-electrical machinery sector, are very low. At a more disaggregate level, Table III-7 is drawn for a set of products identified by several international sources as being "technology-intensive" (CEPAL, 1989). Such a classification shows that the share of these products in Brazilian exports is less than half of the corresponding share in total world exports. A break-down of such exports is shown in Table III-6.

Concerns have increased in the recent past, partly because of the international debate about the policy requirements for "produced comparative advantages" (Lafay et al. 1989), and partly because of a declining relative export performance by Brazil. Thus, although Brazil is the ninth producer of manufactures in the world, it ranks only nineteenth in terms of exports. Moreover, the Brazilian share of world exports, which had increased from 1.3 to 2.3 % between 1976 and 1984 has declined since then, to 1.5 in 1987 (Carvalho 1990).

Therefore, a strong current of opinion seems to be slowly emerging about the need to integrate more closely the foreign trade policy of the country with its industrial and science and technology policy instruments and objectives. Such an approach differs significantly from past performances when the three policies had been managed separately and often in conflictive ways. Although the present government has started to dismantle the export-incentive system, it has not, as yet, made clear any measures related to the other policy areas.

II.2.1.4. Regional integration

The threats to Brazilian exports which stem from internal factors, such as the lack of investment in productive capacity, are being compounded by the international context as perceived in Brazil. The increased protectionism and the trend towards regional integration are viewed as creating structural and longer term risks to Brazilian exports. With respect

to protectionism, non-tariff barriers (NTB) are estimated to have reduced Brazilian exports by at least 10 %, with losses evenly distributed between agriculture and manufacture exports (circa U.S. $ 2 billion each).

Pereira (1989) evaluates the protection derived from the existence of non-tariff barriers applicable to Brazilian exports by the EEC and U.S. This evaluation was based on two indicators : (i) the coefficient of frequency, reflecting the percentage of the number of commodities affected by non-tariff barriers, and (ii) the coefficient of coverage indicating the percentage of the value of the commodities subject to non-tariff barriers.

As shown in Table III-14 the level of protection in the U.S. tends to be higher than in the EEC for mining and manufacturing and lower in agriculture. The EEC coefficients indicate the absence of non-tariff barriers in the case of mineral raw-materials. On the other hand, the coefficient of frequency associated with agricultural products in high, reflecting the Community's agricultural policy. However, the coefficient of coverage referring to Brazilian agricultural products is close to zero, bearing out the fact that the NTBs associated with the EEC common agricultural policy affect only few items exported by Brazil. Nevertheless, some of such items, such as meat, fruit-juice, tobacco and sugar are important exports from Brazil, accounting for about 20 % of total exports.

As regards manufactured exports, Burle (1989) provides data disaggregated at product level (excluding food products). As shown in Table III-15 the developed countries, especially the U.S. and the EEC, apply NTBs to products for which Brazil has "revealed comparative advantages".

Pereira (1989) differentiates between the non-tariff barriers defined by common commercial policies of EEC and those adopted individually by specific countries (Table III-16). The results obtained bear out the fact that the restrictions derived from common policies of the EEC are more frequent and affect Brazilian exports more than the non-tariff barriers imposed by individual countries. That result is undoubtedly significant from the point of view of an evaluation of the possible effects of the EEC-92.

There is a widely diffused opinion in Brazil that protectionist barriers will be strengthened by the integration in North America between the U.S., Canada and Mexico, in Europe by the EEC 1992 project, eventually widened by closer links with Eastern Europe and, finally, in Asia by the informal but not less effective integration between Japan and the local NICs. It is generally believed in Brazil that notwithstanding the positive trade effects that wider markets may have and despite the liberal rhetoric of all Governments involved, Brazil, as an outsider to such integrated markets stands to lose market shares.

With respect to the EEC, it is relevant to examine first, in more detail, the composition of Brazilian exports. As shown in Table III-18, Brazilian exports to the Community are more diversified than its imports, both in terms of products and partners. As regards the latter, the Netherlands stand out as the main market for Brazilian products (23 %), followed by FRG (19 %), Italy (17 %) and France (12 %). The predominance of the Netherlands can be mainly explained by port facilities, especially suitable for the handling of the type of goods Brazil exports to the EEC. In fact, three-fourths of the imports of Brazilian products by the Netherlands are composed of agricultural products, food, beverages and tobacco. Moreover, exports to the Netherlands account for around 40 % of the EEC's imports of food, beverages and tobacco, chemicals and basic metals from Brazil (see Table III-18, parts B and C). It is estimated that over 80 % of the products shipped to Rotterdam go to the FRG, making the latter the main importer of Brazilian products.

Intra-firm trade probably explains part of the concentration of some exports in specific countries. Thus, the absorption by the Italian market of 63 % of Brazilian exports of transport equipment is clearly related to FIAT's global strategy. However, further research is needed to explain other very high concentration ratios, such as 50 % of machinery and equipment (electrical and non-electrical) in Italy or 55 % of wood products and furniture in the U.K.

As shown in the same Table, Brazilian exports to the EEC consist mainly of agricultural products, food, beverages and tobacco, which account for about 60 % of total exports. More technology-intensive exports (chemicals 4.7 %, machinery 5.3 % and transport equipment 3.6 %) account for 13.6 % of total exports and go mainly to the Netherlands (chemicals, with the caveat above), FRG (all three), Italy (all three) and France (transport equipment).

As shown by Guimarâes (1990), Brazil is a marginal supplier to the Community - on average, Brazilian exports represent 1 % of the EEC imports with the largest shares pertaining to the Netherlands (2.4 %), Spain (1.8 %) and Italy (1.3 %). At the sectoral level the same order of magnitude applies, except for food products and tobacco, where the Brazilian share of EEC imports is around 7 %. Exports at the product level are shown in Table III-19. Three products - oil cake, flour and other solid residues, coffee and iron ore - account for 40 % of total exports.

Probably the more sensitive group of Brazilian exports with respect to EEC-92 concerns the more technology-intensive yet mature and scale-intensive products. In such cases the advantages of enterprises located within the Community vis-à-vis third parties are likely to increase. For other groups of products, the major source of competition to Brazilian exports is likely to come from other third parties to the Community, especially from other NICs and from more developed countries, such as the U.S., for temperate-zone products like in soya and beverages. Hence, for the groups which compose the bulk of Brazilian exports to the Community, a decisive factor will be how the EEC arranges its evolving policies on regional and national preferences.

A substantial part of Brazilian exports of the more technology-intensive products is made by intrafirm trade and will thus respond to the global strategies of multinational firms. Despite the uncertainty, Brazilians perceive that, in order to take advantage of the implementation of the EEC 92 project, several (leading) Brazilian firms will have to intensify the establishment of productive facilities within the Community. This will be aimed either for forestalling barriers to trade or for profit from the expanded 1992 market. Guimarâes (1990) reports several of such cases, covering a wide spectrum of sectors - from producers of agricultural products, such as orange juice and soya derivatives, to car parts, covering in-between, producers of apparel goods and wood agglomerates.

Latin American integration has been referred as a possible counter-balance to other regional integration movements. However, the past record of ALADI and of its predecessor ALALC (Latin American Free Trade Association) do not warrant much optimism. Yet, it is of interest to note that within the ALADI framework, Brazil and Argentina signed, since 1986, 22 protocols of agreement covering a wide range of subjects, from the establishment of binational enterprises to sectoral agreements (wheat, capital goods, automotive industry, etc.). Such agreements were consolidated in 1989 by a treaty which has the objective to establish a common market between the countries in the medium term. However, this treaty has not been ratified by the two Congresses as yet.

As shown above (Tables III-9 and 10), trade with ALADI countries plays a significant part in Brazil's external transactions. Within this trade, the share which is negotiated under the norms of the Montevideo Treaty has steadily increased during the eighties, from 27 % in 1980 to 67 % in 1987 (Araujo Jr. 1990). The trade of Brazil with its ten ALADI partners is fairly concentrated with four of them : Argentina, Mexico, Uruguay and Venezuela, which supply about 70 % of the Brazilian imports from the region and purchase around 56 % of the corresponding Brazilian exports. Argentina has increased its role as a regional supplier to Brazil with its share of regional imports increasing from 28 % in 1980 to 38 % in 1988, making it the largest supplier of Brazil.

Within this context, it is useful to examine in more detail the Capital Goods Agreement (CGA), one of the protocols signed between Argentina and Brazil in 1986. The most successful of the sectoral trade agreements established at that date, the CGA illustrates well both strengths and weaknesses of the way in which Latin American integration has been carried so far.

The CGA establishes a partial free trade zone, circumscribed to capital goods. The universe of products embraces the majority of electrical and non-electrical machinery, their parts and components and non-automotive transport equipment. It excludes electronic products because of the Brazilian Information Policy and automotive transport equipment, which is dealt with under another agreement (which has not progressed). As originally conceived the CGA should be a programme of industrial complementarity between the two countries, based on intraindustry trade.

From the signature of the CGA to the present there were four rounds of negotiation on the common list. Within this list non-electrical machinery predominate from a group of products produced in short batches (e.g. machine tools). Trade on parts and components is limited to a percentage of commerce of finished products. Custom-built equipments were excluded, pending upon specific negociations which refer, among others, to procurement policies by state enterprises and credit facilities. As shown in Table III-22 the CGA had notable results in terms of volume of trade, which has increased four-fold over the period 1986-88.

The share of trade of capital goods between the two countries covered by the Agreement has also increased, especially for Argentina, where exports under the CGA accounted for 31 % of her exports of capital goods to Brazil in 1988. For Brazil, such share is much less important (14 %) in 1988. Thus, the Argentinian industry seems to have benefited more, increasing its exports to Brazil over sixteen times in the 1986/88 period.

In spite of such results there are considerable doubts about the capacity of the CGA, as it is now, to act as a force of transformation for the two industries. In practice, the common list included in the CGA has, so far, been defined on the basis of offers of the producers of the two countries, which reflect their present comparative advantages. Since producers are the main negociators and they must approve the inclusion of products in the common list, they are in a priviliged position to avoid major competitive threats from the other country. As a consequence, the pressure emanating from the CGA to alter the lines of production is very limited.

Moreover, the two countries have postponed sine die the date on which their tariffs vis-à-vis third parties should be unified. Finally, several important government measures which should complement the trade incentives and which are critical for the more ambitious restructuring objectives, such as the implementation of a fund for investments in the two industries and coordination of State purchasing policies, have not been designed as yet. It

is not clear if the new governments, recently elected in the two countries, will have the political will to implement such measures.

II.2.2. FOREIGN DIRECT INVESTMENTS

Brazil is the main host-country of foreign investment in the developing world (BNDES 1988). Until recently Brazil provided foreign investors with an attractive combination of a protected and highly profitable internal market, with low barriers to entry and high barriers to exit, and few institutional constraints to the operation of foreign-owned enterprises.

The law which regulates foreign investment in Brazil (Law 4131) dates back to 1962, which, in the Brazilian context, is an example of stability. This Law explicitly states that the legal treatment afforded to foreign investments (either as direct ownership commitments or in financial forms) is the same as the one applicable to national investments, thus restricting any form of discrimination between the two.

The activities, though, to which a differential treatment is applied, depending on the origin of capital, can be grouped in four broad categories :

- activities connected with national security, such as means of communication (TV, radio and newspaper) and establishments located in frontier zones;
- activities connected with the exploitation of mineral resources;
- supply of some services - banking, insurance and transport (maritime and airborne); and
- activities with a high technological content - consulting and engineering services, electronic data processing equipment and telecommunications' equipment.

In all cases, except for media enterprises and the activities of the second group, joint ventures are allowed, provided Brazilian citizens hold more than half of the capital of the enterprises. In practice, with the exception of the informatics and telecommunications' equipment, there are no sectors in the manufacturing industry in which the presence and activities of foreign enterprises is restricted.

Profits of foreign enterprises can be exported up to 12 % of the total registered capital (investment and reinvestment) without additional withholding taxes. The latter are applied if such remittances are above such a limit. There are no pre-established limits or timing for capital repatriation, although the Law 4131 contemplates the possibility of suspending such payments in cases of balance of payments crisis. The same Law forbids payments to affiliates or parent companies abroad for patents and trade marks. Yet, as shown by Barbosa (1979) after the prohibition was enforced, the firms simply shifted the heading under which remittances were made, from "patents" and "trade marks" to "technical assistance", maintaining the overall level of remittances the same. On the whole, the constraints on payments mentioned above are sufficiently elastic in international terms not to have hundered the operations of foreign firms in Brazil in any significant way.

Given the institutional context sketched above, we can examine the pattern of direct foreign investment in Brazil. As shown in Table IV-1, the inflow of foreign investment was positive and increasing during the sixties and seventies but declined in the eighties, when, for the first time in many years it showed net negative results. Moreover, since 1984 the entry of foreign capital which has been increasing, took the form of debt conversion (Table

IV-2). In 1988, this accounted for over three-fourths of gross investment. The share of net investment taken up by profit remittances declined from a half during the sixties to a third during the years 1973/77, but increased thereafter. During the eighties, especially since 1984, profit remittances exceeded net investments. If debt conversion is excluded from the inflow of resources, then in all years since 1983, profit remittances have surpassed investments.

The data used in the Tables discussed above are balance of payments information. The other main source of data on foreign investment in Brazil comes from the registration of such investments (and reinvestments) at the Central Bank, on the basis of which profits and dividends remittances are allowed.

Table IV-3 presents data from such registry for the seventies and eighties. It confirms the sharp drop in foreign investment and reinvestment since the middle of the last decade - especially the former. Thus, for the years 1985/88 new investment falls to almost a fourth of the amount invested in the previous four years, while reinvestment amounts to 40 % of the 1981/84 period. As a consequence, the reinvestment/investment ratio increases from 46 % in 1981/84 to almost 70 % in 1985/88.

If we combine such data on reinvestment with the high debt conversion of the same period, the conclusion is that foreigh investment has provided very scant relief to external constraints of the Brazilian economy during the recent past. Instead, the corresponding activities controlled by foreign firms were being financed largely by financial resources generated internally.

Nonetheless, foreign enterprises have contributed considerably to easing the foreign exchange constraint by providing a hefty trade surplus, as shown in a special study undertaken by CACEX and reported in BNDES (1988).

Table IV-4 shows that during the 1978/86 period foreign enterprises accounted for 27 % of total Brazilian exports, for 18 % of total imports and for 68 % of the total trade surplus. However, as pointed out by BNDES (1988), the latter result is heavily influenced by oil imports, which amounted to 43.6 % of total imports and which are purchased by the State. If we exclude oil imports, the share of foreign enterprises in the total imports and in the trade surplus would, respectively, increase to 32 % and decrease to 24 %.

As shown by Bauman (1990) foreign enterprises were important beneficiaries of the trade incentives mechanisms. For the most important of such incentive programmes (BEFIEX) his data show that 29.3 % of total exports of foreign enterprises were performed under BEFIEX incentives. Most of this trade is intra-firm. In 1977 (the latest year available) intra-firm trade accounted for 70 % of total foreign trade of U.S. subsidiaries located in Brazil (BNDES). More recent data, for some sectors such as automobile and informatics, give even higher shares - three-fourths in the first case, in 1985 (BNDES) and over 90 % in the latter (our estimates for recent years, based on interviews).

The trade results reported above are commensurate with the weight of foreign enterprises in the Brazilian economy. Assessments of the role played by such enterprises are heavily influenced by the universe in which they are placed, since they tend to be relatively large firms.

To our knowledge, the study which used the largest universe is that by Wilmore (1987). The study covered a data base of almost 50 thousand firms of the manufacturing sector, for the year 1980, accounting for 95 % of the industrial census value of production for that

year. Defining foreign enterprise as firms where non-residents held more than 50 % of capital, Wilmore identifies 794 foreign firms, which accounted for 22.5 % of the domestic market and for 31.2 % of exports. Lowering the cut-off share of foreign capital to 10 %, the number of foreign enterprises would increase to 1089 and their share of the domestic market and of exports would increase to 27.5 and 38.3 % respectively.

Taking into account only the largest firms and using the 50 % ratio we can see (Table III-5) that the share of sales held by foreign enterprises increases from 28.7 % for the 500 largest to 37 % for the 25 largest. The same Table shows that during the eighties the share of foreign enterprises falls. This is consistent with the data on investment presented above.

The Central Bank registry of foreign investment provides information on investors' countries and on sectors of investment. However, such information may be partly misleading for a number of reasons. For example, foreign direct investments are registered according to the enterprises' stated nationality, which may be chosen according to their own fiscal and legal preferences. Thus, Panama holds 3 % of total foreign investments in Brazil, a share similar to Italy, and Switzerland is the fourth largest investor in Brazil, with a share (9.15 %) comparable to Japan (9.64 %). Notwithstanding the traditional presence of Swiss firms in sectors such as the food industry (which absorbs 15 % of total Swiss investment), the high share mentioned above can be ascribed to companies registering in Brazil under Swiss nationality, such as part of the operations of Fiat. In fact, the automobile industry holds 30 % of total Swiss investments. Furthermore, almost 7 % of total investment is registered under "holding companies". This is a veritable black box as regards to the origin of such investments, some of which could involve part of the capital flight from Brazil which is subsequently reinvested in the country under foreign status.

With the above caveats, Table IV-6 shows that almost two-thirds of foreign investment in Brazil is in manufacturing industry and, within industry, in the more "modern" branches : automotive vehicles and parts (12.5 % of total foreign investment), basic chemical products (9.3 %), mechanical (8 %) and electrical and electronics products (8 %). Within services, investment is concentrated in export-import companies (3.8 %) and commercial banks (3 %). Investment in mining activities holds a relatively minor share (2 %).

As regards to countries of origin of investment, the USA holds the main share (29 %) followed by the FRG (15.3 %), Japan and Switzerland (above mentioned). These four countries hold 63 % of total foreign investment in Brazil. The EEC as a group hold 35.9 % of total investments, although such a share, for the reasons previously stated, probably underestimates the Community's real presence. Within the EEC, the FRG is the main investing country, holding 43 % of the Community's investment. If we add investments from the U.K. (17.4 % of EEC total), France (11.3 %), Italy (9.9 %) and the Netherlands (8 %), we obtain practically all investments from the EEC in Brazil.

Table IV-6 provides a more detailed breakdown of investment by sectors for the EEC countries, USA, Japan and Switzerland. It shows that the concentration of investment by sector is different for each country. Thus, U.S. investments are concentrated in the mechanical, electrical and communications and chemical industries, while Japanese investment is stronger in steel and electrical and communications' industries. Within the EEC group, German investment is heavily geared to the metal-mechanic complex, with metallurgy (9.7 %), mechanical (14 %) and automotive (33.2 %) holding 57 % of total investment. U.K. investments are heavily concentrated in petroleum derivatives, French investments in chemicals, Italian in the automotive industry and steel and Dutch investments in electrical, electronics and communication and chemical industries.

Although the majority of foreign direct investments in Brazil are performed under the form of wholly-owned subsidiaries, Zoninsein (1985) identified 1420 joint-ventures. His data shows that European firms were more willing to share ownership control than their American and Japanese counterparts. Thus, only 18.4 % of the total number of joint-ventures has U.S. firms as their partner, as compared to 55 % with European partners and 10 % with Japanese firms.

The majority of such joint-ventures were established with Brazilian private firms and with the foreign partner usually holding less than 50 % of capital. Although the number of joint-ventures with State participation is small (57) their economic significance is high because they include some of the main ventures in mining and minerals processing (e.g. iron and bauxite), steel metallurgy, cellulosis, petrochemicals and automobiles. (Fiat of Brazil was partly owned by the State of Minas Gerais). In fact, such activities seem to concentrate the bulk of foreign investment in joint-ventures. Except for petrochemicals, telecommunications' equipment and some investment in non-electrical machinery, the role of joint-ventures in more technology-intensive sectors is limited.

Subsidiaries located in Brazil perform mainly minor adaptations of processes and products to local conditions and train their suppliers in know-how skills but not on know-why. Although a recent (1988) Law on fiscal incentives for technological development included foreign-owned firms as potential beneficiaries, there is considerable scepticism in various circles in Brazil on whether such incentives are strong enough to counter the preferred localization of innovation activities in the more developed countries.

II.3. THE BRAZILIAN SCIENCE AND TECHNOLOGY SYSTEM

II.3.1. ECONOMIC DIMENSIONS AND CHARACTERISTICS OF THE BRAZILIAN S&T SYSTEM

The Brazilian contribution to international scientific and technological advancement appears to be quite below the role played by this country in its international economic relations. Thus, books and articles on science and technology produced by Brazilian authors accounted for 0.65 % of the world total in 1986, scientific papers published by Brazilian authors in journals of international circulation over the period 1973/84 were only 0.31 % of world total and citations of Brazilian authors were only 0.18 % of the overall total in 1980 (computed from BID 1988). As regards patents, out of about 60 thousand patents in the US in 1983, only 23 were given to Brazilian residents (BNDES 1988).

This performance reflects the low level of R&D expenditures by Brazil, which amounts to around 0.7 % of its GNP. This is less than half of the share allocated by other NICs, such as South Korea, and around a third of the level of expenditures by the advanced industrialized countries. Taking a National Science Foundation (1988) sample of 66 countries, which account for most of the market-economy world, Brazil's share of the total R&D expenditures was 0.97 % in 1985.

It is important to notice that Brazilian statistics on R&D encompass a wider range of activities than OECD countries, including, for instance, technical services. For example, it was recently estimated that out of the total expenditures for science and technology by the Federal Treasury (the main source of funds for S&T in Brazil) only 52 % were for R&D strictu sensu. (CNPq, personal communication). Consequently, the effective relative participation of Brazil in the international scientific and technological efforts is even smaller than the figures cited above.

II.3.1.1. The Brazilian S&T system : complete but weak and heterogeneous

According to the Brazilian National Research Council data bank of institutions which perform scientific and technological projects, there were 463 non-enterprise institutions in the system in 1983/85 (CNPq 1987). In the 1985 census, 1288 industrial enterprises reported performing R&D expenditures (FIBGE special tabulation for this study).

Within the first group, 121 (26 %) were higher education institutions. An equal number were institutions "specialized in S&T", of which 21 were privately-owned and 189 (41 %) were public entities depending either on the Federal (70), State (102) or Municipal (17) governments. Ten private foundations and 22 private research-associations completed the picture. Of the government agencies, 105 had research centres, of which 36 were located in Federal institutions, 60 in State agencies and 9 in local government. Such system employed about 56 thousand researchers, of which two-thirds worked at higher-education institutions, mainly at the Federal government universities (see Table V-1).

The system expressed by such numbers is wide. If there were a check-list with the institutions which should comprise a "science and technology system", the application of

such checking to the Brazilian system would leave practically no blank spaces. Nonetheless, the system operates poorly. It is complete but weak, like an undernourished adult.

The evidence of limited performance is widespread. Only 2 % of industrial enterprises included in the industrial census reported R&D activities and their resources covered mainly adaptive technology tasks, related mostly to detail engineering and production technology. They spend only 0.48 % of their earnings for R&D. This percentage is much below international standards, bearing in mind that Brazil is the ninth country in the world manufacturing ranking. Their patenting, even in Brazil, is very limited. Three-fourths of the invention patents requested in the period 1986/88 were by non-residents in Brazil and it is estimated that about half of the patents requested by residents were by subsidiaries of foreign companies. U.S. residents request the largest proportion of invention patents around 30 % in the period 1986/88, followed by the FRG (about 10 %), France and the U.K. (circa 5 % each) and Japan (3.4 %). Such a pattern is similar to that observed in other international relationships of Brazil.

Imports of technology have declined the last ten years, as shown in Table V-2, influenced especially by the reduction of "specialized technical services", which are purchased mainly by public enterprises (see below). Since expenditures by the public administration accounted for less than 3 % of technology imports over the period 1980/89, most of such imports were made by the enterprise sector. In 1985 (the only year for which we have more precise estimates of the enterprise sector expenditures on R&D), the ratio of local expenditures to imports of technology is 1.8 to 1. This shows the heavy reliance of the enterprise sector on imported technology, compared to industrially-advanced countries. For example, the equivalent ratio for Japan is 7 to 1. (computed from OECD 1987). As argued elsewhere in more detail (e.g. Erber 1983), what characterizes technological dependence is not a high level of technology imports but a low ratio of local expenditures to imports. In Brazil, we have a situation in which imports of technology are low and local expenditures even lower.

As shown in Table V-2, 80 % of the foreign technology payments were made for the purchase of specialized technical services. Payments for patented technology are insignificant (3 %) with the balance going to payments made for licensed non-patented technology. There is abundant evidence on the limitations of technology transfer under licensing agreements (see Erber 1980 for a survey). In fact, licensing agreements provide the licensee with skills of production engineering and detailed design but do not usually include the transfer of innovation skills necessary for basic product and process design and other R&D activities.

Nonetheless, such transfer, albeit limited, is in various cases quite expensive compared to the purchase of strictly technical services. The latter are mainly undertaken on an arm's length basis with much less interaction between the supplier of the service and the user than is the case in licensing, where long-term relationships tend to be established, conducive to learning. On the other hand, the use of technical services from abroad does indicate a local capability of search and management of complex technological activities.

Turning to the other end of the spectrum, one can add to the indicators of scientific publications, already mentioned, the low level of "production" of the higher-education system. In this case, the teaching and research staff involved with masters and doctoral courses produced 0.55 "works" per capita in 1984 (CNPq 1987).

The pattern sketched above is not uniformly distributed. Thus, as regards expenditures on R&D by the enterprise sector, six sectors (electronic equipment and apparatus, automobile,

metal minerals, non-ferrous metallurgy, basic chemical products except oil, oil refining and petrochemicals) account for 78 % of total industry R&D expenditures. The two first sectors report around 15 % each of the total, the second two around 13 % each and the last two about 11 % each (see Table IV-3).

Within this group of sectors, non-ferrous metallurgy, electronics, metal mineralss and basic chemical products present an R&D intensity (measured in terms of R&D expenditures as a percentage of earnings) above the average (0.48) - respectively, 5.12, 2.52, 1.12 and 0.94. The other two sectors, automobile and oil and petrochemicals have a low intensity - respectively 0.55 and 0.18.

Brazilian R&D efforts seem to be concentrated in the processing of natural resources. This is a pattern which is coherent with the "revealed comparative advantages" for exports, previously discussed, and with the effort of import substitution of materials which characterized the second half of the seventies and was carried forward into the eighties.

The two industries which are not resource-intensive and use assembling processes, electronics and automobile, respond to different rationales. In the first case, the relatively high level of expenditures and the high intensity are strongly affected by the informatics policy, which has led the Brazilian-owned firms to invest between 8 and 10 % of their earnings on R&D. In the automobile industry the high level of expenditures is mostly a consequence of the size of the enterprises, which, as indicated by the low intensity, seem to rely mainly on the technology supplied from abroad by their parent companies.

The very low R&D intensity of the oil and petrochemical industry is probably due to their reliance on imported technology, either through technical services (in the case of oil) or through joint-ventures in the case of petrochemicals. Nonetheless, it is important to notice that PETROBRAS, the State oil company, has a significant R&D center and its petrochemicals subsidiary is in the course of setting up another.

A similar sectoral pattern emerges from the loans granted by FINEP (Financiadora de Estudos e Projectos), the Federal Government development bank for science and technology, shown in Table V-4. It is noteworthy that although the metal-mechanic group still predominates (31.2 % of the loans value in 1985/89), both electronics and chemical/petrochemicals have increased their share in the last five years, as compared to the period 1973/78, respectively from 7 to 22 % and from 4 to 14 %.

A significant number (75) of large enterprises performing R&D activities have recently established an association - ANPEI. For statistical purposes ANPEI groups its members in three large sectors - metal-mechanic, chemical and petrochemicals and electro-electronics. As shown in Table V-5, half of the enterprises and of the R&D expenditures is accounted for by the second group, but the last one presents the highest levels of average spending and intensity.

Finally, a recent study of leading industrial enterprises (Ferraz et al. 1990) shows that electronics was the sector which tended to spend more on R&D as a share of sales - (a minimum of 2.9 %), while in other sectors R&D intensity was around 0.6 %.

Imports of technology follow a similar pattern, albeit more diffused. Technical services are used mainly by process industries - oil (included in "mining" by INPI), metallurgy (especially steel) and chemicals. The most important assembly industry users of such services are the mechanical and transport industries. As a consequence of the heavy investments in electric power generation and distribution such services are highly demanded by this sector too.

Finally, it is important to notice the use of imported services by scientific institutions and by enterprises of engineering and consulting (see Table V-7). Licensed technology (which accounts for less than a sixth of total import payments) is used mainly by the capital goods sector, especially custom-built machinery and equipment (56 % of total licensing payments), metallurgy, chemicals and informatics (see Table V-2).

In total, over the last decade, five sectors (minerals, mainly oil; metallurgy, mainly steel; electric power; chemicals; and non metallic minerals) accounted for three-fourths of Brazilian payments for imported technology. The first sector alone was responsible for a third of the expenditures.

Turning to differences by size and origin of capital, a study based on 1982 income tax data for the largest 5840 industrial enterprises (accounting for 85 % of industrial value added) shows that expenditures for local R&D were performed mainly by nationally-owned firms, especially the larger firms. Thus the 10 % larger enterprises accounted for 54 % of total R&D expenditures. Also, in sectors where medium-sized firms predominate, such as the non-electrical machinery industry, the largest firms within the sector tend to invest more on R&D (Brogg and Matesco, 1986).

About 92 % of expenditures for local R&D were performed by nationally-owned firms, which composed 81 % of the sample. As regards payments abroad for royalties and technical assistance the same study shows that foreign-owned firms, which were only 3 % of the number of firms making such payments, accounted for 20 % of these transfers (ibid.).

More recent data for 134 leading industrial firms (Ferraz et al. 1990) show that, on average, such enterprises spent 2.7 % of their earnings on R&D, with locally-owned firms spending, on average 3.4 % and foreign-owned firms investing 1.2 % of their earnings on R&D. As noted above, ANPEI members are large enterprises, with, on average, more than 5400 employees and average sales of around U.S. $ 530 million. As shown in Table V-5 for 1987, 53 of the members invested in R&D circa U.S. $ 173 million, more than half (55 %) of the total estimated investment by the enterprise sector in 1985. However, as shown in Tables V-5 and 6, the level and intensity of spending on R&D ANPEI members varies considerably - from 0.1 % of sales to 9.8 %. Nevertheless, on the whole, members spend 1.6 % of their sales earnings on R&D, substantially more than the average of industry.

Such evidence on size and origin of capital confirms the pattern detected by several sector studies, surveyed in Erber (1980), and is corroborated by census data. Thus, the R&D activities of the six leading sectors (which account for 78 % of total industry R&D) is performed by 209 enterprises only. Most of the large enterprises have their own inhouse R&D centers (72 % of the firms interviewed by Ferraz et al. in 1989). Also most of the medium and small size enterprises have limited R&D activities. Coupled with the under-equipment of research institutes this leads to a limited and constrained relationship between the enterprise sector and the S&T system, with very weak synergic effects.

In fact, a recent study of the services provided by the 65 main Brazilian research institutes (IPT 1987) shows that only 27 % of such services are related to R&D strictu sensu. The rest consisted of technical services, mainly tests and analyses (33%), quality certificates (13 %), standards and norms (10 %) and information services (8). Within R&D services, most (44 %) are of basic and applied research, 37 % are for process development and the rest for product development. More than half (53 %) of the demand for the services of the research institutes comes from the technical, chemical, metallurgical and electro-electronic industries, confirming the sectoral pattern previously described.

As with the productive sector, there is also a great heterogeneity in the technical capability of the institutes and in their links with the productive sector. Some institutes, such as the Aeronautics Technological Center, perform high-quality tasks in close relationship with the enterprise sector. Also, some research centers, such as the Universities of Campinas and São Carlos in the State of São Paulo and the Research Institutes of Telecomms (CPqD), Space Activities (INPE) and Aeronautics (CTA) have acted as spin-off nuclei for several high-tech enterprises, especially in the areas of electronics, optical instruments and precision mechanics. Such evolutions seem to be gathering momentum and are being emulated in other States, such as Santa Catarina, in the South of the country, where a research park is being developed with emphasis on precosopm mechanics. Similarly, in the State of Rio de Janeiro a biotechnology pole is being established. Both research parks are based on the Federal Universities of the two States. These endeavors partly Government-sponsored, have not been captured as yet by the statistics on R&D;

Moreover, it is important to note that some enterprise R&D centers, notedly those held by the more technology-intensive State enterprises, such as PETROBRAS (CENPES), TELEBRAS (CPqD) and ELECTROBRAS (CEPEL), hold very close links with the rest of the R&D system. They also have active contacts with the rest of the enterprise sector, mainly with their suppliers of equipment, commissioning R&D projects and transfering product and process developments.

Finally, scientific development is also unevenly distributed. According to bibliometric data related to citations of Brazilian Works (BID 1988) and to the "per-capital productivity" of Brazilian academics working in the higher education system (CNPq 1987), the strongest points seem to lie in scientific activities related to biology and health. These constitute areas in which there is a strong tradition in the country. Also BID (1988) data show that citations for physics and chemistry are above average and, significantly, that citations for engineering and technology have the lowest average of all fields of knowledge covered.

II.3.1.2. The role of the government

Both failures and successes of the Brazilian S&T system are heavily influenced by the actions of the government. The latter has structured the country's S&T system and most of its links with the rest of the Brazilian economy. The description presented above shows the major direct role played by the Federal Government as a performer of scientific and technological activities, bearing in mind that most of the higher education institutions are federally-owned. A key exception are the universities of the State of São Paulo. Within the enterprise group, federal public enterprises play also a major role, both in terms of the complexity of their activities and volume of expenditures.

The overwhelming role of the Federal Government is probably better appreciated by looking at the statistics of funding of scientific and technological activities. As shown in Table V-8, two-thirds of the resources for S&T in Brazil come out of the Federal Treasury. Public enterprises, where Federal enterprises predominate, supply 9.3 %. The treasuries of the States contribute with around 14 % of the funds and private sources contribute with only approximately 8 % of total resources.

Although many of the Brazilian research institutions have a history of several decades (see Erber 1980 for extensive references), the S&T system was structured mainly during the seventies, especially during the second half of the decade. In this latter period the Federal Government equipped the universities and research institutes, increased the salaries of

researchers and teachers, multiplied the number of and resources for scholarships, both abroad and in the country. It also stimulated the public enterprises to set up their research centres and to establish procedures of linkages with their suppliers intended to substitute imports and to increase the local technological content of equipments and materials. The private sector was offered subsidized loans for technological activities through a special development bank for S&T (FINEP). This acted also as the coordinating agency for the system of technological and productive contacts between public enterprises and their suppliers.

The whole effort in promoting the advancement of an S&T system would have required a continued increase in expenditures during the decade of the 1980's which followed. Instead, the process was drastically curtailed reflecting the Government's attempts to reduce its spending and to confront the strong inflationary pressures. Within such an environment, the structural and longer term requirements of technological development were delegated to a secondary level of policy priorities.

Moreover, the Federal funding of S&T during the eighties was characterized by an erratic behavior which prevented any sort of planning by performers of R&D, an activity which tends to long periods of maturation. Thus, in 1980 the Federal Treasury resource allocations for S&T were around U.S. $ 530 million (2.25 % of total Union expenditures), in the next two years they jumped up to, respectively, U.S. $ 1061 and $ 1305 million and then declined in the following two years to U.S. $ 797 and 770 million. Moreover, such oscillations were not only year-by-year but tended to occur within the year, reflecting the vagaries of budgeting at times of high inflation.

The reduction of funds was more profound in the main instruments which support new projects or institutions, as in case of the National Fund for Scientific and Technological Development (FNDCT) managed by FINEP. In real terms, the yearly average of the Funds' resources during the eighties was only 60 % of their value during the seventies.

The other main instrument of FINEP, loans to enterprises, declined from an average U.S. $ 84.4 million during the period 1976/79 to a yearly average of U.S. $ 50.2 during the 1980/86 period. Although they increased again during the period 1987/89 to an average of U.S. $ 180 million, their main source of funds, a levy on oil and car sales, was discontinued in 1989. Presently, FINEP has practically no resources available for such purposes.

Thus, during the eighties the activities of S&T under the responsibility of the Federal Government were kept at a highly uncertain state of subsistence. Already established institutions found great difficulties in maintaining their equipment up-dated. They also faced severe limitations in importing reagents and other inputs and in expanding and even keeping their staff, especially in areas where alternative employment was found.

Nevertheless, the worse plight was that of new institutions. The case of the Technological Centre for Informatics with its project on mask-product is quite illustrative in this respect. The Centre was supposed to be one of the technological mainstays of the Brazilian informatics policy. Its most important project is microelectronics was the setting up of a line of production of masks, intended to service the burgeoning microelectronics firms, which have no alternative source of supply in the country. After laborious negotiations, specialized equipment was imported for this purpose under a turn-key contract with full provisions for training and technology transfer. However, after more than a year it had landed in Brazil, this equipment is still crated due to the inflationary erosion of the budget allocations for the necessary civil works.

The recently instated Federal Government has not, as yet, announced any definite plans on its S&T policy. However, the indications are that the area will not be exempted from the strictures applying to all Government expenditures. For this reason, the S&T authorities seem to be concentrating their efforts in finding alternative sources of funds mainly abroad. They have, thus, entered into negociations with the World Bank and with the Interamerican Development Bank, concluding certain initiatives started during the previous Administration. Such loans refer to figures in the order of one billion U.S. dollars.

As regards the State Governments of the Federation, until recently only the State of Sao Paulo had a significant investment in R&D. This was undertaken through its universities, some enterprises (e.g. in electric power and sanitation) and through a foundation which gets a percentage of state taxes and is an important source of scholarship grants.

Following the example of Sao Paulo, nineteen other States have earmarked fiscal resources for S&T. If such provisions were implemented, the States' spending on S&T would reach about U.S. $ 340 million in 1990, 37 % higher than their estimated level of spending in 1985. However, in most States such provisions have not been fulfilled as yet, largely because of the resistance of local financial authorities. The latter seem to hold other priorities and consider investments in technology as going beyond their business knowledge and/or their risk horizon.

Foreign sources of funds have played an important role in S&T financing in Brazil and have acted mainly through the Federal Government. The most important ones involved loans granted by Inter-American Development Bank to FINEP for its programmes of support of technological activities to local enterprises and the funding of research and graduate education. More recently IDB has granted a further loan of U.S. $ 60 million to the State of Sao Paulo. There was also a sectoral loan by the World Bank to support development in some selected scientific and technological activities.

The latter loan has led to substantial controversy because of the arbitrary way in which the areas were selected and the impression that the Brazilian resource counterpart did not come as an additional commitment but instead was made at the expense of other existing activities, such as the FNDCT. Morever, the insistence of the IBRD to establish new procedures for analyzing projects and implementing the programme has been criticized as leading to a cumbersome bureaucratic duplication.

II.3.1.3. Signs of change in the productive sector

In the recent past there have been some important changes in the perception and in the actions of the productive sector as regards endogenous technical progress. In the second half of 1987, thirty leading industrial entrepreneurs were charged by the National Industry Confederation with the production of a document on industrial competitiveness and industrial policy. Published the next year (CNI 1988), this widely distributed document emphasized the "search for greater efficiency and higher technological qualification", together with a "greater international integration" as the main vectors of the increase in Brazilian industrial competitiveness. The document suggests an increase in local expenditures and imports of technology, to be achieved by appropriate Government measures (e.g. fiscal and credit incentives, human capital development, etc.) and by greater investment by enterprises in technological modernization. Although the emphasis lies on the use of technology as a means for achieving higher productivity, the proposals also

stress the need of local entrepreneurs to invest more in their own R&D and to increase their links with universities and research institutes.

Another study (Ferraz et al. 1989) examined the perception of 134 leading enterprises as regards their sources of competitiveness in the year 2000. Comparing the importance attributed to several competitive factors now and in the year 2000, "research and development" is the factor with the highest rate of increase, identified as "important" or "very important" by all respondents. This constituted the most radical change in the business perceptions covered by the sample. The same study shows that the firms interviewed intend to invest considerably in electronics-based automation and to intensify their use of new techniques for the organization of production, especially total quality control (in-house and of suppliers).

Other examples, taken from statements to the media by entrepreneurs or from interviews support these evolutions. The two above mentioned more formal studies indicate a two-step transformation in course : first, there is the recognition that higher levels of productivity must be sought, spurred in part by the combination of external and internal pressures to reduce the level of protection against imports. This is warranted by the relative maturity attained by the Brazilian industrial structure. Second, there emerges a strong consensus that such an improvement in productivity must be supported by an increase in the endogenous technological capability. This must involve, in turn, R&D skills which go beyond the production and detail engineering ones which were required during the import-substitution stage of industrialization.

Presently, there are some indications that such a change in perceptions is being translated into concrete actions. The powerful Industry Federation of the State of Sao Paulo, which accounts for more than half of the Brazilian industrial output, established an advisory committee for technological development. Also, seventy five enterprises (representing a total of 171 key industrial firms) set up an association of such companies performing R&D (ANPEI) in order to pool information and lobby the Government.

The data previously mentioned suggest that the research-intensity of large firms is increasing, although the differences in the samples and in methods of collecting information indicate that further research is necessary to confirm this trend. On the other hand, the statistics available do not reflect the process of formation of small research intensive enterprises around the universities, as described above.

It is also important to notice that the demand for loans for technological development from FINEP has been highly responsive to the availability of resources. When FINEP could supply funds, such as in the period 1987/88, there was a great demand for R&D loans. Thus, in 1987 when the resources of the levy on petrol and cars were made available to FINEP, its commitments for technological development trebled over the previous year to U.S. $ 180 million. Moreover, the value of loans requested at the end of 1987 was equivalent to U.S. $ 500 million. In contrast, when the market realized that the Agency's funds had been reduced, the demand dried up, as in 1989 and 1990.

Moreover, there have been significant changes in the purpose or the loans given by FINEP to the productive sector. As shown in Table V-9, during the 1979/84 period, half of such loans were for establishing the infrastructure of R&D. In the period 1985/87 (the latest for which there are data available) the share of infrastructure projects reached respectively, 27 and 30 %. Since a substantial part of FINEP operations are made with the same enterprises, this suggests that there is an evolution in course, with enterprises moving from the establishment of the R&D infrastructure to the development of products and processes.

Finally, the greater-than-average R&D intensity of the electronics sector evidenced by several studies surveyed, and the change in the sector composition of FINEP loans, suggest the firms respond positively to Government policies designed to foster local technological capability.

The evidence on changes taking place in the Brazilian industry and cited above is certainly limited. Yet, the "educated guess" of researchers, bureaucrats and entrepreneurs interviewed for this study is that, given a greater degree of macroeconomic stability with its correlate time-horizon and appropriate Government policies, the Brazilian industry would be ready for a great expansion of its internal research and development with complementary technology imports.

II.3.2. HUMAN RESOURCES FOR SCIENCE AND TECHNOLOGY

II.3.2.1. The stock of human resources in Brazil

In developed market economies the density of highly trained professionals in the population, (i.e. number of scientists with a Master or Phd degree per inhabitant) is around 1/400 to 1/100. In Brazil, this density is approximately 1/4000 scientists/inhabitant. Considering the rate of population growth, the country would need to train half a million new scientists in the next decade in order to reach a density of 1/400. This is, of course, quite improbable since it would demand very sizeable investments in financial and human terms which are beyond the country's present capacity. Moreover, there would not be enough graduates with sufficient qualifications to pursue graduate studies.

The Brazilian government, being aware of these immense deficits, committed itself on a massive effort to increase the country's stock in trained professionals. It was considered that the following conditions would favour a concerted and longer term program in human resources training :

- there exists an active entrepreneurial and productive base which will provide an effective new demand for goods and services generated by the introduction of new technologies;
- the advent on emergent "high" technologies in the international arena, specially in the areas of biotechnology and of informatics, make it possible for less developed countries to overcome, under certain conditions, the technological lag and find new lines where they can attain international competitiveness;
- there exists a national system of education and research which, since 1975, is becoming increasingly organized and with a critical mass over which it is possible to expand the system.

The Brazilian explicit policy for the expansion of its skilled human resource base confronts a major constraint in view of a key characteristic of its undergraduate system. About 80 % of the undergraduate students are enrolled in private higher education institutions which, for economic reasons, tend to be limited in their command of resources needed to cover an adequate educational infrastructure, especially in the areas of exact and engineering sciences. As a consequence, the distribution and preparation of graduates through the various knowledge areas and professions do not often meet the requirements and diversity of specializations with high quality standards. The results are also reflected in the growth

of graduate programs. Over 30 % of such programs in Brazil are concentrated in the areas of humanities, social sciences, and the arts.

Using CNPq's categories of knowledge areas, the approximated actual distribution of post-graduates in Brazil in the following :

- Engineering 15 %
- Exact and Geo sciences 15 %
- Agricultural sciences 10 %
- Biological sciences 16 %
- Humanities and soc. sc. 33 %
- Health sciences 10 %

Although it is difficult to have a precise idea as to which should be the desirable structure of Brazil's scientific base, a comparison with some developed countries shows important differences and distortions in the Brazilian distributions. (See Table VI.1 for comparative data).

In 1987 the Brazilian government established the following criteria to redirect its human resources training policy :

- to increase the participation of the several branches in engineering;
- to give special emphasis in the training of selected priority areas : biotechnology, material sciences, informatics, fine chemistry and precision mechanics;
- to foment selective practices for foreign training in areas where there is low internal capacity in graduate programs.

II.3.2.2. The Brazilian graduate system

The number of graduate programs in Brazilian institutions grew from 110 in 1970 to 1226 in 1987 (See Table VI.2). Until 1977, the growth was quite uncontrolled. From then on, the Federal Government started to increase its control over the quality of the programs. Today, the total enrolment of graduate students in Brazilian institutions is about 70,000, of which about half are enrolled in areas considered to be under the official program. In 1973, the corresponding figure was less than 12,000 and in 1984 around 46,000. (See Table VI.3).

This major increase is both the number of programs and the rate of enrolment have created serious concerns about the acceptable quality of education and the duration for the completion of the corresponding degrees. The average time of completion of a master degree in Brazilian institutions is 3 years, and 7 years for a doctor's degree. This is mainly due to the lack of scholarships which could enable the students to pursue their degree on a full-time basis. Moreover, the distribution of academic staff with doctor's degree will give a measurement of the difficulties in establishing a crash program for domestic training. Table VI.4 shows the growth of scholarships granted by the Federal Government for domestic training. In twelve years, the total number increased almost four-fold, specially for doctor's programs. This is expected to have a direct effect on the average time span spent by the students on graduate courses.

A major bottleneck is still the availability of academic staff holding doctor's degree in graduate programs in Brazil. Table VI.5 shows that, although the rates of growth over five-year periods are quite significant, the absolute number of teachers are still below what is required for the needs of enrolment and for research. The problem becomes even more accentuated if the geographic distribution of the academic staff is considered. Of the total academic staff holding graduate degrees, about 81 % are located at the south and southeast regions of Brazil (Table VI.6).

At the end of the '70's, CAPES started to evaluate graduate programs offered in the country. Using academic criteria, its evaluation is considered quite reliable. By 1989, CAPES had all graduate programs ranked on the basis of quality from "A" to "E". If we take the programs evaluated at level "A" and "B" ("excellent" and "good"), as it can be seen from Table VI-2, about half of them are concentrated in only six universities (University of Sao Paulo system - USP, Federal University of Rio de Janeiro - UFRJ, University of Campinas - UNICAMP, Federal University of Rio Grande do Sul - UFRS, Federal University of Minas Gerais - UFMG, and Escola Paulista de Medicina - EMP). All of them are located in the south and southeast. Such a concentration raises important questions about the quality of the majority of the graduate programs throughout the country.

A major conclusion drawn from the above is that Brazil will have to depend heavily on training abroad in order to attain a necessary scientific and technological base and to increase the quality of its own graduate programs. This should constitute an important area for promotiong EEC-Brazilian co-operation in the medium and longer run.

II.3.2.3. Training human resources abroad

(a) Evolution of the system

During the 50's, about 1170 Brazilians obtained their graduate training abroad. Of these, close to one thousand had scholarships granted by foreign institutions or by international organizations. The participation of scholarships granted by national institutions was less than 10 % of the total. It was only in 1975 that the Federal Government started to undertake a major effort in sending Brazilians abroad for graduate training. Table VI.7 shows the growth of the Federal system of scholarships since 1973. There was a steady growth during these fifteen years, although the Table also shows the important variations noted in the government policy in this respect. Such variations also reflect the changes in the Brazilian economy with its consequent capacity to finance foreign scholarships.

The years 1975, 1979, 1987 and 1989, express explicit government policies towards the increase of training human resources in foreign countries. The present number of scholarships (around 5500), if maintained, will make it possible for the country to roughly reach a density of 1/800 scientist/inhabitant in a decade, if one also takes into account the effect of the foreign training on the growth of the domestic system. Today, the scholarships granted by the two Federal institutions (CAPES and CNPq) account for over 90 % of the total scholarships granted. Yet, the program on Agricultural Sciences, implemented from 1976 to 1987 by EMBRAPA that trained about 1000 students in foreign countries, was recently discontinued. Also, the participation of foreign institutions and international organizations in the Brazilian Program is becoming increasingly marginal. In 1988, the system operated with about 300 scholarships given by non-Brazilian institutions (significantly less than 10 % of the total number of scholarships).

The system also shows a high concentration of scholarships in a few countries. The United States (40 %), Great Britain (24.3 %), France (24.5 %), West Germany (only 5 %) and Canada (2 %) are recipients of 96 % of the Brazilians studying abroad. The distribution by country is also uneven when knowledge areas considered. France tends to receive more students in the humanities and social sciences (46 %), while the corresponding percentage falls, respectively, to 33 % in the United States, and to 25 % in Great Britain. Table VI.8 shows the distribution for 1986. Here again, the need for changing the distribution of scholarships granted so as to better reflect certain priorities is evident.

(b) Special program directed to priority areas

In 1987 the Federal Government decided to create a special human resources training program to cope with the need for enhancing training in priority areas. Called the RHAE program (for Human Resources in Strategic Areas), it started to operate in the first semester of 1988. Its main objectives are :

- to correct the structure of the distribution of both domestic and foreign scholarships;
- to link training to concrete research and development projects presented by Brazilian institutions;
- to increase the technological orientation of the training;
- to induce the participation of the private productive sector in the system;
- to offer broader options for training, including short term, non-degree, scholarships with high technological component.

After two years of operation, the RHAE program showed that there was an enormous demand in the country for the type of scholarships that it offered. As presented by Table VI.9, about 19000 scholarships were demanded by diverse research institutions. It is noteworthy that the majority of the demand refers to non-academic institutions which, up to that moment, did not have access to the main scholarship programs exclusively directed to the academia.

The variation in the demand by priority fields in Table VI.9 reflects the level of development of each area in Brazil. While biotechnology and informatics have already had a short history of resource commitments, both in human capital formation and in research, the other priority areas are relatively new in the country. The concerted effort to link such initiatives with the enterprise sector in informatics explains the participation of the private sector in this field. It is also worth noting that for all areas the demand is concentrated in domestic training (78 % of all the demand). Table VI.10 suggests that the effort to implement a crash program to train Brazilians abroad will also need to take into account certain major social considerations or preferences (including language constraints) in favor of comparable training to be advanced in Brazil.

The granting of scholarships shows that the RHAE program is basically following the structure of the demand. It also shows that it may become a major instrument of the Federal Government to modify the distribution of training, since it only grants scholarships in the priority areas. Furthermore, it contributes to build a scientific and technological basis faster, through non-traditional academic degrees. Recent government decisions are directing the RHAE Program to invest also in the areas of mineral technology, energy and environmental sciences.

II.4. HIGH TECHNOLOGY SECTORS : TWO CASE STUDIES

II.4.1. ELECTRONICS AND INFORMATICS

II.4.1.1. Size, growth and performance of sector

At the end of the 1980's, the size of the Brazilian market for electronic equipment and related services including information processing hardware and software could roughly be estimated to exceed a figure of sales of U.S. $ 8 billion on an annual basis. Of these, more than U.S. $ 4.5 billion refer to "professional and/or non-consumer informatics" (including "tele-informatics") and close to U.S. $ 3.5 billion account for consumer electronics.

This total figure brings Brazil's standing in the world's electronic ranking by market size in no lower than the 10th place, and possibly higher. Outside of the U.S., Japan and Western Europe, the Brazilian overall demand accounts for about one fifth of the remaining global market economies total, roughly similar to that of South Korea's. Taking into account (i) the above comparisons and the economy's development commitments, coupled with (ii) the country's size in terms of population, industrial and service activities, plus (iii) its communications needs in view of its geographic dimensions, all of the above suggest that Brazil's outlook for electronics in general and for informatics in particular, is one of the most promising outside the main developed market economies.

In order to trace the composition and growth of the professional electronics and informatics sector in Brazil (excluding, that is, consumer electronics) the data presented in Table VII-1 to VII-4 of the Annex were prepared especially for this report on the basis of a survey published in August 1989 by the Special Secretariat for Informatics (known as SEI in Brazil). The survey covered 454 enterprises representing more than 85 % of the market and participating in the following sub-sectors : general and banking data processing equipment (GBDP), teleinformatics, industrial control and automation (ICA), microelectronics, digital instruments (DI), technical services and sortware specialized firms.

Table VII-1 shows a six-fold increase in the overall size of the market between 1980 and 1989 with nationally owned firms increasing their participation by thirteen times. (The latter figure reflects not only aggregate market growth but also ownership changes by already participating firms). On the whole, nationally owned firms account for 70 % of the market. The share of each sub-sector in the industry's total is, in declining order, as follows : GBDP equipment 55.7 %, teleinformatics 22.7 %, microelectronics 7.9 %, ICA 7 % computer software 5.2 % and DI 1.7 %.

Employment figures (Table VII-2) also express the very high rates of growth of the industry, with national firms accounting for 80 % of the corresponding employment. In 1988, the total direct employment for the sector as a whole (including technical services) reached a figure of just below 130,000.

A better assessment of the Brazilian policy goals in the employment field concerns the relative share of skilled and highly qualified personnel. As shown in Table VII-3, these two categories account for about 31.5 % of total employment with foreign firms reporting a higher corresponding relative share (39.1 %) compared to the nationally owned ones (29.6 %). Yet, as presented in Table VII-4 for the GBDP subsector, the higher use of

professionals by foreign owned enterprises is mainly due to marketing and administrative tasks. In contrast, nationally owned firms engage a significantly higher proportion of professionals in hardware and software development activities. The latter orientation was central in the Brazilian government's policy objectives. It was also used as a justification for the costs incurred by the domestic economy (e.g. higher prices) and represents a targeted human capital development for potential use in new technological initiatives.

Investment figures also indicate important growth rates reaching, in absolute amounts, more than U.S. $ 307 million in 1987 (See Table VII-5). More than half of these investments concern the GBDP subsector followed by teleinformatics. Research and development expenditures (shown for 1987 and 1988 in Table VII-6) are in the order of U.S. $ 200 million. Most of the resource allocations were undertaken by nationally owned firms, which accounted for 87 % of the sectoral total in 1988. About half of the overall R&D expenditures were in the GBDP subsector and another quarter in teleinformatics. The ratio of R&D to sales has levelled to around 6 % which probably represents the highest such level in the whole industrial sector of Brazil. Nevertheless, this high R&D commitment by Brazilian firms does not involve frontier research at world standards. Instead, it concerns research activities for product development, reverse engineering and related tasks.

Trade statistics are presented in Table VII-7 to VII-9 for the non-consomer informatics sector. Of the total imports amounting to U.S. $ 768 million in 1988, the foreign owned firms accounted for more than 56 % although their market share was significantly smaller. What is important about the data presented in Table VII-7 is that they indicate that the overall sectoral import co-efficient (i.e. imports/sales) has stabilized in the range of 16-18 %. Although the difference between local and international prices exaggerates the extent to which real import substitution has taken place, the relatively low import coefficient confirms the importance of some form of local economy presence by foreign enterprises in the pursuit of the Brazilian market.

The export/import volumes on computers and the corresponding ratios presented in Table VII-8 for the period 1980-86 indicate that exports were always higher than imports. For most of the years this ratio was about 1.6 to 1. Interestingly enough, though, practically the totality of exports reported for the whole non-consumer Brazilian informatics sector (see Table VII-9) are undertaken by foreign firms whose transnational corporate strategy, like that of IMB's has allocated to Brazil specific export activities. In contrast, nationally owned firms had not, as of the end of the 1980's, reached a level of competitiveness to tackle the international market. Instead, their spectacular growth rate during the decade was almost exclusively based on the reserved and highly protected domestic market.

Policy makers in Brazil explicitly considered this to be an essential learning period for the country's entrance in the production of technology intensive informatics products. In the pursuit of this strategy, they had to confront the strong pressure and economic sanctions imposed on Brazil by the U.S. government. Apparently, European enterprises were not able to profit, through alternative initiatives of entry, from the U.S. stand. According to interviews, they remained rather "passive by-standers" without proposing differentiated options to the Brazilian private and public sectors.

II.4.1.2. The policy context

Questions of policy on electronics/informatics in Brazil have not been perceived on the basis of general approaches and regulations, such as broad trade regimes and overall treatments on foreign investments and technology, even if particular instruments and practices from each one of these areas were, obviously, used. Instead, through diverse and in certain cases conflicting policy orientations, they have been dominated by specific efforts to develop various national capabilities. Similarly, there is no unified and/or uniform policy approach for the whole electronics complex. Rather, there exist four quite distinct and diverging in objectives and instruments policy packages. They concern :

- the professional informatics segment;
- the teleinformatics equipment and related services;
- the consumer/entertainment electronics segment; and
- software inputs and legal provisions partaking to their protection.

(a) Policies on professional informatics equipment

Within this subsector, whose dimensions and product characteristics were presented above, the policy making process went through four stages over the last two decades. In all of them the central axis of policy instrumentation had to do with the concept of "market reserve". The latter does not fall within the traditional import substitution framework, but instead includes two important particularities : first, it does not address strictly trade concerns on foreign exchange savings and on protection regimes geared towards the promotion of domestic growth in output, employment, etc. Instead, its explicit focus is to foster local technological and product development capabilities through the use of the local market.

By "local technology", what in fact has been achieved in this case is mostly local engineering and product development based on internationally available integrated circuits, key components and certain design concepts. Also local research activities -- like the specific design based on academic research and later taken up by COBRA to produce a mini-computer -- found a possibility of directly linking such activities with the local productive sector and industry in general. The ability to undertake reverse engineering and "cloning" internationally coupled with local control over decision making, proved to be a key factor in business matters which linked product development with local technological advancement.

The other distinguishing characteristic of "market reverse" concerns the fact that the latter is largely geared towards the achievement of "anticipatory" import substitution. The learning process of local production and the development of local human, enterprise and overall institutional resources have more to do with what Brazilian enterprises can achieve, in collaboration with foreign suppliers, in the future than with what they simply produce today under protection. This is a direct result of the technological intensity of the sector and of its high rate of technological change.

The first of the four stages of policy evolution in professional informatics covered the decade of the 1970's (1971-1979). During this period a largely disjoint effort was undertaken to launch a national industrial sector starting with a minicomputer industry. This was mostly pursued by middle-level civilian and military officials of the government together with sections of the local academic and business communities.

Its most concrete result was that five Brazilian firms were chosen by public tender to produce minicomputers, four of which used, under license, foreign designs. This meant preventing nobody less than IBM, Burroughs, Olivetti, NCR, Hewlett-Packard, TRW, and Four Phase from making or assembling in Brazil mini-computers through fully owned subsidiaries. By implication and extension it also provided the basis for comparable exclusions in the future of foreign subsidiaries from making other computers except mainframes and other advanced and/or large types of equipment if considered outside the possibilities of the Brazilian industry. It did establish, though, a definite preference in favor of licensing and related business transactions on technology acquisition and embodied know-how in product imports between foreign and Brazilian firms.

The second phase, 1979-84, started with the creation of the Special Secretariat of Informatics, placed directly at that time under the National Security Council of the military regime. The whole process was expanded and fully institutionalized in the third phase during the period October 1984-1990. This was mainly achieved with the passage of Law 7532 of 29.10.1984, close to the time of transfer of government to civilians and the democratization of Brazil. (See the full text of the law in an English translation in the Annex). Under present legal conditions, any basic change in the informatics regime cannot be decided unilaterally by the executive branch or even by the President himself but, instead, requires Congressional approval. Similarly the PLAFIN -the National Plan for Informatics) requires Congressional debate and approval every three years. It, thus, constitutes a strategic policy concern elevated at the highest political bodies of decision making.

The key features of Law 7232 include : (i) the reaffirmation that the overall objective of the law concerns the development of national capabilities in informatics (Article 2); (ii) the establishment of the National Council for Informatics and Automation (CONIN) which constitutes the highest policy making body and is composed by several Ministers of the National Executive and eight key representatives of non-governmental sectors (Articles 6 and 7); (iii) the central requirement of "project authorization" and the control of imports of finished equipment and components (Article 9); (iv) the definition of national or Brazilian business in terms of location, control of decisions, technology and capital, the latter being specified as at least 70 % ownership of equity (Article 12); (v) tax incentives and waivers to national business (Article 13); and diverse other incentives for producers, for the creation of local research institutions, including incentives for users (i.e. compensation for higher costs), etc. The application of the Law was instrumented by the creation fo a number of commissions by product group which adapted the "authorization requirements" to the specific characteristics of each product category.

A new (fourth) phase appears to have commenced in Brazil with the initiatives of the new Collor administration. In early June 1990, SEI announced a plan to progressively take successive groups of products out of the informatics market reserve lists during the 1991-95 period. The fundamental criterion for the selection of products will be the extent of "completion of technological learning" by local firms so as to directly expose them to foreign competition with the sole protection of an import tax.

A more far reaching announcement was made in June 26, 1990 by the new Minister of Industry. It concerned a comprehensive industrial liberalization policy from which the informatics industry was not explicitly excluded, as it happened in other cases in the past. The overall objective is to eliminate all non-tariff barriers and market reserves and to significantly cut down the level of tariff protection. Also, an advisory committee is called to prepare in the coming two months drafts for new laws on informatics and software. As noted above, all of these initiatives require Congressional approval and are likely to be the

subject of strong pressures and lobbying from both foreign and Brazilian interests. The latter include a number of (banking) conglomerate groups which are heavily involved in the professional informatics sector as users and producers of computers, peripherals, etc.

The above evolutions call for close monitoring on likely policy shifts and the new opportunities which might be available calling for adjustments in corporate strategies by foreign firms interested in the Brazilian market.

(b) Policies in the teleinformatics equipment area

Teleinformatics refer here to digital electronics and programmable devices applied to the transmission of voice, data, etc., their communication (switching) and reception. Policies for the industry supplying the relevant equipment to Brazil have been under the direct control of the Communications Ministry with little or no room of interference by the professional informatics "school of thought" presented in the previous section.

In the teleinformatics sector, Brazil implemented a technological and production policy along more traditional import substitution lines, mostly in close cooperation and agreement with and/or the strong presence of foreign subsidiaries (e.g. Siemens, NEC, Ericsson, etc.). Policies can be interpreted as a rather orderly effort to substitute certain imports, based on the monopsony power of the Brazilian State, and trying through bargaining to influence the conduct of producers (among the largest being foreign owned ones). The "telecom school" views that local production under effective control by foreign transnational enterprises using their own technology, if behaving "correctly" in terms of local content and quality considerations, creates a valuable contribution to Brazil and should be encouraged. In addition, though, Telebras (the state owned company created in 1972) promoted, first, the development of qualified human resources, and, then, of local technology as such. This was initially undertaken through support to university research and subsequently by the creation of its own research center, the CPgD.

Complementary and partly diverging policies exist in specific product lines (e.g. the purchase of central switching equipment giving preference to firms having 51 % or more Brazilian ownership, preferences based on technology developed by CPgD, promotion of small and medium size local firms, etc.).

(c) Policies in consumer electronics

This subsector is older than the informatics or the telecom equipment industry in Brazil. In the past two decades, the main policy decision that was to mark this subsector's profile was an apparently unrelated Decree-Law of 1967. It defined the Free Zone of Manaus (in the Amazon region) as a "development" region. Special tax incentives, import facilities and freedom from diverse regulatory controls were offered to firms locating their activities in Manaus. Furthermore, such firms were allowed to "export" to the rest of the country products assembled there from imported kits and were not required to export to third countries.

These factors combined to generate a general migration of the electronics final consumer assembly and manufacturing industry to Manaus. The Free Zone has kept this subsector outside of the scope of electronics industry policy-making, thus excluding it from any performance commitments as to the extent and content of local technological/productive development. Nor has it evolved as an efficient process-oriented manufacturing zone. When

the Manaus authorities attempted, more than once, to attract non-consumer informatics industries with the same liberal incentives system, serious conflicts arose with SEI and local industrial/technology based groups. The resulting differences had to be resolved through special agreements.

(d) Policies on software

Law 7646, approved in December 1987, recognizes copyright protection for local and foreign originated software in equal terms. A contribution tax on the value of imported software, included in a Congress approved Bill, was vetoed by the President, thus abolishing any "tariff" protection for local software development. Nevertheless, intellectual property rights to foreign software are granted after registration at SEI. Such registration may be denied if there is a "national similar" software product.

Once the Software Law was passed, the strong diplomatic and economic U.S. pressures against Brazil's overall informatics policies were reduced. Commercially, under the 1987 Law the corresponding private sector is dominated by foreign firms and products while Brazilian firms have not yet found clear directions or product niches in which to try to compete.

(e) Concluding remarks

The above synthetic description of the four subsectoral cases constitutes a clear example of the highly diversified and often antithetic environment in which policies have evolved in Brazil in this technology intensive area. Given the overall size of the Brazilian market in electronics/informatics products (in excess of U.S. $ 8 billion annually) and its significant future prospects, a relevant conclusion can be reached as far as EEC interests are concerned : the Commission, in co-operation with interested parties, could consider the promotion of a sector-wide policy strategy with the purpose of identifying specific areas of co-operation (industrial/technological/human resource/institutional, etc.) between Brazil and the EEC and covering a number of years of action oriented programs.

II.4.2. BIOTECHNOLOGY

Production and research activities in operations of a biotechnological nature have a long history in Brazil. Biotechnological industrial sales in the Brazilian market reached a figure of around U.S. $ 10.5 billion in 1988. One, though, should note the dominating importance of the Brazilian Pro-alcohol programme in such economic transactions. Thus, energy related and biomass products accounted for 91.8 % of the above cited market size (ABRABI 1989), while the remaining 8.2 % or U.S. $ 862.57 million, was distributed between the agricultural market share in biotechnology industrial sales (37.5 %), human health (37.0 %), food production (17.7 %), animal related activities (3.5 %) and environment with only 2.2 %.

II.4.2.1. Selected policy issues on the Brazilian biotechnology sector

II.4.2.1.1. The role of the public sector in financing S&T

In 1981, a National Programme for Biotechnology was prepared under the leadership of the Conselho Nacional de Desenvolvimento Cientifico y Tecnologico, (CNPq). The Programma Nacional de Biotecnologia, PRONAB was approved in 1982. The CNPq had the institutional responsibility for its implementation and the Financiadora de Estudios de Projectos, FINEP, a governmental financial institution, had the responsibility to raise and to provide financial resources for R&D studies and projects. For administrative purposes, the implementation of PRONAB is under the responsibility of the Comite Nacional de Coordination, located inside CNPq. The latter committee, through the Comision Nacional Tecnico Cientifico and its three sectoral subcommissions for agriculture, energy and health, establishes the priorities and the administrative mechanisms for the industrial application of policies towards biotechnology.

The PRONAB global objective is to create the means for the implementation of an integrated national effort on biotechnology involving fundamental and applied research, experimental or technological development, and the scientific and technological services required for the wide application of biotechnology in the agricultural, energy and health sectors. The plan considers two types of objectives : those which are basic or of general character and those of practical application and with a more subsectoral character.

Among the first type of objectives, the following are included :

- to provide resources for the scientific and technological training of professionals and to increase the number and the quality of the national biotechnological manpower;
- to create a network of references and collection of cultures;
- to develop the required infrastructure for the advancement and execution of the R&D particularly in genetic engineering.

The main subsectoral objectives include, among others, the following :

- In agriculture the main focus is to improve the production base through the wide dissemination of biotechnological techniques like tissue culture, genetic engineering, etc. Specific goals are :

  - to identify microorganisms for nitrogen fixation suitable for Brazilian ecological conditions and types of cultures;
  - to increase ecological resistance and tolerance of the Brazilian agriculture;
  - to augment the photosynthetic efficiency, particularly for forage cultures;
  - to develop and to implement a biological pest control system;
  - to increase productivity in animal agriculture.

- In the energy sector the main objectives are included in the overall targets set for the Proalcohol Program, going further than the fermentation processes and including enzymatic engineering, biogas system development and the increase of the energy efficiency throughout the productive sectors.

- In the health sector the programme includes the rapid application of biotechnology for the production of vaccines, monoclonal antibodies, enzymes production and diagnostic kits.

PRONAB was the first integrated Brazilian effort towards the consolidation of public investment for research and for support given to academic groups active in biotechnology. Since then, the promotion and financing [3] of scientific and technological developments and their dissemination to the productive sectors have been a constant concern of different Brazilian governments.

During the period 1985-88 the total funding for biotechnology was U.S. $ 269.2 million of which the federal government accounted for 65.7 % and industry for 32.7 %. The rest came from international organizations and private NGO's. The governmental funding was mainly oriented (95 %) to academia and research institutes and 5 % as co-financing in industrial activities. A small fraction of this latter figure took the form of risk capital.

In the cases of resources originating from the productive sector, 61 % were allocated to R&D undertaken by the industrial sector itself while the remaining 39 % went to research centers and universities as part of outright grants or as part of joint research contracts. The details of funding for R&D in the Brazilian efforts in the field of biotechnology are indicated in Table B-1 immediately below.

TABLE B-1 : Funding of biotechnology in Brazil (1985-1988)

Public funds (federal)		US $ 175.9 million
	Executors :	
	Academia and res. institutes	95 %
	Industry (co-financing)	5 %
Industry funds		US $ 88.0 million
	Executors :	
	Academia and res. institutes	39 %
	Industry (self-investment)	61 %
Others (intern. org. and NGOs)		US $ 5.3 million
	Academia and res. institutes	100 %
Total R&D expenditures		US $ 262.2 million
	Brazilian sources	98.6 %
	Government	65.7 %
	Private industry	32.7 %
	NGOs	0.2 %
	Foreign sources	1.4 %

Source : A. Paes de Carvalho, Brazil : Experiments on Industrialization of Modern Biotechnology, 1989.

[3] In 1951, the Banco Nacional de Desenvolvimento Economico (BNDE) was created with the main goal to finance the Brazilian industrialization and technological development. In 1964 the BNDE created the Fundo de Desenvolvimento Tecnologico y Cientifico (FUNTEC), for financing scientific and technological activities and the absorption of technological change by the productive sectors. In 1969, in order to increase public investment in S&T, the government created a new institution, the Fondo Nacional de Desenvolvimento Cientifico y Tecnologico (FNDCT). Since 1971, this institution has been administered by FINEP. The latter constitutes presently the most important financial agent for the promotion of science and technology in Brazil and acts as a technical secretariat for the FNDCT.

In past years, FINEP has stressed the importance of developing alternative energy sources, and the use of biomass as a substitute for imported oil. Until 1988 U.S. $ 56.9 million were allocated by FINEP to 48 projects for energy out of which 23, representing 35 % of the total investment in the sector, were for biotechnological processes, mainly alcohol fermentation.

In the agricultural sector FINEP allocated, between 1984 and 1988, U.S. $ 6 million to 54 biotechnology projects. Among them, 15 projects were for biological fixation of nitrogen, 13 on improved seed varieties, 10 for insect and disease control and 10 for vaccine development. Other projects are related to genetic improvement, specially for traditionally important crops like millet, sorghum, sunflower, etc.

In the health sector the projects supported by FINEP include, among others, training of personnel (particularly on genetic engineering), production of monoclonal antibodies, research on cancer and the development of a human cell culture bank. Between 1979 and 1988, FINEP financed 57 biotechnology projects in the health sector for a total of U.S. $ 13.3 million. Of these, 40 projects accounting for 50 % of the total invested funds were in the pharmaceutical industry (parasitic antigens, polypeptides, diagnostic reagents, enzymes and proteins).

In 1984, the Programa de Apoio ao Desenvolvimento Cientifico Tecnologico (PADCT) was created as a mechanism of the Third Technological National Plan. The PADCT earmarked U.S. $ 42.6 million for biotechnology for the quinquenium 1984/89, of which 17 % for R&D, and 75 % for training. By the end of 1988 and in view of the financial/debt crisis only U.S. $ 12.9 million were effectively disbursed.

Sectoral institutions also provide financial resources for biotechnology. Among others, important functions are exercized by the Department of Industrial Technology, the Central de Medicamentos, CEME (a governmental drug center) and the Agency for the Coordination of Advanced Training for Higher Level Personnel (CAPES). Loans for R&D were provided, until 1989, by the BNDES. Between 1976 and 1987 the bank allocated U.S. $ 25 million of which U.S. $ 10 million to BIOBRAS, U.S. $ 9.5 million to CIBRAN, U.S. $ 4 million to AGROCERES and U.S. $ 2 million to BIOMATRIX.

In view of the fact that Brazil is a federal republic in which each State has its own development plans and finances, parallel to PRONAB there are important State programmes for biotechnology. The available information for the State of Sao Paulo indicates, according to the Departamento de Ciencias e Tecnologia (DECET) and the Fundacao De Ciencia e Tecnologia (FUNCET), investments totalling U.S. $ 5.85 million for the period 1984/88.

At the national level, preliminary figures for 1989 show allocations for biotechnology of more than U.S. $ 55.4 million of which 17 % are for health and 14 % for agriculture (see Table B-2).

Despite the existence, though, of PRONAB which represents the national plan for the development of biotechnology in Brazil, a widely accepted opinion in the country recognizes that a clearly defined policy in this area is still missing.

TABLE B-2 : Brazil - Allocations for biotechnology in 1989

Sector	Allocation in US $
Agriculture	7,690,560
Health	9,454,016
Multisectoral	4,799,060
Other	4,529,520
Not sectorialised	28,971,533

Source : I National Congress of Biotechnology, 1988

II.4.2.1.2. Private sector involvement in biotechnology in Brazil

The annual investment in R&D by national private firms is estimated at about U.S. $ 5 million. The corresponding by foreign firms is concentrated to a limited number of enterprises and reaches about U.S. $ 20 million, mainly due to the activities of two companies : Bioplanta and Rhodia.

In 1986 eight companies, particularly active in the area of biotechnology, created the Brazilian Association of Biotechnology Enterprises, ABRABI, which now includes 36 members present in the advanced aspects of biotechnology R&D activities and in university-industry relations. Of the 36 members 33 are biotechnological companies and three are financial and risk capital firms. It is estimated that only a relatively small fraction of the total Brazilian activities in biotechnology are associated in ABRABI. As a matter of fact, ABRABI had identified another 201 firms directly or indirectly involved in biotechnology application, or that have initiated activities either in the application of classical biotechnology or planning the application of new advanced biotechnologies.

This total number of 230-240 firms represents only half of the estimated overall Brazilian market for classical biotechnology. Its sales volume is about U.S. $ 20 billion or the equivalent of 8 % of the GNP. This figure does not include traditional plant breeding nor the small scale brewing and baking activities. ABRABI puts the Brazilian market for advanced biotechnological products at U.S. $ 600 million per year, a figure expected to increase to U.S. $ 1.5 billion by the end of the century (A. Paes de Carvalho, President of ABRABI, 1989).

II.4.2.1.3. Biotechnological parks

A key initiative in the country's development in biotechnology is represented by the Brazilian Program of Biotechnological Science Parks. This effort attempts to integrate the R&D activities with the productive sectors through the catalytic role and direct support of the government. The idea was developed by the now abolished Ministry for Science and Technology through the Secretaria de Biotecnologia in close collaboration with ABRABI. Its purpose is to create new and efficient mechanisms for the development of biotechnology and its transfer to the productive sectors. This endeavor has a precedent in Brazil, with the

BIOMINAS programme in the State of Minas Gerais created by the Secretariat Estadual de Ciencia e Tecnologia. The latter programme was designed to coordinate and permit the efficient link between the research activities of the mining companies of the State and the research centers located in governmental institutions.

In the case of Biotech Poles, several such centers are planned or are in the execution phase today. The larger and most advanced, the BIO-RIO, is set out in an area of 207,000 m2 within the campus of the Federal University of Rio de Janeiro (UFRJ) and managed by a private foundation created for this specific purpose, the Fundacao Bio-Rio. The founding of this "pole" was possible by the existence of a S&T base on biotechnology in the University of Rio de Janeiro and the Fundacao Oswaldo Cruz (FIOCRUZ). The latter has experience in the integration of R&D activities with the production of pharmaceutical and vaccines, at an industrial scale, and is one of the most important public health research institutes in Brazil.

The initial capital of BIO-RIO has been set at U.S. $ 5 million to be increased with contributions from other donors up to an amount of U.S. $ 20 million. The resources are to be allocated mainly to research activities and the strengthening of R&D groups in the two most important associated research institutions of the park : the Federal University of Rio de Janeiro (UFRJ) and the Oswaldo Cruz Foundation (FIOCRUZ). Industry plans to invest U.S. $ 100 million in their own facilities at the park.

The corresponding facilities of the park include : an incubator which will house 22 R&D specializing companies, advance support labs, including cell and molecular biology facilities, and space to be leased either to small biotech firms or for R&D laboratories of the large existing firms active in biotechnology.

It is expected that the BIO-RIO will evolve to reach maturity in the next ten years. The firms involved in the park should be spending by then nearly U.S. $ 35 million per year in R&D while the governmental Brazilian institutions U.S. $ 15 million. At the end of the ten years it is supposed that the operation of the park should have returned, in taxes, the equivalent of an internal rate of return of 40 % on the original governmental investment (Paes de Carvalho op. cit.).

Other biotechnological parks planned or being developed are : (i) the Polo BIO-MINAS involving the Federal University of Minas Gerais, the Empresa Brasileira de Pesquisa Agropecuaria, EMBRAPA, the UFV, and private firms, and (ii) the Sao Paulo Biotechnological Pole involving the University of Sao Paulo, the BUTANTA, the Instituto Ludwing, IPI and private firms. Other planned poles are those of Campinas and Rio Grande do Sul.

II.4.2.1.4. Intellectual property rights and biotechnology (IPR)

A major and controversial element in policy matters concerning biotechnology refers to the granting and coverage of intellectual property rights. The science intensive aspects of biotechnology and some of its peculiarities raise important questions in relation to the mechanisms for the appropriation of biotechnological innovations. The problem is further exacerbated when innovations occur in the food and in the health and pharmaceutical sectors, where legally imposed exclusivity and property rights raise important social concerns which have always been controversial.

The debate on IPR for biotechnology covers a number of diverse issues on patentable subject-matters, novelty, inventive steps, economic utility of the innovation, claims, disclosure requirements, deposit requirements and enforcement.

Brazilian IPR law (dated from December 1971) establishes that medical, pharmaceutical and food products as well as the processes for their production are non patentable. In relation to microorganisms, including discoveries of new varieties, it is considered in Brazil that since the law is silent on this matter they are not patentable. Similarly, since no IPR law in Brazil covers the protection of plants and animals varieties, these are considered as not being subject to intellectual property rights protection . Furthermore, the law is clear in excluding the utilization or applications related to discoveries linked to species and varieties of microorganisms. Thus, the existing Brazilian IPR system, directly or indirectly excludes the protection of biotechnological innovations, either because microorganisms and living organisms are not the subject to protection or because the law excludes important areas of medical and pharmaceutical products and processes and food.

The new realities from the rapid development of biotechnology have created a controversial situation in this subject. Part of the Brazilian private sector is in favor of some type of IPR system for biotechnology. They are of the opinion that it would facilitate access to international technology. However, there is also a wide-spread opinion in other parts of the private and in the public sectors which claims that any IPR protection for biotechnology should be linked to strategic policies for the defense of the national industry against restrictive practices and market penetration by TNCs. It is also argued that such protection should be granted under the condition of domestic production in a relatively short period of time after the granting of protection. Some opinions expressed in the country are that the granting of protection should be associated with a feasibility study for production in Brazil.

Furthermore, positions on the matter differ depending on specific sectoral characteristics. For example, in the health area, although a system of incentives is welcomed for the development of new innovations, the extension of the current patent system to cover the case of biotechnology is perceived as likely to basically favor the penetration of the Brazilian market by foreign TNCs. It was cited that, by 1987, out of nearly 300 requests for biotechnological patents which are waiting approvals by INPI, 273 of them were submitted by foreign firms, (INPI, 1987). Furthermore, a number of scientists interviewed in Brazil and involved in biotechnological R&D for health and pharmaceuticals consider that patentability on biotechnology should be explicitly excluded.

II.4.2.2. The state of the art in biotechnology related activities in Brazil

II.4.2.2.1. R&D activities

As noted in the previous section, Brazil has a large number of actors and agencies directly involved in R&D in biotechnology. Government institutions, research centers at the universities and institutions sponsored by each State, dominate the research effort of the country. However, private institutions associated with business enterprises are also emerging as important units for R&D and innovation. In the latter case, R&D activities are mainly related to traditional productive activities like fermentation, enzyme production, etc.

It has been estimated that there are at least 29 agriculture R&D centers. The most important is the Empresa Brasileira de Pesquisa Agropecuaria, EMBRAPA. It is involved in diverse types of R&D activities for animal and plant agriculture with the exceptions of sugar cane, coffee and cocoa for which specialized agencies exist.

Research in biological fixation of nitrogen is done, among other institutions, at EMBRAPA, the Biotechnology Center of the University of Rio Grande do Sul, the Instituto Zootecnico de Sao Paulo, the Centro National de Recursos Geneticos (CENARGEN), the Universidad Federal de Rio de Janeiro, the Instituto National de Pesquisa de Amazonia in Manaus, the Instituto de Pesquisas Agronomicas (IPAGRO) in Porto Alegre.

Tissue culture, plant genetics, improvement of seed varieties, etc., is undertaken at EMBRAPA, CENARGEN, the Instituto Agronomico de Campinas, the Escola Superior de Agricultura Luiz de Queiroz (ESALO) de Universidad de Sao Paulo, the Centro de Energia Nuclear para la Agricultura (CENA), the Universidad Federal Vicosa, the Centro Nacional de Pesquisa de Frutas Temperadas (EMBRAPA), the Instituto de Biologia y Genetica de PLANALSUCAR. (For more comprehensive information see Table 1).

The most important enterprises that undertake R&D activities are AGROCERES, the Fundacao BRADESCO and Volkswagen de Brazil. These firms are particularly important in animal R&D (artificial insemination and animal improvement).

A detailed examination of the research programmes in Brazil reveals that priorities are mainly focused in the following areas :

- natural fixation of atmospheric nitrogen, including the inoculation with microorganisms, selection of strains for each eco-region and culture, and the application of genetic engineering;
- tissue culture for plant regeneration, micropropagation of uniform and healthy cultivars and, also, tissue culture as a method for the search of cultivar tolerants to ecological stress;
- monoclonal variation of traditional tropical products like papaya, maracuya and their micropropagation; and
- hybridization of cereals and the search of diseases resistant and environmentally tolerant varieties.

Livestock research seems to be quite widespread in Brazil where several research centers at the universities, in private or public centers, have programmes related to :

- foot and mouth disease;
- the production of diagnostic kits for animal virus disease; and
- production of vaccine and in general animal health.

Lesser activity is reported on the aspects of animal growth hormones and animal genetic manipulation.

Biotechnology R&D for health is mainly oriented in Brazil towards the search of solutions for long standing endemic problems of the country, like tripanosoma cruzi (Chagas disease), the schistomiasis monzoni, etc. Concerning these diseases, the Instituto de Ciencias Biologicas de la Universidad Federal de Minas Gerais uses DNA techniques and undertakes research in interferon, monoclonal antibodies and protoplasmic fusion. Similar research activities are carried out at the Universidad de Brasilia in the Asa Norte Campus, at the

Universidad Federal de Rio de Janeiro the Departamento de Parasitologia de la Escuela Paulista de Medicina, the Fundacion O. Cruz (FIOCRUZ).

Biotechnology R&D is also undertaken in relation to yellow fever, leishmaniasis, typhus, meningitis, poliomyelitis, attempting to develop vaccines against cholera, yellow fever, meningitis and poliomyelitis. In the State of Sao Paulo the Instituto Burantan undertakes R&D for the production of vaccines and sera. Among private firms, the BIOBRAS, also known as Montes Claros, is active in fermentation processes and the production of enzymes, insulin and related products.

II.4.2.2.2. The application of biotechnology in productive activities - biotechnology in the pharmaceutical and health sector

The development and application of biotechnology may represent a major technological breakthrough for the solution of major problems in the Brazilian health and pharmaceutical sectors. It is noteworthy that, by the year 2000, Brazil will rank third in the importance of its market size in the western world, (UNIDO 1984).

A distinguishing feature of the pharmaceutical sector is the dominant presence of foreign transnational corporations (TNC's). In Brazil they account for 83 % of total pharmaceutical sales. Also 68 % of the input value of drugs used for domestically produced medicines are imported from transnational corporations. If raw materials, other than drugs, are taken into account, the import dependence of the pharmaceutical industry is even greater, reaching 77 % of the inputs used in the production process. (Bifani/IDB 1989).

In the health sector it is important to distinguish :

- the pharmaceutical industry proper;
- the production of sera and vaccines; and finally,
- the production of reagents for diagnosis and treatment of infectious and parasitic diseases.

Brazil is presently the seventh national market for pharmaceuticals in the western world. Although final product imports have been largely substituted, the local market is dominated -- as noted above -- by TNC's through a combined process of direct foreign subsidiaries entry and a progressive acquisition of national firms by foreign companies. This situation has important consequences for the domestic development of pharmaceutical innovations, including those through biotechnology.

Antibiotics represent about 58 % of the Brazilian market for pharmaceutical products as compared to the world average which is approximately 30 %. Among the antibiotics, the most important group concerns the case of penicillins which account for 47 % of the total production of biopharmaceutical products in the country. Only 50 % of penicillin production is estimated to be used for direct human and animal consumption while 43 % goes to the production of 6-APA -- an intermediate product in the production of semisynthetic penicillins (ampicillin). The rest is mainly used for synthesizing cephalosporin derivatives.

Vitamins is the second most important pharmaceutical market in Brazil. One of the best prospects for expansion in the future is believed to be in the use of vitamins in animal feeds. As in the case of antibiotics, the production of vitamins is carried out by classical

chemical methods, although microbial production has been shown to be more efficient as in the vitamin B complex.

In the case of pharmaceutical inputs, technical aspects, greater simplicity in the manipulation and the fact that these constitute product areas of a relatively high added value, explain the priority assigned to this group of products by private firms. In Brazil, the BIOBRAS group, a private owned national company with past experience in the production of insulin and enzymes using traditional synthetic methods, is exploring the possibilities of producing human insulin by biotechnological methods, and monoclonal antibodies and leucocytes interferon in a joint agreement with the Argentinian firm BIOSIDUS.

The presence of transnational corporations is less dominant in the area of sera and vaccines. The production of immunological agents is of paramount importance in countries like Brazil that have to overcome serious problems in public health. Infectious and parasitic diseases are still a major cause of mortality and large sections of the population are exposed to tropical parasitic diseases. Some of Brazil's regions report among the world's highest cases of malaria incidence. Half of the Brazilian population is exposed to schistosomias, while leishmaniasis shows also high incidence. In its turn, the chagas disease (the Latin American variant of tripanosomiasis) is widespread all over Latin America. Leprosy is also a major disease in tropical areas, particularly in certain zones of the Amazon basin.

Immunological agents are a fundamental component of the government responsibility in the context of public health plans. As a consequence the governmental presence is reported as very high not only in the corresponding distribution activities but also in production. In this case and for a number of technological reasons related to health considerations and their corresponding social and economic implications, both recombinant DNA and monoclonal antibody technologies have an enormous potential in Latin America.

In the general area of immunological agents, Brazil has relatively well developed technological capabilities and a long tradition since the end of the past century. The Oswaldo Cruz Foundation, FIOCRUZ, with its Bio-Manguinhos plant was founded in 1900 under the name of Instituto Seroterapico Federal. Also, the Butantan Institute in the State of Sao Paulo operates since 1898. These institutes are using classical synthetic methods for the production of vaccines against measles, meningitis, yellow and typhoid fever, canine rabies, etc. However, the Oswaldo Cruz Foundation is already producing meningitis vaccines on a pilot scale by biotechnological methods and it is expected to develop an hepatitis B vaccine within the next three to four years. Similarly, the Butantan Institute hopes to produce, by biotechnological methods, vaccines against poliomyelitis and tetanus in less than three years and against the yellow fever over a longer term period.

The same Brazilian institutes are expected to produce diagnostic reagents for the Chagas disease in the coming years and in a shorter time for the case of schistosomiasis. The production of diagnostic reagents for leishamaniasis and malaria are, apparently, more distant objectives.

Among the most relevant private firms that are likely to be involved in biotechnology development in these areas in Brazil, the following are worth to be mentioned :

- CIBRAN;
- Vallee Nordeste S.A.;
- BIOBRAS bioquimica do Brazil S.A.;
- EMBRABIO;

- BIOTEST S;A; Industria e Comercio;
- BIOFERM, Pesquisa e Desenvolvimento S.A.;
- BIOFILL, Industria e Comercio de Produtos Biotechnologicos;
- IMUNO-SERUM, Tecnologia Immunologica Industria e Comercio LTDA.

The first three have an annual volume of sales of about U.S. $ 60 million, (CIBRAN nearly U.S. $ 30 million and Vallee and Biobras about U.S. $ 15 million each).

- biotechnology in agricultural activities

Biotechnology application in the Brazilian agriculture is not new. The country has had a long experience in the application of breeding and section of plant varieties and, more recently, in the application of techniques like tissue culture. In addition, Brazil has advanced certain experiences in the production and use of biopesticides. A more detailed account of the present situation and the prospects for biotechnology applications in priority product areas appears immediately below.

Natural nitrogen fixation

This is an area in which important activities concentrate in Brazil. The State owned Empresa Brazilera de Pesquisa Agropecuaria (EMBRAPA) has actively worked in the R&D and dissemination of results concerning nitrogenous fixation through its program on Biologia do Solo.

One crop for which the natural fixation of nitrogen has proved to be an important economic activity is that of soybeans. Just over 25 years ago, Brazil introduced the soybean as a culture suitable for the opening of the "cerrado" (savannaha) and the expansion of agricultural frontiers. Between 1965 and 1966 nearly 4 million ha were planted with soybeans. The native rhizobium strains are identified and reproduced at the laboratories EMBRAPA which supply them to seven factories. The latter have been approved by the Ministry of Agriculture for the production of about nine million doses of inoculants equivalent to the inoculation of eight million ha of soybean per year (see Table B-3). The use of 200 gr of inoculum at less than U.S. $ 1.0 makes possible to replace 200 kg/ha equivalent to a total saving of U.S. $ 1.3 billion of fertilizers. At present, soybean crop in Brazil relies solely on rhizobium inoculants for fertilization.

There is a great potential market for inoculants in Brazil for the following key crops :

(i) Beans constitute the most important pulse in Latin America, the latter being the crop's "home land". The region accounts with nearly one third of the world area planted with beans, while Brazil and Mexico concentrate almost 80 percent of the overall Latin American production. In Brazil the "feijao" (kidney bean) is the most important protein source in the diet of the population. Its importance is reflected in the area planted, estimated to exceed 5 million ha, thus representing a potential market for 150,000 doses of inoculants of 200 gr each.
(ii) Peanut crops with a planted area of nearly 230,000 ha, constitute another potential market estimated at 77,000 doses of inoculants of 200 gr each.
(iii) Forage crops.

TABLE B-3 : Producers and production of thizobium inoculants

Firm	Commercial name	Production (1) (1000 pkge of 200 gr)	
		1987	1988
Lab. Leivas Leite	Nitrogen	1,400	2.100
Ind. Bio-Soja de Inoc.	Bio-soja	1,380	1,700
Turfal, Ind. Com. de Prod. Quim e Agronomicos	Turfal	2,800	4,200
Nitral : Ind. de Inoculantes	Nitral	3,950	5,600
Agroquimica Planalto Ltd	Beacon	1,000	400
Nitroar : Ind e Comercio de Pesquisa Agropecuaria	Nitroar	600	500
Fecotrigo-Defensa	Centralsul	900	1,680
Totals		12,030	16,180

(1) All inoculants of which 99 % are for soybean.
Source : direct information from EMBRAPA

The great demand for forestry products and the reforestation programs (mainly in the Nordeste, based on leguminous trees like carob nuts, leucaena, jacaranda, casuarina and other trees used in reforestation programs such as pine and eucalyptus) can generate an enormous potential for rhisobium and ectomycorrhizal inoculum. The first has already been successfully applied in the case of soybeans, while the second, ectomycorrhizal inoculum, is still at an experimental stage. The demand of the sector is based on the need to reforest around five million ha during the next 20 years.

The present biotechnological market for fertilizers in Brazil can be triplicated with the expansion of leguminous culture and the development of mycorrhizal inoculation. The potential impact on the Brazilian economy of these two areas of biotechnological application is huge and according to some market estimates to be around U.S. $ 4 billion. In addition, one should take into account of the reduced dependency on energy and industrial inputs, the reduced capital investment and the beneficial impact on the natural environment.

Tissue culture

Tissue culture technique is being applied in several areas in Brazil, particularly for the rapid multiplication of disease-free and homogeneous ornamental plants, the production of flowers for export, the production of fruits for direct consumption in domestic and foreign markets, or for industrial purposes.

In Brazil, two firms, Equilabo in Campinas and Floranica in Niteroi, apply the technique for the production of orchids for exports. In the fruit growing sector important developments have been achieved after the creation of the Center for Research on Temperate Climate Fruit Trees. Meristem culture is widely applied for the production of disease-free cultivars. In 1983, twenty million units of six different cultivars of strawberries, one for processing and five for table fruit were produced inducing significant increases in productivity per

hectare. The same technique is applied for the production of some varieties of thornless blackberry bush (10,000 units in 1984), pears, citrus fruit, etc.

Biopesticides

The high consumption of pesticide, particularly insecticides and herbicides, present a great potential for substitution by biotechnological products (biopesticides). For example, in the State of Sao Paulo, pesticides account for 26.8 %, 19.5 % and 15.1 % of the total sales revenue of cotton, soybean and orange crops respectively. The advantages of biopesticides (in selectivity, possible all year around use and the saving of energy) make the development of this product line at an industrial scale particularly important.

Since 1972 different institutions have been involved in bio-pesticides R&D in order to control some of the major biological constraints encountered by the Brazilian agriculture. The National Soybean Research Center in Parana, which is attached to the RMBRAPA, isolated in 1972 the virus "baculoviruys anticarsia" to combat a major problem caused by the insect known in Brazil as "lagarta de soja" and scientifically as "anticarsia gemmatalis". This is responsible for about 40 % of the overall losses caused by insects on soybean culture. During 1984-85 more than 300,000 ha were treated with this biopesticide. The costs of soybean protection using biopesticides was equivalent to nearly 75 % of the traditional chemical method. By the middle of the 1980s the production of the virus was undertaken, under the supervision of EMBRAPA, by five cooperatives in the State of Parana, one in Santa Catarina, five in Rio Grande do Sul and one in Sao Paulo.

Another insect, the "duatrea saccharalis" which attacks sugar-cane, soybean, millet and also garden vegetables could be controlled by a virus : the DsGV. It has been isolated and its virulence increased by genetic engineering at the Genetics Department of the University of Campinas, in the context of a programme supported by the National Sugarcane Improvement Program. The industrial scaling up of the process is presently being developed.

Brazil has also developed the production of microbial pesticides using fungi that can synthesize toxins acting as an insecticide. This can be applied either against the noxious insect itself, or on their natural habitat. The identified fungus is used for the production of 500 inoculants per day of an insecticide for the control of diseases that affect sugarcane, soybean, citrus fruit, coffee and forage crops. The most successful application of this biopesticide has been in the control of insects that attack sugarcane. The cost of its application is equivalent to only 18.3 % of the traditional cost based on chemicals with an efficiency of up to 75 %. Between 1970 and 1984 seven plants were installed for the production of this biopesticide. However, apparently only two are presently operating on a continuous basis. Although 43 active principles of insecticides, herbicides and fungicides are synthesized in Brazil, in addition to the biopesticides, the domestic production is still largely insufficient covering only a small fraction of the Brazilian needs of pesticides.

R&D for biotechnological applications on pest control is undertaken both at the university level and by EMBRAPA with support from producers (eg. ASPLANA, PIANALSUCAR, etc.). The state of the art of these activities indicates that basic research is in general well advanced or terminated and that the major problem is industrial and market development.

The overall potential market is relatively large and expanding. In 1984, the total sales of pesticides in Brazil amounted to more than U.S. $ 800 million of which U.S. $ 240 million were for insecticides. At the same time, pest control represents an important proportion of the selling price of most agriculture products. Thus, for cotton it is 26.8 %, for the

soybean 19.5 %, in the case oranges it is over 15 %, in coffee nearly 8 %, for rice 5.6 % and in the case of wheat it reaches 5.0 %.

Livestock sector, food and feed

Biotechnology has a great potential in three main areas of animal agriculture.They are :

- animal disease diagnosis, prevention and control;
- animal nutrition and health; and
- genetic improvement of animal breeds.

The main efforts for the application of biotechnology in the livestock of Brazil concentrate on the techniques of embryo transfer, freezing, superovulation and division of embryos with the purpose to improve the quality of livestock, both bovine and porcine, and to increase meat and milk yields work for animal feed production and improvement. Since 1975 artificial insemination techniques are used by private firms particularly for bovine production. In 1983 more than 24 centers of artificial insemination were operating, although the larger part of the market is controlled by only five firms. By the middle of the 1980s these centers were producing and commercializing nearly 1.6 million doses. More than 65 % of the production and commercialization is concentrated in the State of Sao Paulo.

In 1983, the Brazilian production of bovine semen was 1,415,400 doses of which 66.8 % were for meat producer breed, and 29 % for milk producers breed. In the same year 155,447 doses were imported, mainly for the improvement of milk production (70 % of the bovine semen imports are for this purpose). The most important firms, registered by the Ministry of Agriculture are listed in Table B-4. Brazil has exported bovine semen to Malaysia, Peru and several African countries among others.

Embryo transfer is still at an incipient stage due to problems related to hormone control, sexing, citology, freezing of embryos and availability of materials that should be imported. Eight firms are registered by the Ministry of Agriculture as being active on embryo transfer (see Table B-5).

Animal improvement techniques are also applied for swine and poultry production. Concerning swine improvement, a joint venture exists between AGROCERES and the British

TABLE B-4 : Brazil - Firms commercializing bovine semen

- Agropecuaria Lagoa da Serra Lta. Fazenda Lagos da Serra
- Commercial e Agropecuaria Rodriguez Cunha S.A
- CIANB, Central de Inseminacao Artificial, "Nhorinho Barbosa"
- Agropecuaria Bonfiglioli S.A. Fazenda Sao Marcos
- COPIA, Commercial Prudentina de Inseminacao Artificial
- Central Paulista de Inseminacao Artificial Ltda. ATALLA
- SEMBRA Tecnica e Produtos de Reproducao Ltda
- Laboratorio de Procesamento de Semen. EMBRAPA/UEPAE/Sao Carlos
- TAIRANA S.A.A. Central de Congelamento de Semen
- YAKULT. Industria e Comercio, Fazenda YAKULT
- PECPLAN. Bradesco.

TABLE B - 5 : Registered firms on embryo transfer

- Associa, ao Sao Pedro de Pesquisas Cientificas
  Estada sorocaba-Salto de Pirapora
  Sorocaba - SP.
- Agropecuaria Lagoa da Serra Ltda
  Fazenda Lagoa da Serra Sert'ozinho - SP.
- Tairana S.A. Central de Congelamento de Semen
  Rodovia Raposo Tavares
  Presidente Prudente - SP.
- Semen MF do Brazil Co. Rep. Ltda.
  Leopoldina de Oliveira
  Uberaba - MG.
- Stracta S.A. Emprendimentos Alimentares
  SEPN
  Brasilia DF.
- Faculdade de Veterinaria UFRGS
  Porto Alegre - RS.
- Escola de Veterinaria UFSM
  Centro de Ciencias Rurais
  Santa Maria - RS.
- Central de Embri es.
  Estancia Pioneira
  Camb' - PR

Group Pig Improvement Co. (PIC). Concerning poultry, the basic problem faced by Brazilian farmers is the oligopolistic character of the international market dominated up to 80 % by two firms : Arbor Acres and Hubbard. Domestic firms depend upon the import of the genetic material from these two corporations. To overcome this dependence, AGROCERES has initiated a programme for the genetic improvement of poultry. The objective is to identify and to develop the type of poultry best adapted to Brazilian conditions and its market. For this purpose, Agroceres Ross Melhoramento Genetico, a joint venture between AGROCERES and Ross Breeders of Scotland (subsidiary of Hillsdown Holding), has been created.

The potential market for artificial insemination of bovine is determined by the existence of a population of more than 130 million units. The goal of the Associacao Brazileira de Inseminacao Artificial (ASBIA) is to achieve the insemination of five million bovine female per year.

Finally, the application of biotechnology for the diagnosis, prevention and control of animal diseases has not yet reached the commercial stage although several R&D institutes and private firms are actively involved in their development. Basic economic limitations of biotechnological advances in these areas are similar to those confronted in developed countries. These involve the low value added of individual farm animals which limits veterinary cost and veterinary medicine sales per animal, and, consequently, the funding for veterinary R&D. Moreover, the new biotechnological developments are not always well adapted to current husbandry practices that require skilled labor. On the other hand, veterinary developments in the area of diagnosis (monoclonal antibody, vaccines, antibiotics

and vitamins) are closely associated with their development for human health. Therefore, investments on R&D in biotechnology for pharmaceutical and human health are likely to have important spillovers on animal agriculture.

II.4.2.2.3. Human resources

Brazil has always assigned high priority to the creation of a skilled labor force and particularly so in the areas of biological and chemical sciences. However, skilled manpower is still scarce in the new areas of biotechnology that require interdisciplinary training and expertise. In 1984 a report of the PADCT drew the attention to the lack of specialized personnel to undertake interdisciplinary basic and applied research in biotechnology. At that time, the PADCT report identified 20 large interdisciplinary groups working with ten or more researchers per group, 45 medium groups of five to nine researchers each and 20 small groups with four or less researchers per group active in disciplines directly related to biotechnology. The same report indicated that 610 professionals were working on biotechnology research of which 222 in the biomass and energy area, and 194 each in the agricultural and health. More updated data is scarce. However, the PARANABIO programme shows a list of 200 PhD, 146 M.Sc, 82 graduates and 74 technicians plus other specialists.

Biochemistry is one of the strongest areas in Brazilian university system, generating an average of 18 PhD per year. A similar situation exists for microbiology and genetics. However, these figures are considered insufficient for the requirements of the productive sector and for the needed R&D activities. Molecular biology is a particularly weak area : not only experts are scarce but also universities are not preparing an adequate number of them.

II.4.2.2.4. Equipment and materials for biotechnology

The application of biotechnology requires the development of new equipment and the demand for specific materials. Moreover, the sophistication of equipments and instruments to be used for the application of biotechnology requires specialized manpower. At the beginning of the 1980's the annual purchases of biotechnology equipment were growing internationally at rates of at least 15 % annually. This growing demand has two main components : laboratory equipment and machinery for the scaling up of the new processes. Since new biotechnology is still an emerging industry, many of its practical applications are difficult to anticipate accurately. Thus, lags in the supply of specialized equipments appear quite often. This situation can be more acute in new industrializing countries, like Brazil, which do not have a large manufacturing sector for such types of equipment.

In the case of Brazil the Pro-Alcohol programme contributed to create a relatively solid industrial basis for fermentation equipment. Nearly 50 % of the resources of the Pro-Alcohol programme were oriented towards the productive infrastructure of distilleries. Several national enterprises expanded their production in order to respond to the demand for equipment of this programme. Among them the most important ones were Dedini/Codestil (60 % of the market for distilleries in 1980), Conger (25 %), and Zanini (8 %). All of them signed agreements for the transfer of technology with firms in the FRG, Italy, The Netherlands and Canada. Of particular importance was the adoption by Conger of an Austrian technology which permitted the reduction of residues by 20 %. Other firms, like Nordon, Jaragua, Confab, Vilares, also have agreements for the transfer of technology with foreign firms. As a consequence of a loan granted by the World Bank, which included

the condition to eliminate barriers to foreign capital in the sector, foreign enterprises entered such activities (e.g. Fletcher and Stewart/John Brown/Natron; Mitsubishi; Speichim; Stork; etc.).

A second line of equipment production concerns cooler systems. National firms, like Garcia and Bassi, Gema Alpina, etc., obtained foreign technology from Suzer, BAC, Baltimore, Air Coil, Hitachi.

A third development concerns centrifugal equipment, with an average of three centrifuge per distillery. The corresponding market, also created by the Pro-Alcohol programme, has been important and it is controlled by Alfa Laval Westfalia, and the national firms Fristan and Crisanti.

Concerning materials, the Pro-Alcohol Programme stimulated the production of enzymes creating a market for 300 tons of alfa-amilasa and 2,700 tons of amiloglicosidase, equivalent to more than 100 % of the Brazilian market for enzymes in the food, textile and pharmaceutical sector. The supply of enzymes is dominated by the Danish world leader Novo Industri that has established a subsidiary in Sao Paulo oriented also to the Argentinian market which is estimated to be three times the Brazilian one. Other companies producing enzymes are Pfizer, Miles Industry of the USA and the national firm Biobras.

The import of laboratory equipment was affected by the restrictions imposed by the government in 1975, favoring the development of a national industry, led by the Instrumentos Cientificos, Variam Industria e Commercio, Prozyon and Tecnolab. However, the most sophisticated electronic and optical equipment must be imported. The same policy affected the import of control equipment and instruments. The government's goal was for local production to reach up to 85 % of the domestic market favoring the already established firms in Brazil like Engematic, Bristol/IEF, Ecil and Fuginor. However, the size of the market attracted also other foreign firms, such as Honeywell and Braun.

To sum up the supply of equipment and materials for biotechnology in Brazil has been created by the stimulus of the Pro-Alcohol Programme and has been significantly influenced by government policies on import substitution, subject to certain important technological constraints favoring specialized imports.

ANNEXES

ANNEX 1 - STATISTICAL TABLES

ANNEX 2 - QUALITATIVE ASPECTS OF ELECTRONIC INDUSTRIES IN BRAZIL

ANNEX 3 - INFORMATICS LAW (free translation and transcription)

ANNEX 4 - SOFTWARE LAW (free translation and transcription)

TABLE I-1 : Country data

Area (sq km)	Population (1988)	Density (1988)	GNP per capita in 1988
8,512,000	144 million	16.9 per sq km	US $ 2,020

Population characteristics (most recent estimate)	
Crude birth rate (per 1,000)	28.4
Crude death rate (per 1,000)	7.9
Income distribution (1973)	
% of private income, highest quintile	62.0
lowest quintile	3.0
Access to safe water (1988)	
Percentage of population	84.0
Nutrition (most recent estimate)	
Calorie intake as % of requirements	113.2
Per capital protein intake (grams/day)	61.0

Health (most recent estimate)	
Population per physician	1,080
Population per hospital bed	200
Distribution of land ownership	
% owned by top 10 % of owners	45.0
% owned by smallest 10 % of owners	1.5
Access to electricity (most recent estimate)	
% of population - total	67.0
- rural	21.0
Education	
Adult literacy rate % (1985)	79.0
Primary school enrollment % (1983) (Ages 7-14)	90.0

Gross domestic product in 1988 (1987 prices)		
	Cz$ bill.	%
GNP at market prices	11,849	100.0
Gross domestic investment	2,014	17.0
Gross national saving	2,121	17.9
Current account balance	161	1.4
Exports of GNFS	1,291	10.9
Imports of GNFS	634	5.4

Annual rate of growth (%, constant prices)		
1986	1987	1988
7.6	3.6	-0.3
23.2	-3.1	-23.8
19.3	-4.3	-18.0
...	...	...
-10.2	5.3	17.2
26.3	-2.6	-0.8

TABLE I-1 : Country data (continued)

Output employment and productivity in 1984						
	Net domestic product		Employment		NDP per worker	
	US $ million	%	US $ million	%	US $ million	%
Agriculture	44,181	12.7	15.0	29.9	2,945	25.4
Non-agriculture	303,702	87.3	35.2	70.1	8,628	74.6
Total/average	347,883	100.0	50.2	100.0	11,573	100.0

Government finance			
	General Government (a)		
	(Cz $mill.)	% of GDP	
	1986	1984	1986
Total receipts	1,127,752	29.4	30.4
Total expenditures	1,659,261	35.1	44.7
Overall balance	(531,509)	(5.6)	(14.3)
Government fixed investment	150,433	2.4	4.1
(a) Includes the consolidated accounts of the Central Government, states, and municipalities.			

Money, credit and prices (Cz$ mill.)	1986	1987	1988	1989
Money supply (M1)	455	1,036	6,958	105,956
Bank credit to private sector	1,259	4,855	46,165	...
Money (M1) as % of GDP	12.3	8.7	7.5	7.8
General price index (3/86=100)	101	325	2,549	36,193
Annual percentage changes in :				
General price index (Dec.-Dec.)	65.0	416.0	1037.0	1782.9
Bank credit to private sector	109.4	285.6	850.8	...

TABLE I-1 : Country data (continued)

Balance of payments (US $ millions)			
	1986	1987	1988
Exports of GNFS	23763	27751	35880
Imports of GNFS	17127	18158	17589
Resource Gap (deficit = -)	6636	9593	18291
Interest payments (net)	-7516	-7497	-7001
Other factor payments (net) a/	-4511	-3595	-6774
Net transfers	87	71	100
Balance of current account	-5304	-1428	4616
Direct private foreign invest-ment (net) a/	186	1148	2330
Net MLT borrowing			
- Disbursement b/	3440	3615	6194
- Amortization c/	3946	4572	5103
- Net disbursmnts	-506	-957	1091
Other capital (net) & cap. n.e.i.	-1681	-2706	6720
Increase in reserves(-)	3943	-1469	-1317
Cross reserves (and year) d/	6760	7458	9140
Petroleum imports e/	3020	4123	3515
Petroleum exports e/	675	930	876

Merchandise exports (average 1983-1988)		
	US$mill	%
Coffee (beans and soluble)	2,427	9.3
Soybean products	2,435	9.3
Sugar	417	1.6
Cacao	616	2.4
Irons	1,794	6.9
Manufactured goods	14,298	54.7
All other commodities	4,171	15.9
Total	26,158	100.0

External debt, December 31, 1988 (US$ mill)	
Public debt, incl. guaranteed	89,841
Non-guaranteed private debt	11,514
Total outstanding and disbursed	114,592

Debt service ratios for 1988 (%)	
Net debt service ratio f/	44.7
Public debt service ratio (gross) g/	7.9

IBRD/IDA Lending, (Dec. 31, 89, US$ mill)		
	IBRD	IDA
Outstanding & disbursed	8,316	...
Undisbursed	4,671	...
Outstanding incl.undisb.	12,987	...

Rate of exchange	
Average 1988	Average 1989
US$ 1.0 = NCz$ 0.262	US$ 1.0 = NCz$ 2.84
NCz$ 1.0 = US$ 3.817	NCz$ 1.0 = US$ 0.35

a/ Includes reinvested profits/earnings; b/ Disbursement totals from DRS; c/ Actual repayments; d/ Change in level of reserves differs from reserve change in balance of payments by valuation adjustment; e/ Crude and derivatives f/ Debt service on both public and private external debt net of interest earned on foreign exchange reserves as a percentage of exports of goods and non-factor services; g/ Includes World Bank, official export credits, concessional and non-concessional other.

TABLE I-2 : G.D.P. at constant prices, by type of economic activity, 1970-88 (Cz$ thousands)

	1970	1975	1980	1982	1983	1984	1985	1986	1987	1988 p
Agriculture	778219	963543	1232100	1325938	1318778	1358210	1491450	1369748	1576073	1569403
Industry	2013970	3425000	4902241	4470077	4211641	4479616	4881656	5451345	5508584	5367564
- Mining	63122	93171	125617	130991	151229	197324	220213	228339	226627	227465
- Manufacturing	1588152	2640649	3740089	3351202	3158608	3353388	3633060	4043596	4082010	3943222
- Construction	308625	583680	812737	754206	646807	642732	712725	837595	846557	821837
- Public utilities	68321	121886	217798	239391	258063	289547	319081	345585	356968	379457
Services	2419832	4075511	5944766	5919398	5866715	6113117	6519640	7064030	7295730	7454777
- Commerce	601529	973492	1328306	1246508	1194404	1243375	1340109	1449328	1485996	1444834
- Transport	158046	295151	453361	448920	439044	457923	488649	542694	567386	586677
- air	7414	19178	19815	33333	32036	33356	36658	45313	43831	45190
- rail	19936	31935	49368	46279	43988	51198	55171	57659	58120	60614
- water	4352	8784	10954	9988	9514	11626	11161	11869	11816	11250
- road	128163	235984	368862	369571	363510	372198	396838	440291	466621	483092
- pipeline	...	...	...	...	...	...	...	...	...	...
- communications	16445	38511	110751	145941	161950	183296	201588	197678	188367	188857
- financial institutions	...	...	955622	1062284	1121878	1208599	1235430	1261004	1287107	1313750
- public administration	...	...	780920	315978	834092	852609	852609	852609	852609	852609
- ownership of dwellings	...	...	...	...	...	...	...	...	...	...
- other services	...	...	...	...	...	...	...	...	...	...
GDP plus imputed service charges of financial institutions	5212021	8464069	12079107	11721413	11397035	11951143	12892745	13885122	14379387	14391744

p = preliminary data

Source : IBGE National accounts data (april, 1989)

TABLE I-3 : G.D.P. at constant prices by expenditure category, 1970-87 (1980 Cz$ thousands)

	1970	1975	1980	1982	1983	1984	1985	1986	1987
Total consumption	4431131	6896255	9789251	9549656	9281527	9435537	10002020	10967847	11135365
Gross capital formation	1162203	2469231	2889846	2296886	1774729	1820329	2193272	2680991	2670526
- Gross fixed capital formation	1114574	2256368	2835319	2330215	1950786	1954461	2193272	2680991	2670526
- Change in stocks	47629	212863	54527	-33329	-176057	-134132	...	...	...
Exports of goods & NFS	435111	743595	1121370	1235322	14111620	1721937	1843194	1648290	1965424
Imports of goods & NFS	609945	1346217	1399625	1152762	952203	923502	923990	1188472	1153496
Gross domestic product	5418500	8762864	12399842	11929102	11515673	12104301	13114496	14108656	14617819
Terms of trade effect	156191	120645	0	-21828	-251401	-201641	-213896	71086	-136738
Gross domestic income	5574691	8883509	12399842	11907274	11264272	11902660	12900600	14179742	14481081

Source : IBGE, National accounts of Brazil, april 1989

TABLE I-4 : Balance of payments summary, 1977-88 (US $ millions at current prices)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987p	1988e
1.Exports (g + nfs)	12,841	13,467	16,182	21,316	24,875	21,432	23,197	28,529	27,333	23,763	27,751	35,880
2.Merchandise (fob)	12,120	12,659	15,244	20,132	23,293	20,175	21,899	27,005	25,639	22,349	26,225	33,780
3.Non-factor services	721	808	938	1,184	1,582	1,257	1,298	1,524	1,694	1,414	1,526	2,100
4.Imports (g + nfs)	14,019	15,865	20,843	26,606	25,877	23,300	18,295	16,688	15,834	17,127	18,158	17,589
5.Merchandise(fob)	12,023	13,683	18,084	22,955	22,091	19,395	15,429	13,916	13,153	14,044	15,052	14,690
6.Non-factor services	1,996	2,182	2,759	3,651	3,786	3,905	2,866	2,772	2,681	3,083	3,106	2,899
7.Resource balance	(1,178)	(2,398)	(4,661)	(5,290)	(1,002)	(1,868)	4,902	11,841	11,499	6,636	9,593	18,291
8.Net factor income	(2,860)	(4,664)	(6,100)	(7,685)	(10,931)	(14,434)	(11,847)	(11,967)	(11,890)	(12,027)	(11,092)	(13,775)
9.Factor receipts	864	1,209	1,782	1,960	2,065	2,037	1,144	1,680	2,051	1,368	992	...
10.Factor payments a/	3,724	5,873	7,882	9,645	12,996	16,471	12,991	13,647	13,940	13,395	12,084	...
11.(M&LT interest paid) b/	2,010	3,124	4,749	6,330	7,948	9,331	7,682	7,102	7,262	7,516	7,001	9,288
12.Net current transfers	0	71	18	168	198	(8)	108	171	150	87	71	100
13.Transfer receipts	127	251	231	336	369	196	149	192	174	148	164	...
14.Transfer payments	127	180	213	168	171	204	41	21	24	61	93	...
15.current balance	(4,038)	(6,991)	(10,743)	(12,807)	(11,735)	(16,310)	(6,837)	45	(241)	(5,304)	(1,428)	4,616
M&LT capital inflow												
16.Direct investment, net a/	1,683	2,047	2,223	1,532	2,326	2,547	1,359	1,548	1,263	186	1,148	2,330
17.Official grant aid	4	3	5	42	10	2	2	10	7	(2)	(44)	0
18.Net M&LT loans c/f/	5,828	9,428	5,719	4,598	8,714	8,492	6,657	(1,282)	(506)	(957)	1,091	
19.Disbursements c/	9,496	14,625	12,227	11,428	16,126	16,026	10,362	11,623	2,467	3,440	3,615	6,194
20.Repayments c/d/	3,668	5,197	6,508	6,830	7,412	7,534	3,705	4,529	3,749	3,946	4,572	5,103
21.Other M&LT (net)	(2,461)	(255)	205	871	1,016	2,008	(499)	(1,710)	2,722	952	4,557	(4,757)
22.Credit from IMF e/	-	-	-	-	-	550	2,167	1,788	(65)	(613)	(1,146)	(419)
23.Disbursements	-	-	-	-	-	550	2,167	1,788	0	0	0	491
24.Payments	-	-	-	-	-	0	0	0	65	613	1,146	909
25.Net short-term capital e/	374	1,394	1,120	3,358	1,598	(1,261)	(1,779)	(3,077)	(2,786)	758	153	(590)
26.Brazilian net loans abroad e/	(267)	(357)	(608)	(27)	(921)	(594)	122	834	502	537	(333)	(133)
27.Errors and omissions and capital n.e.i. e/	(602)	(641)	(127)	(343)	(414)	(368)	(670)	403	(405)	49	(481)	(821)
28.Change in reserves e/ (-indicates increase)	(521)	(4,628)	2,206	2,776	(594)	4,934	(522)	(6,935)	285	3,943	(1,469)	(1,317)

a/ Includes reinvested earnings for 1977-1988

b/ For 1988, amount shown is for medium and long-term interest due

c/ Figures from DRS

d/ Actual repayments only, 1982-88

e/ Data after 1986 from IMF report (1989)

f/ For 1988 includes first tranche agreement of US$ 0.715 billion, other tranche agreements of US$ 3.428 billion and reclassification of deposits affected on behalf of the Paris club in 1987, and refinanced in 1988 (US$ 1.175 billion)

p = preliminary data;
e = estimated data.

TABLE I-5 : Merchandise exports, 1980-88 (US $ millions)

Exports	1980	1981	1982	1983	1984	1985	1986	1987	1988
Primary products (A)	10236	10550	9307	9713	10356	10015	8361	9059	10403
Coffee	2773	1761	2130	2348	2850	2607	2360	2185	2230
- Coffee in beans	2486	1517	1854	2096	2582	2338	2063	1959	1998
- Soluble coffee	287	244	276	252	268	269	297	226	232
Sugar	1287	1062	559	527	575	362	368	325	345
- Crystal sugar	317	87	77	26	48	31	46	31	16
- Raw sugar	624	579	250	333	314	166	138	134	167
- Refined sugar	346	396	232	168	213	165	184	160	162
Cocoa products	694	594	427	554	658	771	619	582	513
- Cocoa beans	292	241	216	284	249	360	273	266	215
- Cocoa butter	158	145	120	129	168	203	199	184	171
- Cocoa paste	219	195	80	119	195	177	124	99	95
- Cocoa in breads	25	13	11	22	46	31	23	33	32
Soy products	2244	3191	2096	2563	2570	2545	1582	2325	3045
- Soybran	1449	2136	1600	1793	1464	1177	1181	1450	2023
- Soy beans	374	404	123	309	455	764	243	570	728
- Unrefined soy oil	398	545	222	155	557	331	71	172	45
- Soy-oil (refined)	23	106	151	306	94	273	67	132	249
Irons	1715	1881	1931	1675	1771	1804	1722	1718	2070
- Iron ore	1557	1748	1769	1513	1590	1666	1606	1615	1892
- Manganese ore	59	58	55	36	37	37	32	28	45
- Other met.minerals	99	75	107	126	144	101	84	75	133
Other agricultural goods	1523	2061	2164	2046	1932	1926	1730	1925	2200
Semi-manf.goods (B)	1226	1130	911	1332	1809	1984	2017	2656	4533
Semi-manf.iron	398	384	328	528	815	1038	892	905	1617
- Unprocessed tin	46	62	55	112	174	232	119	144	236
- Iron and steel ingots	13	2	6	12	12	8	0	1	98
- Pig iron	127	87	80	184	267	268	246	214	299
- Unfinished iron alloys	181	225	176	209	227	227	195	218	379
- Iron and steel slabs	31	8	11	11	135	303	332	327	605
Other semi-manf.goods	828	746	583	804	994	946	1125	1751	2916
Manufactured goods (C)	8385	11138	9693	10549	14530	13356	11839	14331	18548
- Shoes	388	586	524	713	1078	969	1017	1169	1281
- Boilers, apparatuses, and mech.instr.	1020	1546	1210	1092	1401	1574	1433	1634	2291
- Machines,elec.app.	725	560	444	440	597	580	784	892	970
- Transportation eqpt.	1512	2076	1760	1448	1341	1688	1548	2780	3054
- Oil	195	366	557	476	632	412	200	212	198
- Steel products	625	801	791	1249	1544	1362	1179	1061	2353
- Orange juice	364	695	587	639	1473	797	756	894	1195
- Chemical products	236	500	414	580	726	737	602	709	1033
Other manf.goods	3320	4008	3406	3912	5738	5237	4320	4980	6173
Special transactions	285	374	263	307	309	283	177	179	303
Total	20132	23192	20174	21901	27004	25638	22394	26225	33787

a/ Free-on-board values

- Source : Cacex and Central Bank of Brazil, Boletim Mensal, various issues

TABLE I-6 : Merchandise imports, 1980-88 (US $ millions)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
Consumer goods (B)	1315	989	1002	796	703	795	1999	1523	1373
-Foodstuffs	552	378	346	249	226	239	1098	643	376
-Apparel	33	45	67	78	134	89	198	223	196
-Other	730	566	589	469	343	467	702	657	801
Raw materials (C)	7059	5739	4664	3521	3718	3702	5041	4862	4901
-Grains	1241	1077	848	905	835	731	823	373	193
-Fertilizers	620	353	239	136	246	231	295	317	313
-Inorganic chemical prod.	589	315	264	160	208	157	296	348	366
-Organic chemical prod.	1115	804	740	667	662	718	1057	1045	1130
Other chemical prod.	572	507	442	372	349	390	516	549	582
-Paper	246	214	198	168	136	119	192	269	269
-Plastic & rubber	453	371	312	303	307	331	417	476	535
-Cast iron & steel	591	735	431	160	159	174	323	286	263
-Nonferrous metals	824	497	422	175	232	220	275	369	281
-salt, sulfur, etc.	153	138	127	109	134	166	194	179	149
-Other raw materials	655	728	641	366	450	465	653	651	820
Fuels & lubricants (D)	10200	11340	10457	8607	7345	6176	3541	4709	4136
-Oil & derivatives	9844	11006	10120	8179	6866	5694	3020	4123	3515
-Other (coal)	356	334	337	428	479	483	520	586	621
Capital goods (E)	4381	4023	3272	2505	2151	2480	3464	3958	4195
-Transportation equip.	843	-581	446	611	503	508	750	947	525
-Machines & electric equip.	3538	3442	2826	1894	1648	1971	2714	3011	3670
Total (A) = (B + C + D + E)	22955	22091	19395	15429	13917	13153	14044	15052	14605

a/ Free-on-board values
Source : CACEX and Central Bank of Brazil, Boletim Mensal

TABLE II-1 : Manufacturing industry growth rate and investment index - 1950/88 (%)

Period	Average Growth Rate (%)	Investment Index (1980 = 100)
1950/60	9.1	N.A
1960/70	6.9	N.A.
1970/74	12.5	N.A.
1975/80	7.2	N.A.
1980/88	0.5	N.A.
1980	9.1	100.0
1981	-10.4	97.3
1982	-0.5	98.9
1983	-6.1	91.3
1984	6.1	77.1
1985	8.3	80.2
1986	11.3	96.5
1987	1.0	100.0
1988	-3.4	N.A.

N.A. : Not available
Sources : E.C.L.A. - 1950/70 - Willberg and Panariello (1990 - 1970/88)

TABLE II-2 : Manufacturing Industry - Imports as a share of internal consumption 1980, 1985, 1987

(% at 1980's prices)			
Industry	1980	1985	1987
Non-Metallic Mineral	1.7	0.8	1.3
Metallurgy	6.2	2.0	2.7
Mechanics	15.2	7.4	10.6
Electric and Telecom Equipment	12.4	8.9	10.4
Transport Equipment	7.3	5.8	10.4
Paper Products	4.1	1.7	2.5
Rubber Products	5.1	2.7	3.6
Chemicals	9.8	4.0	5.2
Pharmaceuticals	8.4	4.6	6.3
Textiles	0.5	0.3	0.8
Clothing and Shoes	0.2	3.7	0.2
Food Products	6.6	3.2	5.0
Manufacturing industry	6.6	3.4	4.6

Sources : Wilberg and Panariello (1990)

Table II-3 : Manufacturing industries value added structure
1970, 1980, 1987 - in %

Industries	1970	1980	1987
Mechanical	7.2	9.7	10.8
Electrical and Electronics Equipment	5.5	7.0	6.8
Chemicals	10.2	14.6	15.6
Subtotal	22.9	31.3	33.2
Perfume, Soaps, Candles	1.5	1.0	0.9
Textiles	9.3	6.6	6.1
Clothing leather and Shoes	4.0	5.5	5.2
Food Products	12.9	11.0	14.4
Beverages	2.1	1.3	1.6
Tobacco	1.3	0.7	1.1
Subtotal	31.1	26.1	29.3
Pharmaceuticals	3.4	1.7	1.7
Wood and Furniture	4.3	4.3	2.8
Printing	3.6	2.7	2.1
Transport Equipment	8.5	8.0	6.7
Metallurgy	11.5	11.4	8.9
Non-Metallic Mineral	5.7	5.6	6.5
Paper Products	2.5	2.9	3.2
Rubber Products	1.9	1.3	1.4
Plastic Products	1.9	2.3	1.5
Others	2.0	2.3	2.1
Total	100.0	100.0	100.0

Source : IBGE

Table II-4 : Brazil, FRG, Japan and Italy Mechanical,
electrical & electronical industries shares of manufacturing value
added in 1980 and 1987 (in %)

Industry	Brazil		USA	FRG	JAPAN	ITALY
	1980	1987	1980	1980	1980	1980
Mechanical	9.7	10.8	17.0	15.8	13.5	11.7
Electrical & Electronics	7.0	6.8	9.7	11.6	11.8	8.7
Chemical	14.6	15.6	9.6	14.2	8.8	12.1
Total	31.3	33.2	36.3	41.6	34.1	32.5

Sources : Brazil - Table II-2, other countries - Furtado (1989)

TABLE II-5 : The electronics structure in brazil
value of proportion in US $ 1000 and %

Sector	1987 Value	1987 %	1987 Value	1987 %	1988 Value	1988 %
Data processing	2126	33.4	2578	39.4	2465	35.1
Telecoms	636	10.0	617	9.4	1004	14.3
Industrial automation	199	3.1	294	4.5	309	4.4
Instruments	55	0.9	77	1.2	74	1.1
(Capital goods s.total)	(3016)	(47.4)	(3566)	(54.5)	(3852)	(54.9)
Consumer goods	3137	49.3	2731	41.8	2813	40.1
Components	209	3.3	242	3.7	348	5.0
Total EC	6362	100.0	6539	100.0	7013	100.0

Source : S.E.I. (1989), except consumer goods from Piragibe and Tigre (1990)

TABLE II-6 : The electronics complex in advanced countries
Main electronics products markets
(in % and total value)

Product	USA	Japan	Europe (i)	Total
EPDE	41.4	17.5	39.8	39.8
Consumer	11.7	17.0	16.4	14.6
Communications	12.8	8.9	19.1	13.0
Automation, instruments and other equip.	14.0	7.4	9.0	10.6
Components	20.1	29.2	17.7	21.1
Total	100.0	100.0	100.0	100.0
Value (US $ millions)	200.7	156.1	111.4	468.2

(i) FRG, UK, France, Italy
Source : Paiva (1988)

TABLE III-1 : International trade and internal market - Brazil and other countries

Countries	"Openness" of the economy (a) %			Imports as a share of internal market (b) %			Exports as a share of GDP (c) %			Degree of internatio-nalization (d)	
	1980	1983	1987	1980	1983	1987	1980	1983	1987	1980	1987
FRG	28.7	30.2	29.0	28.7	29.7	27.8	28.5	31.3	31.8	48.50	50.70
Argentina	8.0	12.2	nd	9.0	10.3	nd	6.7	14.7	nd	15.10	nd
Australia	17.4	15.3	17.0	13.7	15.8	17.5	17.0	14.5	16.3	28.37	31.00
Brazil	10.0	10.1	7.0	10.8	9.1	5.7	8.9	11.2	8.5	18.73	13.68
Canada	27.4	23.8	25.9	26.9	22.9	25.7	28.3	25.5	26.2	47.67	45.21
South Korea	37.6	37.1	40.7	38.5	37.3	39.8	33.7	36.5	44.9	51.52	66.79
Spain	17.0	21.6	19.1	17.7	21.7	18.3 d	15.8	21.3	20.2 d	41.21	34.66
USA	10.4	8.7	9.1	10.7	9.4	10.4	10.2	7.9	7.4	18.81	16.96
France	22.1	22.6	20.8	22.5	22.6	20.7	21.5	22.5	20.9	39.16	37.25
India	8.3	7.4	7.1	9.7	8.3	8.1	6.6	6.4	5.8	15.66	13.41
Italy	21.9	20.5	18.2	23.0	20.8	18.2	19.8	20.0	18.0	38.25	32.92
Japan	15.3	14.6	10.9	15.6	13.9	9.3	14.9	15.5	12.8	28.16	20.89
Mexico	13.0	14.5	nd	13.4	10.5	nd	12.6	19.5	nd	24.26	nd
UK	26.1	26.2	26.8	25.6	26.0	27.0	27.2	26.7	26.3	45.88	46.28
Thailand	27.2	24.0	29.0	28.3	25.7	29.0	24.5	20.3	29.0	46.00	49.59

(a) ((X+M/2i)/GDP; (b) IM = GDP + M - X; (c) X / GDP;
(d) DI = TE + (1 - TE) *TP
TE = X / GDP; TP = M / IM
Source : Carvalho (1990)

TABLE III-2 : Ratios of imports exports and average trade to GDP - 1965/88 - Five year average - in %

Years	Imports (M)	Exports (x)	Trade (M + x)/2
1965/69	4.96	6.22	5.59
1970/74	7.72	6.76	7.24
1975/79	7.88	6.68	7.28
1980/85	7.78	9.56	8.67
1985/88	5.03	9.40	7.22

Source : Computed from CACEX and World Bank data

TABLE III-3 : Ratio of balance of payments items to GDP - 1977/87 (percent)

Year	Ex-ports 1	Im-ports 2	Trade balance 3	Non-factor service export 4	(4)/(i) *100 5	Non-factor service import 6	(6)/(2) *100 7	Net factor ser-vices 8	Services balance 9	Current account balance 10	Capital account balance 11
1977	6.90	6.80	0.10	0.40	5.80	1.10	15.90	-1.60	-2.36	-2.30	2.60
1978	6.30	6.80	-0.50	0.40	6.30	1.10	17.50	-2.30	-3.00	-3.50	5.80
1979	6.90	8.20	-1.30	0.40	5.80	1.20	14.60	-2.80	-3.80	-4.90	3.90
1980	8.60	9.80	-1.20	0.50	5.80	1.60	16.30	-3.30	-4.30	-5.40	4.30
1981	8.80	8.30	0.50	0.60	6.80	1.40	16.90	-4.10	-5.00	-4.40	4.70
1982	7.10	6.80	0.30	0.40	5.60	1.40	20.60	-5.10	-8.00	-5.70	4.00
1983	10.60	7.50	3.10	0.60	5.70	1.40	18.70	-5.70	-8.50	-3.30	3.60
1984	12.70	6.50	6.10	0.70	5.50	1.30	20.00	-5.60	-8.20	0.00	3.20
1985	11.20	5.80	5.50	0.70	6.20	1.20	20.70	-5.20	-5.60	-0.10	0.00
1986	8.20	5.20	3.10	0.50	6.10	1.10	21.10	-4.40	-5.00	-2.00	0.50
1987	8.70	5.00	3.70	0.50	6.70	1.00	20.00	-3.70	-4.20	-0.50	0.80

Source : World Bank

TABLE III-4 : Brazil - Foreign trade - value and volume

Year	Total imports FOB SMN. (1)	Total exports FOB SMN. (2)	Import price index 1980 = 100 (3)	Export price index 1980 = 100 (4)	Terms of trade 1980 = 100 (5)	Import volume index 1980 = 100 (6)	Export volume index 1980 = 100 (7)
1960	1,293	1,268	n.a.	29.0	n.a.	n.a.	22.3
1961	1,292	1,403	24.0	30.0	125.0	25.0	23.5
1962	1,3.4	1,214	24.0	27.0	112.5	25.0	23.3
1963	1,294	1,406	25.0	26.0	104.0	24.5	27.1
1964	1,086	1,430	24.0	32.0	133.3	21.6	23.1
1965	941	1,595	24.0	32.0	133.3	18.6	25.4
1966	1,303	1,741	25.0	31.0	124.0	24.8	29.0
1967	1,441	1,654	25.0	31.0	124.0	26.8	27.6
1968	1,855	1,881	26.0	30.0	115.4	33.1	31.7
1969	1,993	2,311	25.0	31.0	124.0	34.6	36.1
1970	2,507	2,739	26.0	35.0	134.6	41.6	37.2
1971	3,247	2,904	27.0	34.0	125.9	50.7	39.4
1972	4,232	3,991	26.0	38.0	146.2	61.5	50.2
1973	6,192	6,199	36.0	53.0	147.2	74.4	57.6
1974	12,641	7,951	52.0	66.0	126.9	100.5	58.7
1975	12,210	8,670	57.0	66.0	115.8	95.2	64.7
1976	12,383	10,128	59.0	77.0	130.5	94.3	74.3
1977	12,023	12,120	61.0	93.0	152.5	87.3	65.8
1978	13,683	12,659	65.0	86.0	132.3	91.8	74.3
1979	18.084	15,244	78.0	94.0	120.5	99.9	81.4
1980	22,955	20,132	100.0	100.0	100.0	100.0	100.0
1981	22,091	23,192	111.0	94.0	84.7	86.7	120.3
1982	19,295	20,174	107.0	88.0	82.2	79.5	109.8
1983	15,429	21,901	102.0	84.0	82.4	66.5	125.6
1984	13,917	27,004	97.0	85.0	87.6	63.8	153.9
1985	13,153	25,638	91.0	80.0	87.9	63.0	163.9
1986	14,044	22,394	71.0	80.0	112.7	135.0	
1987	15,052	26.225	83.0	80.0	96.4		
1988	14,692	33,781					

Source : CACEX

TABLE III-5 - Brazilian imports structure - value and % - 1964/88

US $ millions FOBs

Period	(0) Total	(%)	(1) Cereals	(%)	(2) Mineral fuels	(%)	(3) Chemical products	(%)	(4) Non-electrical machinery	(%)	(5) Electrical machinery	(%)	(6) Others	(%)
1964	1,086	100	181	16.67	199	18.32	49	4.51	167	15.38	55	5.06	435	40.
1965	940	100	119	12.66	173	18.40	58	6.17	138	14.68	45	4.79	407	43.
1966	1,303	100	149	11.44	191	14.66	83	6.37	198	15.20	70	5.37	612	46.
1967	1,441	100	161	11.17	178	12.35	80	5.55	235	16.31	84	5.83	703	48.
1968	1,855	100	162	8.73	230	12.40	104	5.61	328	17.68	116	6.25	915	49.
1969	1,993	100	144	7.23	237	11.89	105	5.27	400	20.07	140	7.02	967	48.
1970	2,507	100	112	4.47	281	11.21	142	5.66	531	21.16	181	7.22	1,260	50.
1971	3,247	100	114	3.51	377	11.61	166	5.11	751	23.13	210	6.47	1,629	50.
1972	4,232	100	132	3.12	469	11.08	213	5.03	1,070	25.28	321	7.59	2,027	47.
1973	6,192	100	350	5.65	769	12.42	340	5.49	1,232	19.90	476	7.69	3,025	48.
1974	12,641	100	486	3.84	2,961	23.42	636	5.03	1,772	14.02	712	5.63	6,074	48.
1975	12,210	100	372	3.05	3,100	25.39	531	4.35	2,337	19.14	894	7.32	4,976	40.
1976	12,382	100	533	4.30	3,841	31.02	715	5.77	2,114	17.07	927	7.49	4,252	34.
1977	12,023	100	279	2.32	4,081	33.94	640	5.32	1,728	14.37	841	6.99	4,454	37.
1978	13,683	100	702	5.13	4,483	32.76	726	5.31	1,982	14.49	910	6.65	4,880	35.
1979	18.083	100	984	5.44	6,773	37.46	984	5.44	2,267	12.54	1,043	5.77	6,032	33.
1980	22,960	100	1,241	5.41	10,200	44.43	1,114	4.85	2,375	10.34	1,163	5.07	6,867	29.
1981	22,090	100	1,080	4.89	11,340	51.34	804	3.64	2,303	10.43	1,140	5.16	5,423	24.
1982	19,395	100	850	4.38	10,457	53.92	740	3.82	1,666	8.59	1,160	5.98	4,522	23.
1983	15,430	100	905	5.87	8,607	55.78	666	4.32	1,094	7.09	800	5.18	3,358	21.
1984	13,916	100	835	6.00	7,345	52.78	662	4.76	948	6.81	700	5.03	3,426	24.
1985	13,153	100	731	5.56	6,176	46.96	718	5.46	1,223	9.30	750	5.70	3,555	27.
1986	14,044	100	822	5.85	3,540	25.21	1,056	7.52	1,595	11.36	1,200	8.54	5,831	41.
1987	15,052	100	373	2.48	4,709	31.28	1,045	6.94	1,862	12.37	1,150	7.64	5,913	39.
1988	14,605	100	193	1.32	4,135	28.31	1,130	7.74	2,310	15.82	1,360	9.31	5,477	37.

Source : CACEX and Central Bank of Brazil

TABLE III-6 : Brazil - Technology intensive products international trade
1985 - in US $ millions and %

ISIC	Products	Imports		Exports	
		value	(%)	value	(%)
513-514	Inorganical chemical	141.7	9.8	68.7	4.3
266-581	Plastics and synthetic fibres	159.8	11.0	267.1	16.8
541	Pharmaceuticals	110.9	7.6	38.0	2.4
711	Engines, turbines and boilers	360.5	24.8	617.1	38.7
714	Office and calculating machines	215.7	14.8	184.8	11.6
724	Telecoms equipment	74.1	5.1	219.7	13.8
734	Airplanes	198.4	13.7	161.0	10.1
861-864	Instruments	174.1	12.0	38.2	2.4
Total	Total	1,453.2	100.0	1,594.6	100.0

Source : ECLA data bank

TABLE III-7 : Technology-intensive products trade as a share of total imports and exports Brazil and other countries - 1983 - in %

Countries	Imports	Exports
Brazil	23.9	10.0
U.S.	25.0	42.6
Japan	28.2	32.1
EEC	26.6	25.0
Asian NICs (i)	33.1	24.9
World	26.2	26.2

(i) Taiwan, Hong Kong, South Korea, Singapore.
Source : ECLA

TABLE III-8 : Services - factor and non-factor imports and exports in 1987 (in US $ millions)

	Imports	Exports
A - Factor services	10259	558
Interests	9319	527
Profits and dividends	940	31
B - Non-factor services	4291	1974
Transports	2071	1323
Insurance	242	28
Leasing of equipment	448	4
Industrial tech. licensing	60	3
Specialised tech. services	123	76
Patent licensing	1344	540
Others	1344	540
Total	2018	2532

Source : Goncalves (1989)

TABLE III-9 - Brazilian imports per Economic zones
(percentual participation) - 1960/88

Country	1960	1965	1970	1975	1980	1985	1988
United States *	30.99	29.94	32.86	25.28	17.86	19.87	21.37
Japan	2.69	3.41	6.35	9.05	4.64	4.18	6.57
Canada	1.10	1.17	2.45	1.66	3.55	3.02	2.87
Latin-American integration Association-ALADI	14.01	24.20	10.52	5.88	11.73	12.25	12.71
Others of America	4.79	1.58	1.13	0.68	0.88	0.47	1.00
European Economic Community - EEC	26.85	22.00	29.47	24.98	15.31	14.20	22.09
European Free Trade Association - EFTA	5.51	4.80	5.65	5.65	2.71	3.11	5.08
East Europe	5.50	5.47	2.06	1.57	1.08	2.54	2.19
Others of West Europe	4.00	2.11	1.73	1.19	1.17	0.44	0.12
Asia (except Japan and Middle East)	1.41	0.61	0.65	0.55	2.17	4.43	2.23
Middle East	2.61	4.29	4.15	19.03	33.94	21.86	18.76
Africa	0.53	0.35	2.85	4.09	4.82	13.15	4.42
Oceania	0.01	0.07	0.13	0.39	0.14	0.48	0.59
Others **	-	-	-	-	-	-	-
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Including Puerto Rico
** Provision for ships and aircraft, not declared and special operations
Source : Cacex

TABLE III-10 : Brazilian exports per economic zones (percentual participation) - 1960/88

Country	1960	1965	1970	1975	1980	1985	1988
United States *	44.43	32.60	24.68	15.42	17.42	26.53	25.80
Japan	2.42	1.88	5.29	7.75	6.12	5.44	6.72
Canada	1.31	1.56	1.48	1.57	1.21	1.62	2.59
Latin-American integration Association - ALADI	6.96	12.64	11.06	13.81	17.18	8.71	65.40
Others from America	0.98	0.14	0.69	1.99	0.95	0.95	1.17
European Econo-mic Community - CEE	26.67	32.22	34.93	27.82	27.15	23.99	27.66
European free trade association EFTA	5.69	5.79	5.42	3.58	3.26	2.85	1.60
East Europe	5.59	5.60	4.51	8.79	6.49	3.87	3.09
Others from West Europe	3.46	4.06	5.93	6.00	3.70	2.63	0.58
Asia (except Japan and Middle East)	0.91	1.14	2.96	2.14	3.75	6.94	8.18
Middle East	0.38	0.81	0.64	5.14	5.16	5.73	4.40
Africa	0.95	1.40	2.15	47.61	5.73	6.55	2.71
Oceania	0.25	0.16	0.11	0.32	0.58	0.72	0.81
Others **	-	-	0.15	1.06	1.29	3.47	3.73
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Including Puerto Rico

** Provision for ships and aircraft, not declared and special operations

Source : Cacex

TABLE III-11 - Brazilian Manufacturing Export
"Revealed comparative advantages"
Index (1) - 1976-87

Product	1976	1980	1984	1987
Non-metallic minerals	0.41627	0.92831	1.64804	0.987136
Metallurgy	0.54946	0.80993	1.53408	2.012922
Mechanicals	0.33816	0.71933	0.43658	0.449378
Electric & Telecom equipment	0.46079	0.29885	0.20504	0.333186
Transport equipment	0.49398	0.65130	0.43164	0.835720
Wood products	0.60771	0.68058	0.60591	0.818869
Furniture	0.29898	0.10705	0.10617	0.183321
Paper products	0.27614	0.99463	1.09489	1.042930
Rubber products	0.35900	0.80597	1.18149	1.418400
Leather products	2.45224	1.33970	0.86880	0.945401
Chemicals	1.97734	1.38925	1.83520	1.757838
Pharmaceuticals	0.18015	0.28125	0.32336	0.328123
Perfume, soap and candles	0.17959	0.63567	0.35409	0.245317
Plastic products	0.08361	0.37327	0.48909	0.263293
Textiles	0.85002	0.78022	0.65296	0.973823
Clothing and shoes	0.68188	0.55801	0.88267	0.869199
Food products	3.79154	3.52711	3.45512	3.092438
Beverage	0.21345	0.90387	0.98201	0.137989
Tobacco	3.61930	3.23656	3.77157	3.956357
Printing & publishing	0.22375	0.22709	0.12397	0.152394
Others	0.09092	0.13944	0.15857	0.156135

(i) Specialization measured for each sector "i" as : $\frac{[\ Xi\hat{}B\ /\ Xt\hat{}B\ ]}{[\ Xi\hat{}w\ /\ Xt\hat{}w\ ]}$

where Xi^B are Brazilian exports of sector "i"; Xt^B are Brazilian total exports; Xi^w are total world exports of sector "i" and Xi^w are total world exports

Source : Carvalho (1990)

TABLE III-12 : Manufacturing industry exports structure
1980/87 (%)

Industry	1980	1983	1987
Non-metallic mineral	1.3	1.2	1.5
Metallurgy	6.8	10.3	13.0
Mechanics	8.7	5.6	6.8
Electric and telecom equipment	2.7	2.6	3.9
Transport equipment	7.4	7.9	12.3
Paper products	3.0	2.7	3.3
Rubber products	0.8	0.7	1.3
Chemicals	18.1	23.3	18.4
Pharmaceuticals	0.3	0.3	0.4
Perfume, soaps, candles	0.2	0.2	0.2
Plastic products	0.3	0.4	0.3
Textiles	4.3	4.6	4.2
Clothing and shoes	2.8	3.9	5.3
Food products	34.8	29.0	22.9
Beverages	0.9	0.5	0.1
Tobacco	1.7	2.5	1.9
Others	4.9	4.3	4.3
Manufacturing industry	100.0	100.0	100.0

Source : Willberg and Panariello (1990)

TABLE III-13 : Brazilian export participation in world trade (%)

Product	1976	1980	1984	1987
Non-metallic minerals	0.62	1.61	3.70	1.57
Metallurgy	0.74	1.53	3.69	3.01
Mechanics	0.43	1.25	0.99	0.67
Electric & telecom equipment	0.67	0.59	0.52	0.52
Transport equipment	0.71	1.23	1.05	1.24
Wood products	0.84	1.23	1.50	1.22
Furniture	1.17	0.20	0.26	0.27
Paper products	0.40	1.90	2.60	1.58
Rubber products	0.60	1.54	2.92	2.12
Leather products	3.52	2.55	2.15	1.41
Chemicals	2.04	1.77	2.75	2.64
Pharmaceuticals	0.26	0.54	0.80	0.50
Perfume, soap and candles	0.21	0.78	0.53	0.37
Plastic products	0.12	0.70	1.19	0.46
Textiles	1.30	1.50	1.64	1.45
Clothing and shoes	0.98	1.05	2.17	1.30
Food products	5.46	6.87	8.69	4.61
Beverage	0.31	1.72	2.43	0.21
Tobacco	5.19	6.22	9.29	5.91
Printing & publishing	0.31	0.43	0.31	0.23
Others	0.13	0.26	0.39	0.23
Exports total	1.36	1.77	2.28	1.5

Source : Carvalho (1990)

TABLE III-14 : Frequency and coverage of NTB for Brazilian products EEC and USA (percentage)

	Frequency coefficient				Coverage coefficient		
	1983	1985	1986		1983	1985	1986
	EEC						
Agriculture	48.58	49.76	49.76		3.57	4.01	4.01
Mining	0.16	0.65	0.65		0.00	0.00	0.00
Manufacturing	28.37	44.88	44.88		29.23	45.37	43.33
Total	25.32	39.22	39.22		24.52	38.03	38.01
	USA						
Agriculture	0.11	0.11	0.11		0.11	0.11	0.11
Mining	49.65	8.23	8.23		49.65	20.36	20.36
Manufacturing	24.08	24.73	26.39		39.67	32.51	34.34
Total	25.08	22.94	24.45		39.20	30.78	32.44

Source : L.V. Pereira, "O Protecionismo dos paises desenvolvidos e o acesso de produtos brasileiros aos mercados externos", FUNCEX, 1989

TABLE III-15 : Coverage coefficient of NTBs applied by developed countries to Brazilian manufactured exports 1981 and 1986 in % and 1985 value (US$ millions)

	USA		EEC		Japan		Others		Total		Value
Products	1981	1986	1981	1986	1981	1986	1981	1986	1981	1986	
Organic chemicals	54.54	54.54	18.69	19.47	98.98	98.98	34.82	34.82	65.10	65.10	725
Other chemical	0.00	0.00	3.02	3.02	100.00	100.00	76.37	76.37	13.30	13.30	156
Leather goods	0.00	0.00	18.10	18.10	0.00	0.00	18.60	18.60	14.30	14.30	137
Textile fibres and yarns	77.20	77.20	100.00	100.00	16.60	16.60	29.60	29.60	74.60	74.60	274
Cotton fabrics	100.00	100.00	100.00	100.00	0.00	0.00	43.26	100.00	97.80	100.00	139
Other	100.00	100.00	62.40	62.40	0.00	0.00	2.00	24.85	78.20	79.90	105
Iron	41.20	41.20	13.10	16.70	0.00	0.00	0.00	0.00	16.40	17.00	506
Iron and steel plates	0.00	100.00	100.00	100.00	0.00	0.00	0.00	34.10	23.60	73.70	465
Iron and steel tubes	0.00	99.50	100.00	100.00	0.00	0.00	0.00	100.00	2.30	99.50	167
Clothing	64.10	68.30	77.30	77.30	0.00	0.00	27.70	27.70	67.80	68.90	172
Footwear	100.00	0.00	100.00	100.00	98.70	98.70	82.40	62.40	98.60	23.20	907

Source : Burle (1989)

TABLE III-16 : Frequency and coverage coefficients in the EEC Community and individual country policies (percentage)

	Total		Community		Individual countries	
	FC	CC	FC	CC	FC	CC
1981	25.32	24.53	21.30	20.06	9.01	14.77
1983	25.35	24.53	21.33	20.10	9.01	14.77
1985	38.92	38.03	21.84	20.33	37.26	37.26
1986	39.22	38.01	21.73	20.30	37.27	37.27

Source : See table III-14

TABLE III-17 : Brazilian exports to EEC under GSP schemes

	1984			1985		
	GSP exports (US$million)	GSP exports (%)	GSP exports/ total exports (%)	GSP exports (US$million)	GSP exports (%)	GSP exports/ total exports (%)
Agriculture	25.20	1.40	8.60	66.30	3.50	10.60
Mining	1.70	0.10	0.30	2.70	0.10	0.40
Food, beverage and tobacco	475.00	25.60	21.00	465.30	24.40	23.90
- Food products	284.00	15.30	13.90	280.00	14.70	16.60
- Tobacco	190.00	10.20	91.40	185.20	9.70	73.50
Textiles, wearing apparel, leather	303.50	16.30	70.30	251.30	13.20	70.00
- Textiles	205.60	11.10	70.30	165.70	8.70	73.40
- Wearing apparel	57.70	3.10	80.40	58.60	3.10	74.60
Wood products and furniture	80.30	4.30	60.20	85.90	4.50	72.30
Paper, printing and publishing	83.80	4.50	35.10	54.00	2.80	36.80
Chemicals	359.70	19.40	27.70	353.00	18.50	25.80
Non-metallic mineral products	16.80	0.90	68.30	14.90	0.80	95.50
Basic metals and metal products	490.00	26.40	61.40	596.20	31.20	62.90
- Basic metals	100.00	5.40	44.90	130.00	6.80	37.80
- Machinery and equipment	155.30	8.40	79.10	233.70	12.20	89.30
- Elect.equip. and apparatus	23.50	1.30	29.90	21.20	1.10	29.40
- Transport equipment	211.20	11.40	70.40	211.30	11.10	78.20
Other	22.20	1.20	77.90	20.10	1.10	87.80
Total	1858.20	100.00	30.20	1909.70	100.00	30.70

Source : Computed by FUNCEX from CACEX data

Table III - 18 : Brazilian exports to EEC by country and sector - 1985

	Benelux	Denmark	France	Germany	Greece	Ireland	Italy	Nether-lands	Portugal	Spain	United kingdom	Total
A - Value (US $ million)												
Agric.prod./food/beverage/tobacco	322.90	79.90	570.80	588.90	42.20	6.20	438.20	1153.90	85.90	393.60	339.30	4021.0
- Agriculture products	173.20	68.70	204.00	360.60	38.90	0.20	336.70	310.30	73.20	231.90	83.00	1880.0
- Food, beverage and tobacco	149.80	11.20	366.80	228.40	3.40	6.00	101.40	843.60	12.70	161.80	256.30	2141.0
Mining	98.20	0.70	80.80	301.30	1.00		139.40	37.50	1.40	67.60	48.60	776.0
Textiles, wearing apparel, leather	25.60	12.60	57.70	143.80	8.40	5.10	58.50	28.80	28.40	15.10	71.50	455.0
Wood products and furniture	4.70	1.90	4.80	21.80	0.20	5.30	5.20	6.00	1.70	3.70	66.70	122.0
Paper, printing and publishing	78.30	0.10	12.20	24.40	1.20	0.10	19.10	1.70	5.60	0.20	8.40	151.0
Chemicals	18.50	1.90	25.10	61.30	1.20	0.20	46.80	139.50	3.00	7.30	20.00	325.0
Non-metallic mineral products	1.20	0.30	0.50	9.70	0.10		0.50	0.70	0.00	0.10	3.20	16.0
Basic metals	6.10	3.00	2.20	44.30	4.70	0.10	99.40	155.80	1.30	39.90	22.50	379.0
Machinery and equipment	15.70	0.70	14.10	77.00	0.70	0.10	184.50	24.80	5.50	3.50	41.40	36.0
Transport equipment	3.90	19.20	26.20	27.30	1.00	0.00	156.10	5.90	2.70	0.30	7.00	249.0
Other	2.00	0.20	2.60	9.30	0.10	2.50	2.20	3.80	0.40	1.30	2.80	27.0
Total	577.10	120.30	797.00	1309.10	60.90	19.70	1149.80	1558.30	136.00	532.50	632.20	6893.0

Table III - 18 : Brazilian exports to EEC by country and sector - 1985

	Benelux	Denmark	France	Germany	Greece	Ireland	Italy	Nether-lands	Portugal	Spain	United kingdom	Total
B - Country percentage												
Agric. Prod./food/bever./Tobacco	56.00	66.40	71.60	45.00	69.30	31.60	38.10	74.00	63.20	73.90	53.70	58.0
- Agriculture products	30.00	57.10	25.60	27.50	63.80	1.00	29.30	19.90	53.80	43.50	13.10	27.0
- Food, beverage and tobacco	25.90	9.30	46.00	17.40	5.50	30.70	8.80	54.10	9.30	30.40	40.50	31.0
Mining	17.00	0.60	10.10	23.00	1.60		12.10	2.40	1.10	12.70	7.70	11.0
Textiles, wearing apparel, leather	4.40	10.50	7.20	11.00	13.80	25.80	5.10	1.80	20.90	2.80	11.30	6.0
Wood products and furniture	0.80	1.50	0.60	1.70	0.40	26.80	0.50	0.40	1.30	0.70	10.60	1.0
Paper, printing and publishing	13.60	0.10	1.50	1.90	2.00	0.70	1.70	0.10	4.10	0.00	1.30	2.0
Chemicals	3.20	1.50	3.10	4.70	2.00	1.10	4.10	9.00	2.20	1.40	3.30	4.0
Non-metallic mineral products	0.20	0.20	0.10	0.70	0.10		0.00	0.00	0.00	0.00	0.50	0.0
Basic metals	1.00	2.50	0.30	3.40	7.80	0.40	8.60	10.00	0.90	7.50	3.60	5.0
Machinery and equipment	2.70	0.60	1.80	5.90	1.20	0.60	16.00	1.60	4.00	0.70	6.50	5.0
Transport equipment	0.70	15.90	3.30	2.10	1.70	0.10	13.60	0.40	2.00	0.10	1.10	3.0
Other	0.30	0.10	0.30	0.70	0.10	12.90	0.20	0.20	0.30	0.30	0.40	0.0
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	10.0

Table III - 18 : Brazilian exports to EEC by country and sector - 1985

	Benelux	Denmark	France	Germany	Greece	Ireland	Italy	Nether-lands	Portugal	Spain	United kingdom	Total
C - Product percentage												
Agric.prod./food/beverage/tobacco	8.00	2.00	14.20	14.60	1.00	0.20	10.90	28.70	2.10	8.40	100.00	
- Agriculture products	9.20	3.70	10.80	19.20	2.10	0.00	17.90	16.50	3.90	4.40	100.00	
- Food, bevarage and tobacco	7.00	0.50	17.10	10.70	0.20	0.30	4.70	39.40	0.60	12.00	100.00	
Mining	12.70	0.10	10.40	38.80	0.10		16.00	4.80	0.20	6.30	100.00	
Textiles, wearing apparel, leather	5.60	2.80	12.70	31.60	1.80	1.10	12.80	6.30	6.20	15.70	100.00	
Wood products and furniture	3.90	1.50	3.90	17.90	0.20	4.30	4.30	4.90	1.40	54.60	100.00	
Paper, printing and publishing	51.70	0.00	8.10	16.10	0.80	0.10	12.60	1.20	3.70	5.60	100.00	
Chemicals	5.70	0.60	7.70	18.80	0.40	0.10	14.40	42.80	0.90	6.40	100.00	
Non-metallic mineral products	7.20	1.60	3.10	60.10	0.50		2.80	4.10	0.10	20.10	100.00	
Basic metals	1.60	0.80	0.60	11.70	1.20	0.00	26.20	41.10	0.30	5.90	100.00	
Machinery and equipment	4.30	0.20	3.80	20.90	0.20	0.00	50.10	6.70	1.50	11.20	100.00	
Transport equipment	1.60	7.70	10.50	10.90	0.40	0.00	62.50	2.40	1.10	2.80	100.00	
Other	7.30	0.60	9.60	34.50	0.30	9.40	8.00	13.90	1.30	10.20	100.00	
Total	8.40	1.70	11.60	19.00	0.90	0.30	16.70	22.60	2.00	9.20	100.00	

Source : Guimaraes (1990)

TABLE III-19 : Brazilian exports to EEC - 1986

Products	US $ million	Percentage
Agriculture products	298.60	5.60
Ores	649.80	12.10
Manufacturing	4417.70	82.30
- Pig iron	26.40	0.50
- Steel ingots and ferroalloys	103.10	1.90
- Flat and non flat steel products	41.30	0.80
- Non-ferrous metals	145.50	2.70
- Other steel products	16.20	0.30
- Machinery parts	124.20	2.30
- Office machines	24.60	0.50
- Domestic electric appliance and parts	18.00	0.30
- Electronic appliance and parts	25.90	0.50
- Radio/television receiver; appar. for sound reproduction	59.20	1.10
- Motor vehicles	127.60	2.40
- Motor vehicle motors and parts	27.90	0.50
- Others vehicles and parts	67.90	1.30
- Wood sawn or chipped	112.80	2.10
- Pulp and chemical wood pulp	129.00	2.40
- Paper and paperboard	85.70	1.60
- Leather products	61.80	16.60
- Basic chemicals	58.60	0.50
- Petrochemical products	85.20	1.40
- Oil-cake, flour and other solid residues of oil seeds	890.90	2.90
- Pharmaceutical products	29.10	0.90
- Other chemical products	74.80	1.40
- Textiles	153.90	10.70
- Wearing apparel	45.90	1.50
- Footwear	75.60	1.60
- Coffee not roasted	576.70	2.70
- Coffee roasted or concentrated	78.60	1.20
- Meat, fresh, chilled or frozen	83.70	1.60
- Meat products	145.20	2.70
- Preparation used in animal feeding	62.30	1.20
- Other food products	403.70	7.50
- Beverage	15.10	0.30
- Tobacco	197.50	3.70
- Other	243.80	4.50
- Total	5336.00	100.00

Source : Computed by FUNCEX from CACEX data, in Guimaraes (1990)

TABLE III-20 : Brazilian trade with ALADI countries 1970/88 (in US $ millions)

Year	Exports	Imports
1970	303	264
1971	355	271
1972	408	350
1973	557	557
1974	918	944
1975	1,197	718
1976	1,202	1,173
1977	1,480	1,343
1978	1,619	1,422
1979	2,475	2,209
1980	3,458	2,692
1981	4,209	3,126
1982	2,862	3,286
1983	2,057	2,204
1984	2,829	2,140
1985	2,231	1,614
1986	2,522	1,823
1987	2,973	1,779
1988	3,704	1,857

Source : Araujo Jr. (1990)

TABLE III-21 : Brazilian exports of capital goods to Argentina, Mexico, Uruguay and Venezuela - In value (US $ millions) and as % of total exports 1980/88

Year	Argentina		Mexico		Venezuela		Uruguay	
	Value	(%)	Value	(%)	Value	(%)	Value	(%)
1980	357	32.7	311	66.2	91	39.6	150	48.4
1981	269	30.6	379	58.9	141	34.6	198	53.1
1982	114	17.1	126	38.8	179	37.8	48	34.8
1983	165	25.2	42	24.3	125	46.5	26	25.0
1984	171	20.0	67	23.5	153	41.9	34	25.0
1985	140	25.5	97	43.9	156	53.1	48	34.3
1986	170	24.9	66	42.3	215	61.6	72	35.5
1987	252	30.3	81	47.4	208	55.6	126	47.2
1988	240	24.5	116	42.3	231	45.9	131	40.8

Source : Araujo Jr. (1990)

TABLE III-22 - Capital goods trade between Argentina and Brazil under the capital goods agreement (CGA) - in US $ 1000 - 1986/88

	Years		
	1986 Value	1987 Value	1988 Value
(1) Exports from Argentina			
Total capital goods	2131	17888	35575
Machine tools	631	7961	17577
NCMT	n.a.	3436	8911
CGA trade coverage (%) (a)	3.4	19.7	31.5
(2) Exports from Brazil			
Total capital goods	14591	25267	33122
Machine tools	553	952	693
NCMT	-	-	-
CGA trade coverage (%) (a)	8.6	10.0	13.8
Balance : (1) - (2)			
Total capital goods	-12460	-7379	2453
Machine tools	78	7009	16884
NCMT	n.a.	3436	8911
Total trade : (1) + (2)			
Total machine goods	16722	43155	68697
Machine tools	1184	8913	18270
NCMT	n.a.	3436	8911

(a) Exports of capital goods under the CGA as a % of total exports of capital goods

Source : Secretaria de industria y comercio exterior of Argentina for trade under the CGAA and Araujo Jr. (1990) for total exports of capital goods

TABLE IV-1 : Foreign investments and remittances 1960/88 (in US $ millions)

Year	Net direct foreign investments [i] (a)	Profits and dividends remittance (b)	(a) - (b) (c)
Average 1960/68	68	34	34
Average 1969/72	199	120	79
Average 1973/77	898	303	595
Average 1978/81	1317	469	848
1982	991	585	406
1983	664	758	(-)94
1984	1077	796	281
1985	720	1057	(-)337
1986	(-)263	1351	(-)1614
1987	531	909	(-)378
1988	2266	1538	728

[i] Foreign investments in Brazil (inflow less outflow minus Brazilian investments abroad (outflow minus return)
Source : Central Bank of Brazil and Bauman (1990)

TABLE IV-2 : Direct foreign investment and debt conversion - 1978/1988 (in US $ millions)

Year	Direct foreign investment (a)*	Conversion (b)	(b)/(a) (%)
1978	1320.5	159.9	12.1
1979	2038.6	207.4	10.2
1980	1634.4	39.3	2.4
1981	1905.0	1.8	0.1
1982	1513.1	143.2	9.5
1983	1019.0	452.0	44.4
1984	1235.7	745.6	60.3
1985	1056.5	581.3	55.0
1986	641.3	206.0	32.1
1987	995.0	343.9	34.6
1988	2687.0	2051.1	76.3

* Foreign investment gross inflow
Source : Central Bank of Brazil and Bauman (1990)

TABLE IV-3 : Registered foreign direct investment and reinvestment in Brazil - 1971/88 (*)
(in US $ millions)

Year	Investment (1)	Reinvest-ment (2)	Total (3)	(2)/(3) (%)
1971/80	11,218	4,434	15,653	28.3
1981	1,915	848	2,763	30.7
1982	1,568	807	2,375	34.0
1983	1,390	466	1,856	25.1
1984	1,012	578	1,590	36.3
1985	404	371	776	47.8
1986	162	136	298	45.6
1987	635	341	976	34.9
1988	379	249	628	39.7

(*) By year of registration at the Central Bank
Source : Central Bank

TABLE IV-4 : Brazil - foreign trade of foreign companies (1)
1978/86

Year	Exports - F.O.B.			Imports - F.O.B. (*)		
	Total	Foreign companies		Total	Foreign companies	
	US$ millions	US$ millions	%	US$ millions	US$ millions	%
1978	12,659	2,918	23.0	13,683	2,949	21.6
1979	15,244	3,773	24.8	18,084	3,482	19.3
1980	20,132	5,719	28.4	22,955	3,921	17.1
1981	23,293	7,141	30.7	22,091	3,567	16.1
1982	20,175	5,670	28.1	19,395	2,874	14.8
1983	21,899	5,824	26.6	15,429	2,342	15.2
1984	27,005	7,197	26.7	13,916	2,414	17.3
1985	25,639	7,123	27.8	13,154	2,305	17.5
1986	22,393	6,356	28.4	14,044	3,522	25.1
Total	188,439	51,721	27.4	152,751	27,376	17.9

(1) Companies where the majority of capital is held by non-residents
(2) Includes all imports
Source : CACEX and Central Bank of Brazil

TABLE IV-5 : Brazil - sales participation of government, foreign and private national companies (%)

Year	Country's top 25			Year	Country's top 500		
	Foreign	Government	National		Foreign	Government	National
1986	37.3	54.3	8.4	1986	28.7	28.9	42.4
1985	31.2	56.7	12.1	1985	28.5	30.8	40.7
1984	29.9	59.4	10.7	1984	27.2	32.9	39.9
1983	32.9	57.2	9.9	1983	29.7	31.2	39.1
1982	31.8	57.5	10.7	1982	30.9	33	36.1
1981	32.2	58.8	9.0	1981	31.2	33.6	35.9
1980	36.5	59.3	4.2	1980	32.5	31.6	35.9
1979	39.5	55.2	5.3	1979	34.5	31.3	34.2
1978	40.8	53.8	5.4	1978	35.4	29.7	34.9
Change 1985/78	-9.6	2.9	6.7	Change 1985/78	-6.9	1.1	5.8

Source : BNDES (1988)

TABLE IV-6 : Registered foreign investments in Brazil by country and sector - 1980 (1) - In US $ millions and percentage

Country	Agri-culture	Animal husbandry	Mining	Manufacturing industry													
				Steel	Metal-lurgy	Mechanical industry	Electric & communication	Automotive	Auto parts	Basic chemicals	Petroleum derivates	Drugs	Textiles	Food	Tobacco	Other industries	Total
FRG	6,977	12,063	90,934	20,085	457,879	667,686	301,262	1,126,934	441,134	310,434	58	308.671	8,716	176,668	19,745	360,238	4,178,512
(%)	0.16	0.28	1.93	0.43	9.72	13.96	6.36	23.89	9.36	6.59	-	6.55	0.18	3.75	0.42	7.43	88.67
Belgium	137	415	9,470	4,713	3,823	1,220	-	-	252	173,458	-	79	94	3	-	21,071	200,000
(%)	0.03	0.1	2.36	1.17	0.95	0.3	-	-	0.06	43,05	-	0.02	0.02	-	-	5.23	50.8
Denmark	-	-	-	-	88	8536	-	-	-	1443	400	1447	-	2,833	-	7,221	21,968
(%)	-	-	-	-	0.17	16.45	-	-	-	2.78	0.77	2.79	-	5.46	-	13.91	42.33
Spain	23	2,588	3,781	17,780	736	1,574	712	-	-	3,477	3,833	3,889	440	2,555	1,852	4,564	41,412
(%)	0.02	2.5	3.66	17.2	0.71	1.52	0.69	-	-	3.36	3.71	3.76	0.43	2.47	1.79	4.42	40.06
France	9,290	4,856	4,699	3,442	23,886	46,981	38,111	952	11,205	316,690	75	38,433	21,765	36,312	2,499	194,159	734,509
(%)	0.71	0.37	0.36	0.26	1.82	3.58	2.91	0.07	0.85	24.16	0.01	2.93	1.66	2.77	0.19	14.81	55.76
Greece	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
(%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Holland	6,835	1,068	7,212	5,531	14,166	24,837	264,632	13,184	11	192,731	2,128	39,852	649	2,394	15	119,660	669,790
(%)	0.78	0.12	0.82	0.63	1.61	2.83	28.99	1.5	-	21.95	0.24	4.54	0.07	0.27	-	13.62	76.25
S.Irl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3
(%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.36	2.36
Italy	398	878	1,325	155,585	86,239	104,073	10,681	455,789	-	3,408	2,557	21,733	65	4,029	-	129,892	974,051
(%)	0.04	0.08	0.12	14.32	7.94	9.58	0.98	41.96	-	0.31	0.24	2	0.01	0.37	-	11.96	89.67
Luxemb.	3,138	7,253	75	53,534	25,783	59,241	23,187	25,897	167	2,569	105	20,465	3,993	1,700	38,115	44,703	299,459
(%)	0.63	1.46	0.02	10.74	5.17	11.89	4.65	5.2	0.03	0.52	0.02	4.11	0.8	0.34	7.65	8.97	60.09
Portugal	-	-	-	-	-	-	-	-	-	25	-	3,707	-	-	9,521	418	13,671
(%)	-	-	-	-	-	-	-	-	-	0.04	-	6.12	-	15.72	0.69	22.57	
U.K.	4,737	405	115,935	789	20,544	44,848	30,022	5,935	7,279	116,416	513,806	19,748	63,121	3,041	4,363	98,948	928,860
(%)	0.25	0.02	6.06	0.04	1.07	2.34	1.57	0.31	0.38	6.08	26.82	1.03	3.29	0.16	0.23	5.17	48.49
Total	31,535	29,526	233,431	261,649	633,143	948,996	658,607	1,627,691	460,048	1,120,651	522,962	458,024	98,845	70,535	76,110	970,874	7,907,945
E.E.C.	0.29	0.27	2.12	2.37	5.75	8.61	5.98	14.77	4.17	10.17	3.63	4.16	0.90	0.64	0.69	8.81	71.76
U.S.A.	89,881	1,285	273,926	6,377	367,181	944,597	1,051,479	397,674	239,440	1,065,973	323,442	642,151	59,497	320,464	225,534	1,165,720	7,074,621
(%)	1.01	0.01	3.08	0.07	4.13	10.61	11.81	4.47	2.69	11.98	3.63	6.09	0.67	3.6	2.53	13.1	79.48
Japan	20,175	32,076	80,850	292,950	325,419	220,099	324,586	190,473	14,436	45,366	33,460	3,497	193,757	61,000	1,299	472,719	2,312,162
(%)	0.68	1.08	2.73	9.9	1	7.44	10.97	6.44	0.49	1.53	1.13	0.12	6.55	2.06	0.04	15.98	68.14
Switzerl.	9,030	11,461	1,222	14,582	35,540	110,629	243,668	839,252	64,361	56,883	4,332	104,104 ,829	45,086	414,502	6,166	636,473	2,598,016
(%)	0.32	0.41	0.04	0.52	1.27	3.94	8.68	29.89	2.29	2.03	0.15	3.73	1.61	14.76	0.22	22.67	92.53
Total all countr.	150,621	74,340	589,429	575,368	1,361,283	2,224,321	2,278,340	3,055,090	778,285	2,288,873	884,196	1,108,501	397,397	866,501	309,107	3,246,786	20,187,236
(%)	0.49	0.24	1.92	1.87	4.43	7.24	7.42	9.95	2.53	7.45	2.88	3.61	1.29	2.82	1.01	10.57	65.75

TABLE IV-6 (continued)

Country	Services					Non specified activities	Total	(%) by country
	Trans-port	Commer-cial banks	Invest-ment banks	Holding companies	Other services			
FRG	8,042	31,856	33,891	171,665	161,908	16,595	4,712,443	15.35
(%)	0.17	0.68	0.72	3.64	3.44	0.35	100	
Belgium	-	22,879	-	68,862	80,041	16,400	402,917	1.31
(%)	-	5.68	-	17.09	19.87	4.07	100	
DK	571	-	-	14	29,206	147	51,906	0,17
(%)	1.1	-	-	0.03	59.27	0.28	100	
Spain	29	33,279	-	15,662	4,744	1,835	103,353	0.34
(%)	0.03	32.2	-	15.15	4.59	1.78	100	
France	3,183	137,068	9,277	224,629	132,280	50,871	1,310,662	4.27
(%)	0.24	10.46	0.71	17.14	10.09	3.88	100	
Greece	-	-	-	-	-	10	10	0.00
(%)	-	-	-	-	-	100	100	
Holland	1,905	40,212	3,086	55,978	79,289	12,894	878,239	2.86
(%)	0.22	4.58	0.35	6.37	9.03	1.47	100	
S.Ireland	58	-	-	-	-	124	127	0.00
(%)	0.01	-	-	-	-	97.64	100	
Italy	15,210	19,686	19,894	55,082	13,126	1,628	1,086,126	3,54
(%)	3.05	1.81	1.83	5.07	1.21	0.15	100	
Luxemb.	-	-	515	95,360	59,391	18,048	498,449	1.62
(%)	-	-	0.1	19.13	11.92	3.62	100	
Portugal	-	44,627	-	163	1,980	129	60,570	0.20
(%)	-	73.68	-	0.27	3.27	0.21	100	
U.K.	-	108,985	34,002	528,281	116,200	76,576	1,915,665	6.24
(%)	-	5.69	1.77	27.58	6.07	4	100	
Total	30,682	438,592	100,665	1,215,696	678,165	195,255	11,020,467	35.89
E.E.C.	0.28	3.98	0.91	11.03	6.15	1.77	100.00	
U.S.A.	7,033	299,554	96,212	725,277	590,484	107,006	8,900,107	28.99
(%)	0.08	3.37	1.08	8.15	6.63	1.2	100	
Japan	183	122,049	90,987	76,641	242,480	113,977	2,958,479	9.64
(%)	-	4.13	3.08	2.59	8.20	3.85	100.00	
Switzerl.	5,075	15	8,217	79,753	05,558	31,331	2,807,965	9.15
(%)	0.18	-	0.29	2.84	3.05	1.12	100.00	
Total all countr.	42,973	860,210	296,081	2,097,367	1,596,657	447,569	30,703,072	100.00
(%)	0.14	2.80	0.96	6.83	5.20	1.46	100.00	

(1) Investment and reinvestments as registered by
Source : Central Bank of Brazil

TABLE V-1 : Non-enterprise institutions performing S&T activities in Brazil - Number of institutions and of researchers employed - 1983/85

Institutions	Number	(%)	Researchers	(%)
Higher education	121	26.1	38,310	67.7
- Federal gov.	n.a.	-	22,898	40.4
- State gov.	n.a.	-	10,980	19.4
- Municipal gov.	n.a.	-	92	0.2
- Private	n.a.	-	4,340	7.7
Specialized in S&T	121	26.1	13,599	24.0
- Federal gov.	32	6.9	6,320	11.2
- State gov.	68	14.7	6,940	12.2
- Private	21	4.5	339	0.6
Government	189	40.8	4,163	7.4
- Federal	70	15.1	1,418	2.5
- State	102	22.0	2,360	4.2
- Municipal	17	3.7	383	0.7
Private	32	6.9	483	0.9
- Foundations	10	2.2	158	0.3
- Research associations	22	4.7	325	0.6
Total	463	100.0	56,556	100.0

Source : CNPq (1987)

TABLE V-2 : Technology imports - 1979-88 (in US $ millions)

Year	Patents & trade-marks	Licensed technology capital goods ind.	Others	Total	Technical services	Total
1979	9	6	11	17	287	313
1980	12	11	14	25	284	321
1981	12	18	12	30	234	276
1982	5	17	10	27	208	240
1983	12	10	14	24	182	218
1984	9	8	8	16	177	202
1985	5	21	41	62	108	175
1986	2	20	43	63	119	184
1987	3	39	26	65	106	174
1988	3	12	27	39	93	135
Total	72	206	162	368	1,798	2,238
(%)	3.2	9.2	7.2	16.4	80.4	100

Source : INPI

TABLE V-3 : R&D spending by industry in Brazil - 1985

Sector	NE (1)	Earnings (2)	%	R&D (2)	%	R&D average (4)	Intensity (3)
Metallic-Minerals	32	3528	5.5	39.5	12.7	1.23	1.12
Non-ferrous metallurgy	23	768	1.2	39.3	12.6	1.71	5.12
Electronic equipment	92	1813	2.8	45.6	14.7	0.5	2.52
Automobile	36	8181	12.7	45.0	14.5	1.25	0.55
Basic chemicals	23	3715	5.8	34.8	11.2	1.51	0.94
Oil refining & petrochemicals	39	21310	33.0	38.2	12.3	0.98	0.18
Subtotal	245	39315	61.0	242.4	78.0	0.99	0.62
Others	1043	25208	39.0	68.5	22.0	0.07	0.27
Total	1288	64523	100.0	310.9	100.0	0.24	0.48

(1) Number of enterprises reporting spending on R&D
(2) Values in US $ millions. Converted at US $ - 6.20 Czs
(3) R&D spending as a percentage of earnings
(4) Average R&D expenses by enterprise
Source : FIBGE, 1985 census, special tabulation, preliminary results

TABLE V-4 : FINEP - Loans to enterprises for technological development by sector
- value (US $ thousands) (V) and number of contracts (N) - 1973/87

Sectors	1973/78				1979/84				1985/87			
	N	(%)	V	(%)	N	(%)	V	(%)	N	(%)	V	(%)
Mining and metal-mechanic	110	38.0	117.68	44.3	273	34.5	81.52	34.8	80	17.9	50.29	19.7
Electrical & Electronics	45	15.6	18.33	6.9	100	12.7	18.98	8.1	102	22.8	92.92	36.4
Infrastructure & construction	44	15.4	46.76	17.6	78	9.8	30.69	13.1	94	21.0	4.85	1.9
Chemical & Petrochemical	23	8.0	10.09	3.8	126	15.9	44.98	19.2	97	21.7	69.44	27.2
Others	66	23.0	72.79	27.4	214	23.9	58.09	24.8	74	16.5	37.78	14.8
Total	288	100.0	265.65	100.0	791	100.0	234.26	100.0	447	100.0	255.28	100.0

Source : Melo (1989)

TABLE V-5 : ANPEI (1) - R&D expenditures and main features of members - 1987

Sector	Enterprise		Capital (3)			R&D expenditure			R&D employees (2)	
	Nr	Empl. (2)	BP	MN	S	Ne (4)	Value (5)	Inten-sity(6)	Total	Higher education
Metal-Mechanic	26	7216	17	1	8	20	5494	1.7	153	52
Chemical-Petrochem.	37	4657	22	11	4	27	87985	1.2	105	43
Electro-Electronic	12	3508	7	2	3	6	30480	2.7	173	80
All members	75	5416	46	14	15	53	173059	1.6	134	53

(1) ANPEI - Associacao Nacional de Pesquisa e Desenvolvimento das empresas Industriais - National Association of R&D of Industrial Enterprises
(2) Average number of employees
(3) Origin of capital : BP, Brazilian Private; MN, Multinational; S, State
(4) NE : Number of enterprises providing information
(5) Value in US $ thousands
(6) R&D expenditures as a percentage of earnings. Average.
Source : ANPEI (1988)

TABLE V-6 : ANPEI - Dispersion of R&D expenditures and of R&D intensity

Sector	R&D expenditures (1)			R&D intensity (2)		
	Average	Min	Max	Average	Min	Max
Metal-Mechanic	2729	198	11564	1.7	0.14	9.8
Electro-Electronic	5068	90	14000	2.7	0.6	6.5
Chemical-Petrochem.	3258	82	32000	1.2	0.1	5.0
All members	3298	82	32000	1.6	0.1	9.8

(1) In US $ thousands
(2) R&D expenditures as a percentage of earnings
Source : ANPEI (1988)

TABLE V-7 : Contracts for specialized technical services authorized by INPI - by sector
Number of contracts (N) and value in US $ millions (V) - 1986/88

Sectors	N	(%)	V	(%)
Mining and oil	313	19.2	130.0	38.9
Industry				
Non metalic minerals	49	3.0	7.7	2.3
Metallurgy	259	15.9	44.9	13.4
Mechanics	220	13.5	16.0	4.8
Transport Eq.	62	3.8	4.1	1.2
Chemicals	151	9.3	16.1	4.8
Services				
Electric power	136	8.3	58.1	17.4
Consulting eng.	99	6.1	17.4	5.2
Scientific instit.	47	2.9	10.0	3.0
Public admin.	23	1.4	13.2	3.9
Others	272	16.6	16.4	4.9
Total	1631	100.0	333.9	100.0

Source : Computed from INPI 1988 yearly report

TABLE V-8 : Science and technology expenditures in Brazil by source of funds - in US $ millions and percentage - 1985

Source	Value	%
Federal government treasury	1267	69.4
States treasury	247	13.6
Enterprise sector	311	17.0
- State enterprises	170	9.3
- Private enterprises	141	7.7
Total	1825	100.0

Sources : Our estimates are based on data from CNPQ (1987), on the Federal Governments and State enterprises and on the 1985 census preliminary data on R&D spending by industrial sector

TABLE V-9 : FINEP loans to enterprises - Objective of project 1979/84 and 1985/87 - Number of projects (N) Total value in US $ thousands and %

Type of project	1979/84				1985/87			
	N	(%)	V	(%)	N	(%)	V	(%)
Infrastructure of R&D	314.0	39.7	117.13	50.0	170.0	30.0	67.39	26.4
Product development	249.0	31.5	28.11	12.0	112.0	25.1	78.37	30.7
Process development	187.0	23.6	70.04	29.9	90.0	20.1	68.92	27.0
Technology absorption	30.0	3.8	7.50	3.2	29.0	6.5	14.55	5.7
Others	11.0	1.4	11.48	4.9	46.0	10.3	26.04	10.2
Total	791.0	100.0	234.26	100.0	447.0	100.0	255.27	100.0

Source : Melo (1989)

TABLE VI-1 : Comparison of distribution of scientific base between Brazil and selected developed countries.

Countries	Year	Areas					
		I	II	III	IV	V	VI
Brazil	1984	15.4	14.6	13.8	10.6	33.4	12.2
Japan	1983	---------- 66----------				22	12
Sweden	1983	18	15.0	----- 3 -----		44	20
Israel	1984	14.2	----------23 ----------			62.3 --------	
USA	1981	32.1	26.5	2.9	11.3	23	4.2

Source : CNPq - Plano de Metas, 1986. For the definition of areas, see p. in the preceeding text

TABLE VI-2 : Number of graduate programs offered by Brazilian institutions 1970-1987 (approximate numbers from 1970 to 1983)

Year	Master's programs	Doctor's programs	Total
1970	80	30	110
1971	150	60	210
1972	260	110	370
1973	350	130	480
1974	400	140	540
1975	440	170	610
1976	490	180	670
1977	610	210	820
1978	650	230	870
1979	700	250	950
1980	710	280	990
1981	730	300	1030
1982	760	310	1070
1983	790	330	1120
1984	805	330	1135
1985	816	330	1146
1986	831	344	1175
1987	872	354	1226

Source : CAPES

TABLE VI-3 : Total enrolment in graduate programs at Brazilian institutions

Year	Master's	Doctor's	Total
1973	11,165	434	11,599
1976	24,214	2,041	26,255
1977	32,767	3,841	36,608
1982	40,691	6,999	47,690
1984	38,675	7,400	46,075
1986	55,287	9,272	64,559

Source : CAPES

TABLE VI-4 : Number of scholarships granted by Brazilian agencies to students enroled in Brazilian institutions - 1976-1988

Year	Doctor's	Master's	Non-degree (1)	Undergrad (2)	Total
1976	668	5139	1338	843	7988
1977	762	5865	1341	879	8847
1978	888	6834	1302	837	9861
1979	938	7215	1287	879	10319
1980	961	7389	1479	1077	10906
1981	1007	7749	1407	1053	11216
1982	1238	9522	1491	1272	13523
1983	1420	10920	1245	1176	14761
1984	1520	11697	1356	1317	15890
1985	1543	11871	1515	1599	16528
1986	1638	12600	1614	1509	17361
1987	2003	14997	3057	3924	23981
1988	2334	17481	4032	5892	29739

(1) Post-graduate training not leading to an academic degree
(2) Research assistanships granted to undergraduate students
Source : CAPES and CNPq

TABLE VI-5 : Distribution of academic staff, in graduate programs, holding Doctor's degree or equivalent by year and by categories of areas of knowledge in Brazil

Areas	1975		1980		Growth	1986		Growth
	no	%	no	%	80/75	no	%	86/80
1.Exact sc.	872	21.5	1326	16.9	52.1	1965	17.5	48.2
2.Biolog.	717	17.6	1170	14.9	63.2	1429	12.7	22.1
3.Engineering	518	12.8	707	9.0	36.5	1169	10.4	65.3
4.Social prof.(1)	297	7.3	400	5.1	34.7	645	5.7	61.2
5.Agriculture	366	9.0	678	8.6	85.2	1422	12.6	109.7
6.Other (2)	1289	31.8	3574	45.5	177.3	4630	41.1	29.5
Total	4059	100.0	7855	100.0	93.5	11260	100.0	43.3

(1) Social professions (like law, economics, social service, etc.)
(2) Arts, social sciences, health
Source : CAPES

TABLE VI-6 : Distribution of academic staff, in graduate programs, holding graduate degree, by geographic regions - Brazil - 1986

Region	Doctors		Masters		Total	
	no	%	no	%	no	%
Southeast	8265	73.4	1383	44.2	9648	67.0
South	1318	11.7	704	22.5	2022	14.1
Northeast	1144	10.2	869	27.8	2013	14.0
Centerwest	407	3.6	88	2.8	495	3.4
North	126	1.1	83	2.7	209	1.5
Total	11260	100.0	3127	100.0	14387	100.0

Source : CAPES

TABLE VI-7 : Number of Brazilian students in graduate programs abroad with scholarships granted by CAPES and CNPq 1973-1989

Year	CAPES	CNPq	Total	Growth
1973	163	124	287	
1974	160	139	299	.01
1975	379	321	700	1.34
1976	606	321	927	.32
1977	658	464	1122	.21
1978	746	484	1230	.90
1979	1430	531	1961	.59
1980	1432	555	1987	.01
1981	1113	646	1759	-.11
1982	997	911	1908	.08
1983	1035	986	2021	.06
1984	980	909	1889	-.06
1985	1173	936	2109	.12
1986	972	939	1911	-.09
1987	1125	1142	2267	.19
1988	1696	1611	3307	.46
1989	2000	3238	5238	.58

Source : CAPES and CNPq

TABLE VI-8 : Distribution of scholarships in four foreign countries by areas of knowledge - 1986

Area	USA	G.Brit.	France	West Germ.
Engineering	106	112	58	18
Informatics	134	81	62	17
Biotechnology	114	60	44	16
Chemistry	26	15	21	6
Oceanography	36	21	32	3
Aerospace	8	2	2	-
Humanities and SC	255	117	215	24
Other	80	57	34	6
Total	759	465	468	90

TABLE VI-9 : Demand of scholarships at RHAE program by five priority areas and by type of institution 1988-1989

Institution	Priority areas										Total	
	Biotechnol.		Informat.		Prec.mech.		New mats.		Fine chem.			
	n	%	n	%	n	%	n	%	n	%	n	%
Enterprises	328	5.9	1510	23.8	273	13.3	246	8.7	216	9.6	2573	13.5
Research	3262	59.2	2311	36.4	522	25.5	1262	44.7	727	32.2	8084	42.6
Academic	1925	34.9	2524	39.8	1253	61.2	1318	46.6	1315	58.2	8335	43.9
Total	5515	100.0	6345	100.0	2048	100.0	2826	100.0	2258	100.0	18992	100.0
%/grand total		29.0		33.4		10.8		14.9		11.9		100.0

Source : RHAE program, executive secretariat

TABLE VI-10 : Demand of scholarships at RHAE program for domestic and foreign training by priority areas - 1988-1989

Areas	In Brazil			Foreign countries			Total	
	n	% col	% row	n	% col	% row	n	% col
Biotechnology	4098	29.6	74.3	1417	27.2	25.7	5515	29.0
Informatics	4401	31.7	69.4	1944	37.9	30.6	6345	33.4
Precision mechanics	1588	11.5	77.5	460	9.0	22.5	2048	10.8
New materials	2016	14.5	71.3	810	15.8	28.7	2826	14.9
Fine chemistry	1766	12.7	78.2	492	9.6	21.8	2258	11.9
Total	13869	100.0	73.0	5123	100.0	27.0	18992	100.0

Source : RHAE program, executive secretariat

TABLE VI-11 : Scholarships granted by RHAE program by priority areas, type of scholarship, and place of training - 1988-1989

Type of scholarship	Area						
	Bio	Inf.	P.M.	N.Mat.	F.Ch.	Total	% grand total
Graduate scholarships	380	110	205	302	84	1081	15.0
Row percentage	35.1	10.2	18.9	28.0	7.8	100.0	
Domestic	171	90	169	254	51	735	10.2
Foreign	209	20	36	48	33	346	4.8
Non-degree scholars.	996	1036	417	621	419	3489	48.5
Row percentage	28.5	29.7	11.9	17.8	12.0	100.0	
Domestic	525	664	221	337	258	2005	27.9
Foreign	471	372	196	284	161	1484	20.6
Undergraduate schol.	374	448	337	339	171	1669	23.2
Row percentage	22.4	26.8	20.2	20.3	10.2	100.0	
Visiting researcher	324	180	110	204	133	951	13.2
Row percentage	34.1	18.9	11.6	21.4	14.0	100.0	
Domestic	324	159	110	199	128	920	12.8
Foreign	-	21	-	5	5	31	0.4
Total (all types)	2074	1774	1069	1466	807	7190	100.0
Row perc. (total)	28.8	24.7	14.9	20.4	11.2	100.0	
Domestic	1394	1361	837	1129	608	5329	74.1
Row perc. (domestic)	26.2	25.5	15.7	21.2	11.4	100.0	
Foreign	680	413	232	337	199	1861	25.9
Row perc. (foreign)	36.5	22.2	12.5	10.1	10.7	100.0	

TABLE VII-1 : Brazil - Informatics industry and technical services revenues (million dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
All informatics sectors										
National firms (NF)	280	370	558	687	952	1,400	2,081	2,378	2,948	3,600
Transn.corporations (TNC)	580	670	950	800	881	1,278	1,311	1,638	1,480	1,500
Subtotal	860	1,040	1,508	1,487	1,833	2,678	3,392	4,016	4,428	5,100
All technical services	---	---	---	---	---	914	1,186	1,346	1,415	---
Total	860	1,040	1,508	1,487	1,833	3,592	4,578	5,362	5,843	---
Participation national firms (% NF)	32	36	40	46	49	51	56	57	67	71
General and banking data processing										
Nat. firms	280	370	558	687	847	1,082	1,242	1,375	1,509	---
TNC	580	670	950	800	881	1,033	884	1,203	956	---
Subtotal GBDP	860	1,040	1,508	1,487	1,728	2,115	2,126	2,578	2,465	---
% NF GBDP	32	36	40	46	49	51	58	53	61	---
Teleinformatics										
Nat. firms	---	---	---	---	---	192	359	378	715	---
TNC	---	---	---	---	---	245	277	239	289	---
Subtotal Teleinf.	---	---	---	---	---	437	636	617	1,004	---
% NF Teleinf.	---	---	---	---	---	44	56	61	71	---
Indl. control and automation										
National firms (% NF=100)	---	---	---	---	86	101	199	294	309	370
Microelectronics										
Nat.firms	---	---	---	---	---	---	109	132	210	---
TNC	---	---	---	---	---	---	100	110	138	---
Subtotal microel.	---	---	---	---	---	---	209	242	348	---
% NF	---	---	---	---	---	---	52	54	60	---
Computer software										
Nat.firms	---	---	---	---	---	---	117	122	131	---
TNC	---	---	---	---	---	---	50	86	97	---
Subtotal software	---	---	---	---	---	---	167	208	228	---
% NF	---	---	---	---	---	---	70	59	57	---
Digital instruments Nat. firms (% NF=100 %)	---	---	---	---	19	25	55	77	74	

Source : prepared for this report on the basis of SEI data

TABLE VII-2 : Brazil - informatics industry : total employment

	1981			1988		
	National firms	Foreign firms (1)	All firms	National firms	Foreign firms	All firms
Electronic data processing (2)	12,584	11,797	24,381	26,344	7,383	33,727
Teleinformatics (telecom + other equipment for data transmission and teleprocessing) (3)	5,250	11,773	17,023	13,526	3,724	17,250
Industrial automation (4)	NA	NA	NA	7,510	---	7,510
Microelectronics	NA	NA	NA	3,135	1,871	5,006
Software	NA	NA	NA	NA	NA	2,857
Digital instruments	NA	NA	NA	NA	NA	(5) 1,657
Total industry	8,800	12,200	21,000	54,714	13,550	(5) 68,264
Technical services	NA	NA	NA	NA	NA	61,351
Total informatics	NA	NA	NA	NA	NA	129,615

(1) Official denominations of firms switched from 'national/multinational' to 'Brazilian firms of national capital/Brazilian firms"
(2) 1982 and 1988
(3) 1984 and 1988. Also note : some subsidiaries were sold to local holdings, which causes shifts in allocation of numbers of workers to the national or foreign firms groupings
(4) Breakdown data for foreign and local capital firms not available. Possibly no foreign firms operate in this market segment
(5) 1987

Source : tables and data from SEI, summarised for this report

TABLE VII-3 : Brazil - Employment in the informatics industry by qualification and nationality of firms

		1981	1985	1988
Total	Local firms	8,800	40,591	(1) 54,714
	TNE	12,200	(2) 20,091	(3) 13,550
	All firms	21,000	60,682	68,264
Professional * (higher qualification)	Local firms	2,074	9,064	16,184
	TNE	2,554	4,256	5,300
	All firms	4,628	13,320	21,484
Professional/Total	Local firms	23.57 %	22.33 %	29.57 %
	TNE	20.93 %	21.18 %	39.11 %
	All firms	22.03 %	21.95 %	31.47 %

(1) These 1988 figures, and particularly the reduction of employment in the foreign or multinational firms category, reflect the process of sale of shares to local capital firms by foreign affiliates; correspondingly employment by local firms increased but not by the same amount because of other variations within the local firm's employment

(2) Part of the 1985/86 increase is due to the incorporation of telecom-equipment-making foreign affiliates to the "informatics" statistics

(3) See (1)

(4) "Profissionais de Nivel superior", presumably university graduates and post-graduates.

Source : prepared for this report on the basis of SEI data

TABLE VII-4 : Brazil - General data processing and banking equipment subsectors. Breakdown of higher professional employment by areas of the firm

	1983		1987	
	Local capital firms	Multinationals	Local capital firms	Multinationals
Production	692	379	1,183	555
Sales	482	1,204	1,417	1,359
(% relative to total)	(12,4)	(42.84)	(19.7)	(36.11)
Development (hard/software)	1,177	121	1,818	213
(% to total)	(30.3)	(4.3)	(25.27)	(5.66)
Maintenance	572	273	1,440	559
Administration	961	833	1,148	1,014
(% to total)	(24.74)	29.64)	(15.96)	(26.95)
Human resources development	---	---	155	45
Total	3,884	2,810	7,192	3,763

Source : prepared for this report on the basis of SEI data

TABLE VII-5 : Brazil - investment by informatics industry main segments (1986/88) (million dollars)

Sector	1986	1987	1988
General EDP (and banking equipment)	124	155	N.A.
Teleinformatics	36.25	80.74	76.3
Industrial control and automation	28.75	32.28	30
Microelectronics	N.A.	39	45
Total	189	307.02	N.A.

Source : prepared for this report with SEI data

TABLE VII-6 : Brazil - Research and development outlays, informatics firms (million dollars)

	1987	1988
General EDP and banking equipment	96 (appr. 96 % LF)	97 (appr. 96 % LF)
Teleinformatics	59 (appr. 65 % LF)	54 (appr. 57 % LF)
Industrial controls and automation	NA	18 (mostly LF)
Microelectronics	10	10
Software	30	21
Digital instr.	5	4
Total	200	204 (of which 177 by LF)

Note : LF = local firms
Source : prepared for this report with SEI data

TABLE VII-7 : Brazil - Imports by informatics sector industrial firms (million dollars)

	1981	1982	1983	1984	1985	1986	1987	1988
Total imports informatics								
Foreign firms (amount)	81	50	49	205	281	316	362	432
(% of sales)	22	9	7	22	20	15	15	15
Local firms (amount)	223	208	179	202	206	229	281	339
(% of sales)	33	22	22	23	16	17	17	23
Total (amount)	304	258	228	407	487	545	643	768
(% of sales)	29	17	15	22	18	16	16	17
General and banking data proc.								
	---	50	49	90	96	93	106	110
	---	9	7.1	10.6	8.9	7.5	7.7	7.3
	---	208	179	187	174	187	216	268
	---	21.9	22.4	21.2	16.8	21.1	18.0	28.0
		258	228	277	270	280	322	378
		17	15	16	13	13	12	15
Teleinformatics								
			---	21	22	44.1	69.9	83.9
			---	13.5	11.5	12.3	18.5	11.7
				15	32	25	41.1	51.2
				7.2	13.1	9	17.2	17.7
				36	54	69.1	111	135.1
				---	12	11	18	13
Industrial control and automation								
						0.28	0.29	0.26
						10.5	13.7	14.6
						10.8	13.9	14.86
							9	
						5	5	5
Microelectronics								
						53	83	77
						48.4	62.8	36.5
						17	24	17
						17.2	21.9	12.3
						70	107	94
						33	44	27

Source : prepared for this report with SEI data

TABLE VII-8 : Brazil - Computers : exports and imports, 1980-86 (million dollars)			
	Exports (x)	Imports (n)	x/M
1980	156.9	99.5	1.6
1981	198.9	120.3	1.7
1982	372.1	235.7	1.6
1983	258.3	176.0	1.5
1984	338.5	177.8	1.9
1985	198.5	194.4	1.0
1986	225.4	143.7	1.6

Source : P. Evans and P. Tigre ("Paths to Participation in HiTech Industry. A competitive Analysis of Computers in Brazil and Korea", Asean perspective, Vol.13, N° 1, Spring-Summer 1989), based on International TradeStatistics Yearbook data for SITC 752, AutomaticData Processing Equipment

TABLE VII-9 : Brazil - Exports by informatics sector (million dollars)

	1986		1987		1988	
Total informatics sector (1)	Volume 267	Comments	Volume 201	Comments	Volume 268	Comments 96 % by TNC
General data processing and banking equip.	N.A.		163	Destinations USA 27.8 % Canada 25.6 % Japan 16.9 % Other Asian countries 3.5 % Argentina 4.7 % Mexico 2.9 % Other countries 18.6 %	231	98-99 % TNCs (IBM>80 %)
Telecoms and teleprocessings			22.7		16.4	87 % by TNCs Destinations: (%) Urug. 44.3 Surinam 23.3 Ecuador 16.3 Colombia 6.2 Sweden 2.5 Others 7.4
Industrial control and automation			0.6		2.5	Mostly CNC units
Microelectronics	13.6	Local firms 3.5 TNC 10.1	14.9	L.F. 3.5 TNC 11.4	17.6	LF 4.9 TNC 12.7
Software			+/-0.072		+/-0.100	
			+/-0.147		+/-0.197	

Source : prepared for this report on the basis of SEI data

TABLE VII-10 : Brazil - Software sales by type of firm/specialization (1986/1988) (million dollars)

	1986	1987	1988
Software houses	18.94	32.04	31.68
Other firms selling software (general E.D.P. hardware producers, etc.)	15.65	18.47	26.42
Technical services firms	61.96	53.42	50.44
Industrial control and automation, and other	5.97	6.39	10.13
Total	102.52	110.32	118.67

Source : prepared for this report on SEI data

TABLE VII-11 : Brazil - Local capital firms in general data processing equipment industry. Number units of equipment sold including equipment for banks financial data processing

	1985	1988
Central processing units		
Minicomputers	829	858
Micro. 8 bits	147,603	63,091
Micro. 16 bits	9,735	50,288
'Supermicro' (multiuser)	232	1,470
Superminis	93	119
Peripheral units		
Hard disks (removable)	2,072	34
Fixed disks (Winchester)	5,635	40,424
Flexible disks	45,437	61,141
Magnetic tapes	693	4,799
Printer (serial)	30,112	88,232
Printer (line)	1,389	---
Video terminals	15,941	31,230
Video monitors	---	36,224
Special terminals	37,270	8,517
Data collectors	440	1,040
Banking data processing		
Bank terminals	9,961	19,816
ATM	98	(1987) 88
CPU/concentrators	1,455	3,849
Cash register/tellers (teller terminals)	72	812

Source : prepared for this report with SEI data

ANNEX 2 : QUALITATIVE ASPECTS OF ELECTRONICS INDUSTRIES IN BRAZIL

It is interesting to present some data showing the upgrading of microcomputing equipment produced in Brazil and the reduction of the time gap of delay in introducing new models using more powerful microprocessors. In Table XII the growth in the class of 'supermicrocomputers' is possibly a proxy for the rate of introduction of processors of the 68.000 series (Motorola). Independent data on use of the Intel microprocessors indicates that production based on INTEL 8088/8086 chips (XT compatibles) peaked in 1987 with a number of 57,337 CPUs; 80286-based machines in the same year (AT compatibles) numbered less than 2,000 and estimates for 1989 and 1990 were 10,000 units for each year. Machines on the 80386 processor were introduced in 1988 with the sale of 1,386 units, and estimates for 1989 and 1990 were 5,000 and 10,000 respectively.

Regarding larger equipment made in Brazil, there are in fact few data on the first models made by the foreign affiliates, and the dates and volumes of their production. One source indicates that in July 1981 there were 1,302 units of IBM, models 4331 and 4341, Brazilian made, computers, in operation, as well as 345 Burroughs B-6900, and 134 CII-Honeywell-Bull Telematic (Models 1, 2 or 3), all of them made in Brazil. A total of 2,774 mainframes in operation included those machines plus 659 units supplied as imports by Digital, Sperry Univac and others, Multinationals' production in the eighties is accounted for in the preceding tables. The largest and most powerful models currently produced include IBM 3090 and Unisys (formerly Burroughs) A-15.

"Banking" or "financial" processing equipment has been a key component in the development of an informatics industry in Brazil. The banking sector of Brazil has got a very large transaction workload as inflation has increased the circulation of money, and because taxes and utilities are paid at all banks by the general public. In this context, first the COBRA episode took banks, already intensive users of electronic data processing, into a new role as partners in production of equipment used for that function; later, the same group of banks plus others, undertook or supported a number of independent ventures in that sector. Although prices of equipment are not low, Brazil has now a rather dynamic activity in production and in integration of systems for that sector. In fact it is now expected that besides extending electronic information processing to most branches everywhere in Brazil which had not been reached before, the banks already require replacement of equipment of the 1980s by more modern and adequate material; the outlook is in principle bright, but the effects of the new government's financial management and attempted money deflation started March 1990 in the country may have a strong impact on the size and level of activity of the financial system, and the derived demand for processing power.

Production of components, printed circuits, mounted boards, and other inputs (not microelectronic) for data processing equipment is high as import substitution at that stage of production has not been selective. The qualitatively and quantitatively most important imported inputs are the integrated circuits. Most other inputs and parts, subassemblies, etc., are produced locally; in many cases firms integrate vertically instead of buying from third parties due to problems of supply and quality, but this solution is not efficient. The

demand for components is fragmented and reduced also as a consequence of the separation of the main markets, particularly because the consumer electronics sector follows the patterns of evolution of foreign designs and the components to make them must largely be imported. There are in general many complaints from final producers about the price of inputs, and both local suppliers and supplier firms belonging to foreign corporations are said to charge many times the international price for any Brazilian-made supply. Quantitative data on the overall component sector are not generally available; an estimate for 1984 said that 200 firms employing 30,000 persons were the suppliers of all electronic industry inputs then supplied from within the country.

The semiconductor industry is not fully developed in Brazil; on the other hand the informatics authorities have come to view it as an strategic industry. The history of this subsector in Brazil starts in the mid-seventies when about 15 foreign firms established semiconductor operations in Brazil, although only one integrated the full wafer-processing and "chip" production cycle while the rest only assembled and tested. Creation of those firms responded partly to export incentives (they exported 40 % of production in 1980) and they supplied part of the local demand, mainly for production of calculators or consumer electronic goods, while 60 % of the internal demand was supplied from imports. Entry of local firms took place later. Currently the locally supplied total semiconductor value is US $ 350 million; two firms concentrate 58 % of the sales of national capital firms while also two firms concentrate 68 % of sales of foreign affiliates. Foreign affiliates sell mostly to industry located in the Amazon region, although one of them has at times practically exported all its production. Buyers of Brazilian made semiconductors in 1987 were, government, 3 %; trade, 14 %; information technology industries, 20 %; telecom industry, 10 %; consumer electronics, 35 %; other, 15 %.

Breakdown of industrial output by product was in 1988 as follows : discrete semiconductors, 50 % (56 % of which made by foreign firms) and 47 %, integrated circuits (72 % made by national firms). "Other products" (3 %) were hybrid circuits and optical fiber. Both for locally owned and foreign firms in 1987 and 1988 the total value of imported inputs was higher than the total value of local inputs used. Two Brazilian firms (one of which already owns the diffusion plant originally established by a U.S. firm) have investment plans (several hundred million dollars each) approved by the Informatics Council for integrating the product cycle starting from the silicon wafer.

The "consumer electronics" industry has largely migrated to Manaus in the Amazon. Firms are mostly foreign owned or joint-ventures and technology used by the latter is usually licensed. Some local groups placed themselves in competitive positions vis-à-vis the foreign ones and at least one of them, already very active in informatics and microelectronics, seems to have bought a large foreign firm. No systematic current data are available on this sector. The general view is that foreign ownership is more extended in the television sets industry than in audio equipment, and that Japanese firms have displaced U.S. firms. There is also a Philips subsidiary and a U.S. firm makes automobile radios and cassette-radios for export to the U.S.; total consumer electronics exports from Brazil in 1987 were over 400 million dollars, mostly in the automobile audio segment. Since 1982 there have been initiatives to induce integration of production of components in the same (Amazon) region, also with foreign firms participation. In other regions of the country some companies survive making either cheap audio products for local markets, or sophisticated audio equipment in low quantities. In spite of export performance just reported for some products, the consumer electronics industry at large is not considered competitive; it is highly dependent on imported inputs and technology, and pays more than international prices for inputs such as integrated circuits.

Sales of the "teleinformatics industry" are oriented in up to 70 % - 80 % to the public sector, hence variations in the level of public investment tend to bring down from time to time both the revenue obtained from that market and "teleinformatics" participation in the total electronics and informatics market. The degree of local integration as measured by imports participation in total value produced is high (imported contents are probably not more than 10 %). Total production value of approximately 800 million dollars in 1988 was oriented 73 % to digital switching, 18 % to data communications and 5 % to terminal equipment (telex, telephones, etc.). There are contradictory views about the "degree of nationalisation" of production, as measured by foreign firm and local firm participation in gross output. Views are different according to whether analysts accept or not the criterion that former foreign subsidiaries have become national firms by selling parts of or all their voting stock to local financial and industrial groups (not previously experienced in the electronics sector). Official Informatics Secretariat data for 1988 in which such "formally nationalised" firms are included in the national ownership category, give 72 % of total production value to the latter, which now include for example the Siemens operation in Brazil. Overt and/or indirect presence of investors such as Siemens, NEC, Ericsson, and of licensors such as Northern Telecom, ITT and Philips dominates respectively public switching, and (possibly) large PABX production. On the other hand the policies of technological development and transfer of products to the national private sector have encouraged national firms participation in some segments of the switching business (e.g. manufacture of the CPqD designed Tropico switches) and in most other transmission, communication and reception product lines. Some observers find that local technical innovations in public telephones, equipment for line sharing, and other adaptations to the needs of Brazilians living outside the main developed areas or central cities are very succesful.

The general pattern in the industrial automation and control market subsector includes the widespread utilisation of foreign technology for the larger or more complex types or models of equipment (in programmable logic controllers, numerical control units, distributed control systems, computer aided design systems, or robots) - and product development by local engineering for part of the medium sized, and practically all of the small and/or simple, equipment models groups. Over 70 local firms are involved in production; foreign firms supplying licences in the various mentioned areas include Allen-Bradley, Asea, Siemens, Modicon, Hitachi, Mitsubishi, Calma, FANUC, Hewlett-Packard, Intergraph, Apollo, Cincinatti-Milacron, and others. The patterns of diffusion are complex, depending not only on user sector needs but on nationality and preferences of both capital goods makers and capital goods users (German affiliate machine makers are reported to demand German origin electronics while German origin automakers buy machines from German-origin machine makers).

In the software market the copyright legislation has given advantage to imported software, and to the distribution business, over local production. Before the law was passed, foreign products, as well as local products (the latter including both "clones" of popular foreign software and locally created items) had their markets reduced by the universal custom of unauthorised copy and utilisation. The market seems now more disciplined but growth or new investment by local firms has stopped as they must find niches in an environment now dominated by imported "best sellers". It is said that in many occasions Brazilian firms have developed good products, but that they lack marketing and business capability to do better in competition against established international products. In fact many Brazilian products fall within the "applications software" class but there is also much activity in utilities, programming tools, etc. (i.e. already quite sophisticated softwares).

Local and foreign technology, foreign direct investment, and standards

Technological policy is a central theme in Brazilian informatics. In practice this has meant a major emphasis on product technology, a "derived need" status for process technology, - and only recently recognition of the need for optimisation of processes for quality and cost considerations. Product technology was largely a question of engineering based on university groups, migration of university electronics teaching staff to start-up firms, the work of graduates with further practical experience or post-graduate training abroad, etc., but use of foreign technology was from the very start (the 1977 experience with minicomputers) also a possibility, open to discussion with the authorities and to decision case by case. At the time, availability of components from merchant independent producers, diffusion of technical specifications by original designers, and the possibility of taking apart and understanding the principles of practically any product, triggered "reverse engineering" and "cloning" activities all over the world, and within certain ranges of equipment, Brazil (under protection) was no exception. Local designs however often had to include adaptations according to local limitations in supplies or processes or know-how. In some cases foreign licences were used and eventually abandoned for diverse reasons (including disappointment of the Brazilian technology buyer once alleged limitations of the licensed technology or of the "transfer" process were perceived) but left experiences and knowledge which Brazilian engineers were able to recycle and blend with other technical information and their own work to develop their own versions of the products.

The limits of use of foreign technology were never rigidly established and they were in fact a source of disputes of at least two kinds. In some cases, like the general authorisation in 1982 to build 32-bit minis (superminis) under licence, a few local firms, including the State-owned COBRA, claimed that Brazilian engineering had already become qualified to design such machines, but the Special Secretariat (SEI) ruled in favour of allowing licences. In other conflict area, the local firms that tried to "play fair", spending resources in engineering their own products (or re-engineering the "de facto standards" available for "compatible designs" or "clones"), protested loudly against "technology smugglers", as they called other lesser firms, adept at obtaining unauthorised designs from abroad in order to skip the engineering phase - which was meant to be the learning ground that justified the whole policy. In fact at some stage the Special Secretariat issued a ruling against the use of standardised operational systems in order to force certain local firms to invest resources in engineering. The Special Secretariat (SEI) had the power to authorise every new product on the basis of presentation of a project by the interested firm, and it was therefore its responsibility to determine if there was a local technological alternative actually or potentially available.

Many products were therefore engineered locally with variable success, probably including the recycling of foreign technology elements. The whole line of microcomputers up to 32-bits, banking automation equipment, the smaller or simpler units of industrial control and automation, as well as various kinds of add-ons, networking boards, etc., or UNIX like and other basic softwares, were produced as the result of local engineering and/or imitation work. In parallel, foreign purchased technology was used for the production of printers, magnetic tape units, hard disk units, floppy-disk drives, modems, terminals, etc.

It is important to notice that licensing was allowed but no Brazilian main informatics firm seems to have developed an identity as "the licensee" of x, y or z multinational firm. It happens instead that many Brazilian firms have either diversified their sources of foreign technological inputs, or limited the use of foreign technology to only part of their products,

and/or to part of the time, or combinations of those (Incidentally, they therefore have established their own brand names).

Local technological learning (product technology) could probably be assessed by charting progress in the launching of various types of local versions of the equipments that become international standards, and computing the time lags between Brazilian and international launchings and the differences between them. For example there is a trend to use microprocessors earlier in their life cycle, e.g. for the more advanced ones in the Motorola 68000 series, or the INTEL 80386 or the forthcoming 486. But firms have also discovered that after centering their expectations on being able to follow the trends in electronic design on the basis of the factors already mentioned (human resources, availability of independent supplies of integrated circuits, etc.) they have to spend time and resources in learning precision metalworking, acoustics, and other process and operational technologies relevant to actual "industrialisation" of prototypes based on their electronic design skills. The number of firms thus having registered with SEI and implemented their "projects" is now over 300; a large number of engineering schools and computing departments of universities pursue research projects and the upgrading of human resources. Furthermore, the Special Secretariat has created a Center for Informatics Technology (CTI) with strong divisions for microelectronics and industrial automation, among others; and both universities and the CTI, and private groups, have gained at least some experience in custom and semicustom integrated circuit design (including some cases of custom design for clients abroad). Assuming that a certain "controlled gap" in technology is compatible with the rhythm of development of more advanced needs by users (and/or with the satisfaction of such advanced needs by temporary imports), it seems that the claim that the policy of technological learning is succesful, should be taken prima facie seriously. A definitive statement would however require independent case studies of the local development of technologies, and/or of the blending of foreign technological inputs and local technical activities, and their implications for the diffusion of informatics applications.

Regarding more detailed knowledge of the flows of foreign technology to Brazilian independent firms, no systematic studies or tabulations covering the almost 15 year period from 1976 to 1990 (e.g. analysing the technology contracts by content, nationality of source, levels of royalties, etc.) are available. Partial and anecdotal evidence would allow to compile a tentative list of possibly over 50 or 60 foreign suppliers of technology ranging from IBM, DEC, Hewlett-Packard, Control Data, Fujitsu, etc., to small specialist firms in particular product of component segments. It should be however noticed that only a case by case analysis would show the different levels of obsolescence or "updatedness" of the licensed model or line of products in the market of origin, as well as the varying degrees of technical or business success of the technology transfer. It would also be interesting to assess at the same time the increase or reduction of reliance on one, or several, foreign sources by the Brazilian licensee firm as time elapsed. It is clear that while Brazilian firms, on their own volition or because of the control by the Special Secretariat, tried to limit the degree of dependence, the foreign suppliers often directly refused, or put limits on the types of, technologies to be transferred. The in-depth evaluation of the overall relationship of foreign suppliers of technology and Brazil's firms would require special research; the main point to make regarding the goals of this study is that by now Brazilian firms (and research centers) have accumulated more than fifteen years experience in the search for, selection, negotiation and acquisition of foreign technologies, under the rule of constantly comparing such alternatives with the local development (or imitation), alternatives, under the vigilance not only of the Special Secretariat but of competing firms and/or "technology ideologists" who would object to superfluous licensing.

The experience of foreign direct investment in the informatics sector shows that, in spite of restrictions to operate in areas reserved for the local firms, many operations of the transnational companies have grown considerably (see table I), and are profitable. IBM business in Brazil may be as large as one thousand million dollars a year, including manufacture of SIERRA mainframes, peripherals, and sophisticated subassemblies as the HDA (head disk assembly), sales of imported hardware, exports, leasing, services, and not less than eight agreements with local enterprises involving joint operations in different activities in the informatics industry, services and exports. Burroughs, now Unisys, partly replicates IBM's pattern in a smaller scale, making A-15 mainframes among other products; while Bull is a partner in a joint venture making mainframes, Hewlett-Packard has also an association with a local partner, and Digital Equipment (DEC) is about to start manufacturing in Brazil certain items on its own besides having licensed VAX and Microvax production to a Brazilian firm. In telecommunications Siemens, Ericsson and NEC are main participants in production under the already mentioned particular arrangements involving sales of equity. Philips makes consumer electronic goods and components.

Some foreign firms have been less able to make such arrangements - or perhaps not so willing and/or able to adapt - or have chose to lower their profile. For example, a semiconductor firm was allegedly "forced" to sell the only full-cycle semiconductor plant in Brazil for close to nothing to a local group, but other firms may have found it convenient to sell or close their plants to become licensors instead of manufacturers. The general rule followed was that those foreign firms which had already located industrial facilities in Brazil and had products beyond the capabilities of (licensed or autonomons) Brazilian firms, were allowed to stay, and to be profitable. Many multinationals adapted and today stay, partly perhaps waiting for 1992, when the period of (strict) control of the informatics market reserve (by SEI) is due to expire. It is true that several times from 1976 to 1988, both foreign firms and at least one foreign government, the government of the United States, have questioned the principles and practice of the reserve, and have taken action to probe its resilience, or to force some limits on it, but irreversible conflicts were avoided. The latest such case, and possibly the first one to show some backtracking by the Brazilians, was the sanction threats campaign by the U.S. government ending in 1988 after approval of the software law and other (unusual) goodwill gestures by the Brazilian government facing economic sanctions in the U.S. market for Brazilian goods at large.

In conclusion, both flows of foreign technology and direct producing activities of foreign firms have not just continued but could even be said to have increased in Brazil in spite of nationalistic policy - IBM Brazil's president recently announced they are investing 100 million dollars per year in 1989 and 1990 as, in his view, IBM Brazil together with all other firms in the Brazilian market could double their sizes in five more years. This implies that if one looks at facts rather than allegations neither side (local policy-makers or foreign firms) have made it impossible to the other to continue on its main overall course, whatever the differences on many particular points. The outlook for the future (judging from the trend of the last few years but not yet introducing as a factor in the equation the possibility of revision of the situation by the Collor de Mello administration) is that while an scenario of confrontation has become practically impossible - at least from the Brazilian side - and a scenario of sudden softening of the policy is in turn rather unlikely due to the overall internal acceptance of the policy and the strength of the sector in Brazil, the main possibilities are on the side of moderately or even significant increasing cooperation between foreign firms and Brazilian firms - the latter now being important actors on their own merits, rather than just ad-hoc agents tentatively constituted as at the time of the 1977 tenders for the right to operate in the minicomputer industry.

A final aspect related both to the international technical and business environment and to the possibility that organisational or regulatory measures will condition or close access to the Brazilian market, is standardisation.

The informatics industry in the world has largely evolved from closed architectures and proprietary systems, to open and standard systems; commodity microprocessors, operational systems like UNIX and MS-DOS, electronic bus or channel, standards, input-output systems, networking systems (Ethernet, token-ring), communications protocols (TCP-IP, X-400, X-25), define a largely common environment for hardware or software makers worldwide, coexisting of course with the world of proprietary systems marketed by certain important firms. Also some company designs based on standard elements have become "de facto standards" (e.g. the IBM personal computer line) - and their makers are interested in independent companies developing application softwares or "add-on" pieces of hardware to enhance the value of their products to the user, hence their diffusion of information to make such secondary industry viable. Telecommunications worldwide is oriented towards ISDN, the Integrated Services Digital Network, on standards defined by OSI/ISO (21), while in the mainframe computers world firms like Digital with NAS (Network Application Support) or IBM with SAA (Systems Application Architecture), allow different types of equipment to be connected to their larger machines.

Most of these world's market characteristics are reflected in Brazil's industry practice and government's regulations. A few questions should though be asked before stating that the Brazilian environment presents no unexpected idiosyncracies with restrictive potential :

i) The future of SOX : sox is a UNIX-related operational system, developed by the State company COBRA in its role of "flagship" of national technology. SOX has been approved by X/Open, an internationally recognised agency that ensures compatibility with UNIX. The architecture of SOX is claimed to be better adapted to transportability to different machines than that of other UNIX-like systems. This is due, according to COBRA's development director, to the fact that SOX is 85 % written in language "C" and can be recompiled on any machine supplied with a "C" compiler, leaving only 15 % of the system to be rewritten in source language for transport to the new type of machine. From the point of view of restriction of access to the Brazilian market for other operational systems, machines, or applications software, the odds are very much against SOX becoming compulsory. Several equipment manufacturing firms are keen to license UNIX and there is allegedly a widespread concern about how could SOX keep its compatibility with new versions of UNIX. The most likely outcome seems to be that SOX will remain in use by COBRA and perhaps other manufacturers while it will also stand as a proof of ability reached by the Brazilian industry to do sophisticated work. One proposal is to create a partial market reserve for SOX covering government purchases of data processing equipment.

ii) The future of MS-DOS and the OS/2 system : while the latter has not yet entered Brazil, the former has been challenged by a national "functional equivalent" called SISNE. This challenge and the U.S. response were at the heart of the software dispute mentioned before. The Brazilian Informatics Council (CONIN) first ruled against registering (i.e. allowing the marketing of) MS-DOS version 3.2 but later they ruled in favor of MS-DOS 3.3 in the sense of not having a Brazilian equivalent, thus been apt to be authorised to be marketed (a similar ruling based on version-to-version differences in features was passed recently favouring a U.S. networking software most advanced version over a slightly less advanced Brazilian "functional equivalent"). The conclusion is that foreign operational systems will be widely

marketed in Brazil, while local alternatives, compatible but partially differentiated, will also be sold.

iii) Regarding connectivity, communication protocols, and ISDN, the general principle so far seems to be not to introduce different national standards. This however deserves more technical verification. For a start, the rules of the Communications authorities concerning authorisation of equipment to be connected to the Brazilian systems should be analysed; the implications of local technology developments like equipment for packet-switching, or for satellite communications, or for implementation of ISDN, should also be studied technically. In this context it should be mentioned that in 1987 plans for a pilot TELEBRAS ISDN network joining areas equipped with switches of Siemens, Ericsson, NEC and (Brazilian) Tropico technologies were reported (no up to date information on this subject could be obtained for this report).

A tentative conclusion should in any case be that neither on the initiative of the Brazilians themselves nor of any foreign country or company capable of influencing Brazilian decisions, Brazil has enforced any standards or regulations going against the broad universal trends toward compatibility and connectivity, and independent production, of digital technology equipment.

Process technology, costs, prices, and the diffusion of applications

From the start, the dominating view in Brazilian informatics policy-making, referred technological learning to product engineering. Questions of manufacturing, scale, and production cost were not given the same priority. The issue of understanding product design and whether and when to authorise technology licensing instead of forcing firms to try to develop local versions of the products to be manufactured was difficult enough to practically monopolise the attention of government officials as well as of producers who were not aware of the many problems involved in turning a development prototype into a product produced with reliable quality and at reasonable cost. As required integration was high, the same problems were found all along the component supply lines of final manufacturers, within or without their plants. Furthermore, the market reserve mechanism did not provide direct comparisons of price and quality with international market goods, at a time in which even if Brazilian industrialists managed to reduce their prices, other world market suppliers were doing so even faster.

Given those conditions, plus the fact that neither multinationals' computer production nor consumer electronics in Brazil had provided productive skills, it is not surprising that so far Brazil is a high cost producer of most types of information technology goods. Other factors blamed are the general high cost of the Brazilian industrial production environment, high tariffs on imported parts and high taxes on industrial production.

On the other hand, an admittedly impressionistic view of utilisation of data processing equipment in Brazil, based on the type of applications reported in the press, and of course on the statistical data on sales of hardware, services, etc., suggests that Brazilians in the general industrial and other sectors, are investing in data processing, e.g. connecting small machines in networks, and that Brazil may well be using computers and other "informatics" goods more intensely than other Latin American countries where imports are allowed.

Law N.7.232 - 29/10/84 (Free translation and transcription)

On the National Informatics Policy and other dispositions

THE PRESIDENT OF THE REPUBLIC

I make know that the National Congress decrees and I sanction the following Law :

Article 1 - The present Law establishes principles, objectives and guidelines for the National Informatics Policy, its ends and formulation mechanisms, creates the National Council on Informatics and Automation - CONIN, decides regarding the Special Informatics Secretariat - SEI, creates the Information Export Districts, authorizes the creation of the Informatics Technology Center Foundation - CTI, sets up the National Informatics and Automation Plan and the Special Informatics and Automation Fund.

REGARDING THE NATIONAL INFORMATICS POLICY

Article 2 - The objective of the National Informatics Policy is the development of a national capability in informatics activities, to the benefit of the social, cultural, political, technological, and economic development of the Brazilian society, according to the following principles :

I - government action to guide, coordinate and foster informatics activities;

II - participation of the State in the production sectors in a supplementary fashion, whenever national interests so demand and the national private sector is unable to take action or is not interested in taking action;

III - intervention of the State in order to insure the balanced protection of the national production of certain classes of goods and services as well as to guarantee a growing national capability in informatics;

IV - prohibition of the creation of monopolistic situations, whether by law or in fact;

V - continuous adjustment of the informatization process to the characteristics of the Brazilian society;

VI - provision of policy guidance for information activities, which shall take into account the need to preserve and enhance the cultural identity of Brazil, the strategic nature of informatics and the influence of informatics upon on the efforts made by Brazil to attain higher levels of social well-being;

VII - direction of all the national efforts in the sector towards meeting the needs of priority economic and social development programs, and to strenghtening the National Power, in its various fields of expression;

VIII - establishment of legal and technical mechanisms and instruments for protecting the confidentiality of stored, processed and transmitted data which are of interest to the privacy and the security of individuals and corporations, private and public entities;

IX - establishment of mechanisms and instruments for ensuring to every citizen the right to have access to and to correct information regarding his/her person which is contained within public or private data bases;

X - establishment of mechanisms and instruments for ensuring a balance between increases in productivity and employment levels in all cases of automation of production processes;

XI - government stimulation and protection aimed at the development of a national technology, and at the economic, financial, and commercial strenghtening of national enterprises, as well as at a cost reduction of products and services, thus ensuring their greater international competitivity.

Article 3 - For the purposes of this Law, any activity related to the rational and automatic treatment of information is considered informatics activity and, specifically, those activities regarding :

I - research, development, production, importation and exportation of semiconductor electronic components, optical-electronic, as well as their electronic degree inputs;

II - research, importation, exportation, manufacturing, marketing, and operation of machines, equipment and devices based on digital techniques and having technical functions such as collecting, treating, structuring, storing, switching, retrieving, and displaying informations, its respective electronic inputs, elements, parts and physical operation bases;

III - importation, exportation, production, operation and marketing of programs for computers and automatic information treatment machines, as well as the corresponding technical documentation (software);

IV - structuring and exploiting data bases;

V - rendering technical information services.

1st. Paragraph - VETOED.

2nd. Paragraph - The structuring and exploitation of databanks (VETOED) shall be regulated by specific legislation.

REGARDING THE INSTRUMENTS OF THE NATIONAL INFORMATICS POLICY

Article 4 - The instruments of the National Informatics Policy are :

I - fostering the growth of informatics activities in a manner compatible with the development of Brazil;

II - institutionalizing norms and standards for the homologation and

certification of the quality of informatics products and services;
III - marshalling and applying in a coordinated manner public financial resources intended for the development of informatics activities;
IV - perfecting international cooperation patterns for the enhancement of the Brazilian capability in informatics;
V - educating, training and perfecting human resources for informatics;
VI - instituting a special regime for the granting of financial and tax incentives benefitting Brazilian businesses for the purpose of fostering the growth of informatics activities;
VII - imposing administrative penalties for the non-compliance with the provisions of this Law and pertinent regulations;
VIII - controlling imports of informatics goods and services for a period of eight years, dating from the publication of this Law;
IX - standardizing communication protocols among information treatment systems, and
X - establishing specific programs for fostering informatics activities on the part of state-owned financial institutions.

REGARDING THE NATIONAL COUNCIL ON INFORMATICS AND AUTOMATION

Article 5 - Article 32 of Decree-Law 200, of 25 February 1967, shall now be in force with the following wording;

"Article 32 - The Presidency of the republic is essentially composed by the Civilian Affairs Advisory Office and the Military Affairs Advisory Office. The following are also part thereof as immediate advisory bodies to the President of the Republic .

I - The National Security Council;
II - The Council for Economic Development;
III - The Council for Social Development;
IV - The planning Secretariat;
V - The National Intelligence Service;
VI - The General Staff of the Armed Forces;
VII - The Civil Service Administration;
VIII- The Office of the General Counsel of the Republic;
IX - The Supreme Command of the Armed Forces;
X - The National Council on Informatics and Automation.

(*) Sole Paragraph - The Heads of the Civilian Affairs and Military Affairs Office, the Head of the Planning Secretariat, the Head of the National Intelligence Service, and the Chief of the General Staff of the Armed Forces are Cabinet Ministers and head their respective agencies."

Article 6 - The National Council on Informatics and Automation - CONIN is composed by (VETOED) representatives from the Executive Branch of Government, among which the Ministers of Communications, of Industry and Commerce, of the Treasury, of Education and Culture, of Labor, the Secretary of Planning of the Presidency, and the Secretary General of the National Security Council as well as by eight representatives of other non-governmental organizations, among which are representatives of the informatics industry, representatives of users of informatics and electronics goods of services, representatives of the professionals and workers of the sector and representatives of the scientific and technologic communities, together with Brazilians of recognized competence and/or experience.

1st.Paragraph - The President of the republic is the Chairman of the National Council on Informatics and Automation - CONIN.

2nd.Paragraph - In order to attain the objectives of the National Informatics Policy, the National Council on Informatics and Automation - CONIN may authorize the creation and the termination of Informatics and Technology Research Centers, anywhere within Brazil of abroad.

3rd.Paragraph - The organization and operation of the National Council on Informatics and Automation shall be determined by the Executive Branch of Government.

4th.Paragraph - The duration of the term of office of the Members of the Council shall be three years due regard being given to the stipulations of paragraph 5 herein.

5th.Paragraph - The term of office of the Members of the Council shall terminate, in any event, concomittantly with the term of office of the President of the Republic who appointed them.

Article 7 - The National Council on Informatics and Automation shall :

I - advise the President of the Republic regarding the formulation of the National Informatics Policy;
II - propose, every three years, to the President of the Republic the National Informatics and Automation Plan to be approved and evaluated on a yearly basis by the National Congress, as well as oversee its implementation;
III - establish, according to the stipulation of the National Informatics and Automation Plan (VETOED) specific resolutions as well as procedures to be followed by Federal Agencies;
IV - monitor continuously the strict compliance with these provisions;
V - advise previously on the creation and restructuring of agencies and organizations concerned with the informatics sector within the Federal Government;
VI - advise on the granting of tax, financial or any other benefits by agencies or organizations of the Federal Government to projects in the field of informatics;
VII - establish criteria for the harmonization of regional or sectorial development policies that affect the informatics sector with the objectives and principles set forth in this Law, as well as adopt measures for promoting regional economic decentralization;
VIII - establish norms and standards for the homologation of informatics goods and services and for the issuance of the corresponding certificates, with due regard given to the opinion of the pertinent technical agencies;
IX - advise on the drafts of such international treaties, agreements, conventions, and commitments of any kind as may affect the informatics sector;
X - set standards for the control of transborder data flows and for the granting of data transmission channels and facilities for linkage to databanks and networks abroad (VETOED);
XI - establish measures for the State to adequately safeguard individual and public rights in matters relative to the informatization of the society, in conformity with article 40,
XII - advise on minimum curricula for the professional training and for the definition of careers to be adopted for informatics activities, by the agencies and organizations of the Federal Government, both Direct and Indirect Administrations, and by foundations under Ministry supervision;
XIII- decide, at the appeal level, matters pertaining to the decisions of the Special Informatics Secretariat;
XIV - advise (VETOED), regarding the basic conditions of actions or

contracts in the area of informatics activities;
XV - propose to the President of the Republic the forwarding to the National Congress of any supplementary legislative measures necessary for the implementation of the National Informatics Policy, and
XVI - create Informatics and Technology Research Centers, anywhere within Brazil or abroad, in conformity with the National Informatics and Automation Plan.

REGARDING THE SPECIAL INFORMATICS SECRETARIAT

Article 8 - The Special Informatics Secretariat - SEI, an agency subordinated to the National Council on Informatics and Automation - CONIN, shall :
I - give technical and administrative support to the National Council on Informatics and Automation - CONIN;
II - issue, disseminate, comply with and enforce the resolutions of the National Council on Informatics and Automation - CONIN, in conformity with item III of Article 7 herein;
III - draft a proposal for the National Informatics and Automation Plan, submit such proposal to the National Council on Informatics and Automation, and implement such plan within SEI's scope of action, in conformity with items II and III of Article 7 herein;
IV - adopt, within SEI's scope of action, the necessary measures for the implementation of the National Informatics Policy;
V - analyze and decide upon development and production projects regarding informatics goods, (VETOED); and
VI - advise previously, regarding any proposed import of informatics goods and services, for a period of eight years dated from the publication of this Law, due account being taken of the provision in item III of Article 7 herein.

REGARDING THE MEASURES APPLICABLE TO INFORMATICS ACTIVITIES

Article 9 - In order to ensure adequate protection to national informatics businesses, while still unable to compete in international markets, in conformity with different criteria according to the characteristics of each specific segment of the market, to be periodically assessed by the National Council on Informatics and Automation - CONIN, the Executive Branch of Government shall adopt temporary restrictive measures for the production, operation, marketing and importation of informatics goods and services.
1st.Paragraph - No restrictions or obstacles shall be imposed upon national companies, in the manufacturing, marketing or rendering of technical services, provided such companies use national technology and do not benefit from fiscal or financial incentives, due regard being given to the stipulations of Article 10 herein.
2nd.Paragraph - The restrictions of the heading of this Article shall also not apply to informatics goods (VETOED) whose manufacturing does not depend on the import of elements, parts and components of foreign origin.
Article 10 - The Executive Branch of Government may establish limits for the marketing of informatics goods and services within the domestic market, even for products manufactured in Brazil, whenever such marketing, implies the creation of "de facto" monopolies in segments of the market (VETOED).
Article 11 - The agencies and organizations of the Federal Government, both Direct and Indirect Administration; the foundations instituted or maintained by the Government and the other organizations which are under the direct or indirect control of the Union shall give preference in the acquisition of informatics goods and services to those produced by Brazilian businesses.
Sole Paragraph - In order to exercise such deadlines, service support, qualities, standardization, compatibility, and performance characteristics, consideration shall be given to the difference in price over similar imported equipment by a percentage to be proposed by the National Council on Informatics and Automation - CONIN to the Presidency of the Republic (VETOED).
Article 12 - For the purposes of this Law, Brazilian or national businesses are those corporations constituted and with headquarters in Brazil, whose control is, permanently, exclusively and unconditionally, directly or indirectly in the hands of individuals resident and domiciled in Brazil, or in the hands of domestic public law entities, control being understood as :
I - decision making control - the exercise in fact and by law, of the power to elect corporate administrators and to direct the operation of corporate organizations;
II - technological control - the exercise, in fact and by law, of the power to elect corporate administrators and to direct the operation of corporate organizations;
II - technological control - the exercise, in fact and by law, of the power to develop, generate, purchase and transfer, and vary the technology of the product and of the production process;
III - capital control - the holding, directly or indirectly of the whole capital, with effective or potential voting power, and of at least 70 % (seventy per cent) of the equity or share capital;
1st.Paragraph - For open capital corporations, the voting stock and fixed or minimum dividend stock shall correspond to a minimum of 2/3 (two-thirds) of the equity capital and may only be owned, subscribed or purchased by :
a) individuals, resident and domiciled in Brazil, or domestic public law entities;
b) private law corporations, constituted and with headquarters and venue in Brazil, which fulfill the requirements defined in this article for Brazilian or national businesses;
c) domestic, public law corporations;
2nd.Paragraph - Voting stock and fixed or minimum dividend stock shall remain registered.
Article 13 - National businesses may receive, jointly or separately, in connection with informatics goods and service research, development and production projects which are consistent with the purposes set in Article 19, the following incentives :
I - Waiver or reduction to zero of import duties in cases of imported items without domestic equivalents, such as :
a) equipment, machines, apparatus, and instruments with corresponding accessories, spare parts and tools;
b) components, intermediate products, raw materials, elements, parts, and other imputs;
II - Waiver of the export tax in the cases of exports of homologated goods;
III - Waiver or reduction to zero of the Industrialized Product Tax - IPI :
a) for the goods listed in item I, either imported or manufactured domestically, provided that the suppliers of the items in question are assured the tax credits perfaining to raw materials, intermediate products, elements,

parts, and other imputs used in the industrialization process;
b) for the homologated final products;
IV - Waiver or reduction to zero of the Credit, Foreign Exchance and Insurance Operations Tax and of the Tax on Stock Exchange Operations, applicable to foreign exchange operations related to payments for imported goods or technology transfer contracts;
V - Deduction, as operational expenditure, for Income Tax Purpose, of up to double the amount spent in programs, whether the programs is the business own program or for a third party, which have been previously, approved by the National Council on Informatics and Automation. Such programs should have as their objective research and development activities related to goods and services in the informatics sector or the education, training and enhancement of human resources for informatics activities;
VI - accelerate depreciation of goods which are part of the business' fixed assets;
VII - priority in direct financing granted by federal financial institutions or in indirect financing through reallocation of administratives funds by the above mentioned institutions for the purpose of covering investments in fixed assets, including foreign goods without domestic equivalent.
Article 14 - National businesses which carry out or may eventually carry out the physical-chemical processing in the manufacturing of semiconductor electronic, optical-electronic or similar components, as well as their inputs and involving techniques such as epitaxial growth, diffusion, ionic implant or other similar or more advanced techniques, may be granted, by decision of the President of the Republic, in addition to the incentives contemplated in article 13 herein, the benefit of a reduction in the taxable profits, for Income Tax Purposes, by a percentage equivalent to the share in the business' total revenue represented by the gross revenue derived from such goods.
Sole Paragraph - In a parallel manner, as an incentive, the businesses which use the inputs listed in the heading of this article, particulary in microelectronics, may be given the possibility of deducting twice the purchase value from their taxable profits.
Article 15 - National businesses, which have projects approved for the development of software which is of relevant interest for the country's production system, may be given the benefit of a reduction in the taxable profits, for income tax purposes, by a percentage equivalent to the share in the business' total revenue represented by the gross revenue derived from the marketing of such software.
Sole Paragraph - (VETOED).
Article 16 - The incentives specified by this Law shall only be granted in the classes of goods and services, within the application criteria, limits and brackets explicitly determined by the National Informatics Plan.
Article 17 - Due account being taken of other conditions to be established by the National Council on Informatics and Automation, the businesses which benefit from the incentives herein shall invest in technology creation, development and adaptation programs an amount equivalent or corresponding to a percentage determined by the norms in the National Informatics and Automation Plan and set prior to the granting of incentives, proportional to the quarterly revenue from the marketing of goods and services in the sector, after deducting the freight and insurance expenditures, whenever entered separately in the fiscal documents and corresponding in current market prices.
Sole Paragraph - VETOED).
Article 18 - The non-compliace with the conditions established at the time of granting fiscal incentives shall require payment in full by the violating business of the taxes waived or which were subject to a reduction, and which would otherwise by fully due, updated in value by monetary correction and increased by a fine equivalent to 100 % of the updated principal.
Sole Paragraph - (VETOED)
Article 19 - The criteria, conditions and period for approval, in each case, of the measures mentioned in articles 13 through 15 shall be established by the National Council on Informatics and Automation - CONIN, in accordance with the guidelines of the National Informatics and Automation Plan, with a view to :
I - increasing the participation of national private businesses;
II - meeting adequately the requirements of the users of informatics goods and services;
III - developing applications which show an optimization of the economic and social cost-benefit ratios;
IV - substituting imports and generating exports;
V - gradually reducing the final prices of goods and services;
VI - creating a capability for significant technological development.
Article 20 - The Development activities shall be carried out directly by public and private financing and loan institutions, due attention being given to the criteria established by the National Council on Informatics and Automation - CONIN and to the statutory provisions of said institutions.
Article 21 - During the financial years 1986 through 1995, corporations may deduct up to 1 % (one per cent) of the income tax due, provided they apply directly, by the time single payment or the last payment of the tax is due, an equal amount in new shares of private law national corporations which have as sole or main activity the production of informatics goods and services, the applications of such benefits being forbidden to companies belonging to the same conglomerate and/or companies whose capitalization plans have not been approved by the National Council on Informatics and Automation - CONIN.
Article 22 - (VETOED) in the case of informatics goods and services, which are considered of relevant interest for scientific and domestic production activities and for which there are no national businesses capable of meeting the effective needs of the domestic market, with their own technology or with foreign acquired technology, their production may be considered for businesses which do not fulfill the requirements of Article 12, provided that the organizations concerned :
I - have had approved, by the National Council on Informatics and Automation - CONIN, programs for the effective training of their technical personnel in the technologies of the product and of the production process;
II - apply, in Brazil, in research and development activities, directly or through agreements with Technological Research and Development Centers which work in the area of Informatics and Automation or Brazilian Universities, according to the priorities defined by the National Council on Informatics and Automation - CONIN, an amount corresponding to a percentage fixed by CONIN in the National Informatics and Automation Plan, proportional to the total gross revenue for each financial year;
III - present an export plan, and

IV - establish programs for developing local suppliers.
1st.Paragraph - The National Council on Informatics and Automation - CONIN shall authorize the acquisition of foreign technology solely when there is a recognized interest on the part of the market and there is no Brazilian company technically able to cater to the demand.
2nd Paragraph - The requirements stipulated in this article do not apply to products and services which, on the date this Law goes into effect, are already producing and marketing informatics goods in Brazil, according to projects approved by the Special Informatics Secretariat - SEI-VETOED).
Article 23 - The producers of informatics goods and services shall guarantee to the users a technical quality appropriate to such goods and services and shall be responsible for proving quality.
1st Paragraph - According to the criteria to be established by the National Council on Informatics and Automation - CONIN, the manufacturers of machines, equipment, subsystems, instruments, and devices, produced in Brazil or abroad, for marketing in Brazil, shall provide the technical information necessary for linking or connecting such goods with those produced by other manufacturers and to render, through third parties, technical maintenance services, as well as to furnish elements and parts for a five years period after the manufacture of the products is discontinued.
2nd.Paragraph - The period, the conditions and sanctions contemplated in the previous paragraph shall be established by regulation from the National Council on Informatics and Automation - CONIN.

REGARDING THE INFORMATICS EXPORT DISTRICTS
Article 24 - Excepting the situations which may already exist and in the event that the corresponding technology is available in the country, the use of foreign technology by business which do not meet the requirements of Article 12 shall be conditioned to :
I - production (VETOED) exclusively for the foreign market and
II - location of the production unit in any of the Informatics Export Districts.
Article 25 - The municipalities in the North and Northeast Regions which are indicated for that purpose by the Executive Branch and so designated by the National Congress shall be considered Informatics Export Districts.
Article 26 - The production and exportation of Informatics goods, as well as the importation of their elements, parts, accessories and inputs to the Informatics Export Districts shall be exempted from Export, Import, (VETOED) Industrialized Product, and Foreign Exchange Operation Taxes.
Article 27 - The exports of parts, components, accessories, and inputs of Brazilian origin for consumption and industrialization in the Informatics Export Districts, or for reexportation abroad shall be equivalent to Brazilian exports abroad with regard to the fiscal effects of existing legislation.
Article 28 - (VETOED).
Article 29 - The terms of the "Convention for the harmonization of procedures in matters of informatics and microelectronics, in the Manaus Free Zone, and for the rendering of technical and operational support", of November 30, 1983, concluded between the Superintendency of the Manaus Free Zone - SUFRAMA and the Special Informatics Secretariat - SEI, with the intervention of the Informatics Technical Center - CTI and the Center for the Analysis of Industrial Production Foundation are hereby ratified.

REGARDING THE SPECIAL FUND FOR INFORMATICS AND AUTOMATION
Article 30 (VETOED)
Sole Paragraph (VETOED)
Article 31 - The National Council on Informatics and Automation - CONIN shall annually approve the budget of the Special Fund for Informatics and Automation, taking into account the plans and projects which stand approved by the National Informatics and Automation Plan, and allocating resources to the entities described in Article 30.

REGARDING THE INFORMATICS TECHNOLOGY CENTER
Article 32 - The Executive Branch of Government is hereby authorized to create the Informatics Technology Center Foundation - CTI, with the purpose of fostering the development of scientific and technological research in informatics.
1st Paragraph - The Foundation shall be linked to the National Council on Informatics and Automation - CONIN, be administratively and financiallly autonomous, and shall be a corporation upon the filing of its corporate charter, by-laws and of the sanctioning decree.
2nd Paragraph - The President of the Republic shall designate a Union representative on the Foundation's corporate charter.
3rd.Paragraph - The structure and the operation of the Foundation shall be according by-laws to be approved by the President of the Republic.
Article 33 - The Foundation's objectives are the following :
I - to promote the implementation of research, plans and projects through agreements, conventions and contracts with public and private institutions;
II - to issue technical reports;
III - to monitor nationalization programs, together with the pertinent agencies, in accordance to the guidelines of the National Council on Informatics and Automation - CONIN;
IV - to give support to national informatics companies;
V - to implement the policy of integration of the Brazilian Universities with the national endeavor for the development of informatics, through agreements, conventions and contracts.
Article 34 - Through an act of the Executive Branch of Government, the Informatics Technology Center Foundation shall be endowed with the assets and rights belonging or destined to the Informatics Technology Center.
Article 35 - The assets of the Informatics Technology Center Foundation shall consist of :
I - resources originating from the Special Fund for Informatics and Automation, as may be allocated by the National Council on Informatics and Automation - CONIN;
II - budgetary allocations and subsides from the Union;
III - grants-in-aid and subsides assigned by the State and Municipalities, their autarchies, mixed-economy corporations or public corporations;
IV - assest and rights of the Informatics Technology Center;
V - earnings from services rendered in conformity with agreements, conventions or contracts;
VI - other revenues.
Sole Paragraph - In the creation of the Foundation, the Executive Branch shall encourage the participation of private resources in the assets of the Foundation as well as in its current expenditures, without the requirements stipulated

in the final part of sub-paragraph "b" of Article 2 of Decree-Law 900, of September 29, 1969.

Article 36 - The National Council on Informatics and Automation - CONIN shall guarantee to the Informatics Technology Center Foundation, within its scope of action, the incentives stipulated in this Law.

Article 37 - The staff of the Informatics Technology Center Foundation shall come under the provision of the Brazilian Labor Legislation.

1st.Paragraph - The staff on Informatics Technology Center, to be abolished, shall be entitled to become part of the staff of the Foundation.

2nd.Paragraph - The Foundation may contract, in Brazil or abroad, the services of specialized businesses or professionals to render technical services on a temporary basis, after consulting the National Council on Informatics and Automation - CONIN.

Article 38 - In the event that the Foundation is abolished, in assets shall be absorbed by the Union.

Article 39 - The expenses incurred in connection with the incorporation, installation and operation of the Informatics Technology Center Foundation shall be charged against budgetary resources which are at present assigned to the National Security Council and, subsequently, shall be allocated to the Presidency of the Republic/National Council on Informatics and Automation - CONIN or against other resources earmarked for that purpose.

FINAL PROVISION

Article 40 - (VETOED)

Sole Paragraph - (VETOED)

Article 41 - -VETOED)

1st.Paragraph - (VETOED)

2nd.Paragraph - (VETOED)

3rd.Paragraph - (VETOED)

Article 42 - In addition to maintaining and improving the instruments and mechanisms of industrial and service policies in the field of informatics which are in effect on the date of publication of this Law, the National Council on Informatics and Automation - CONIN shall submit, within 180 days, to the President of the Republic a proposal for adapting the norms and procedures now in force to the stipulations of this Law.

Article 43 - Matters pertaining to computer programs and associated technical documentation (software)(VETOED), and the right to privacy, as well as personal rights, because of their scope, shall be dealt with in specific legislation to be approved by the National Congress.

Article 44 - The first National Informatics and Automation Plan shall be submitted to the National Congress within 350 days from the publication of this Law.

Article 45 - Tis Law shall come into force 60 days after its publication.

Article 46 - All provisions to the contrary are hereby revoked.

Brasilia, October 29th, 1984, 163th of the Independence and 96th of the Republic.

JOAO FIGUEIREDO

(*) Decree-Law No 91.171 dated march, 22, 1985, includes, in CONIN's composition, the Ministry of Technology and Science.

Law No 7.646 of December 18,1987 (Free Translation and transcription)

Dispositions for the protection of intellectual property of computer programs (software) and their marketing in Brazil, and other dispositions.

TITLE I

Preliminary dispositions

Art.1 - The production and marketing of computer programs, of national or foreign origin, shall be free in the Country, full protection being assured to the owners of their respective rights, under the conditions established by Law.

Sole paragraph. A computer program is the expression of an organized set of instructions in natural or codified language, contained in a physical device of any nature, whose employment is necessary in automatic machines for information processing, devices, instruments or peripheral equipment, based on digital techniques, so as to make them function in a specific manner and for specific purposes.

Art.2 - The system for protecting the intellectual property of computer programs is that established by Law No 5.988, of December 14, 1973, with the amendments that this Law establishes to meet the peculiarities inherent in computer programs.

TITLE II

Of the protection of author's rights

Art.3 - The tutelage of the rights relative to computer programs are assured for a period of 25 (Twenty-five) years, counting from their lauching in any country.

Par.1 - The protection of the rights to which this Law refers are independent from registration or filing in the Special Secretariat for Informatics - SEI.

Par.2 - The rights granted by this Law to foreigners domiciled abroad are assured, as long as the country of origin of the program grants to Brazilians and foreigners domiciled in Brazil equivalent rights, in extension and duration, to these established in the heading of this article.

Art.4 - Computer programs may, at the author's discretion, be registered in an agency to be designated by the National Copyrights Council (CNDE), regulated by Law No 5.988, of December 14, 1973, and reorganized by Decree No 84.252, of July 28, 1979.

Par.1 - When applying for registering the copyright owner shall submit to the agency designated by the National Copyright Council (CNDA) sections of the program and other data that he considers to be sufficient to characterize independent creation and the identity of the computer program.

Par.2 - In order to be identified as the copyright owner, the program author may use his civil name, in full or in abbreviated form, or even its initials, as established in art. 12 of Law No 5.988, of December 14, 1973.

Par.3 - The information that serves as basis for the register shall be kept secret, and may not be revealed, except by a court order, or at request of the owner himself.

Art.5 - To the exception of stipulations to the countrary, the copyright relative to computer programs developed and created during the validity period of a labor contract or public service, clearly devoted to research and development, or in which the activity of the employee, servant or contracted party, for service rendering, is foreseen, or else, which arises from the very nature of the contracted duties, shall belong solely to the employer or the service contractor.

Par.1 - To the exception of agreements to the contrary, the compensation for the work, or service rendered, shall be limited to the agreed payment or salary.

Par.2 - The rights concerning a computer program whose creation is not related to the labor contract, public service or service rendering, and which does not employ resources, technological information, materials, facilities, or equipment belonging to the employer or contractor, shall belong solely to the employee, servant or contracted servant.

Art.6 - When so stipulated in the contract agreed upon by the parties, the right upon technological alteration and derivations shall belong to the authorized person who makes them and who will exercise them autonomously.

Art.7 - The following do not constitute infringements of computer programs copyrights :

I - Reproduction of a legally acquired copy, insofar as it is essential for the adequate utilization of the program;

II - Partial quotation, for didactic purposes, as long as the author and the program to which it refers are identified;

III - Occurence of similarity between a program and a pre-existing one, when this occurs due to the functional characteristics of its application, of the adherence to legal precepts and regulations or technical norms, or to the limitation of alternate modes of expression;

IV - A program's integration to an application or operations system which is technically essential to the user's needs, insofar as the program's essential characteristics are maintained, insofar as it is carried out exclusively for use by those who performed it.

TITLE III

Of filing (*)

Art.8 - For the marketing referred to in art.1 of this Law, the previous filing of the computer program or group of programs is mandatory by SEI, who will classify them into different categories, according to whether they were developed in the

(*) refers to SEI's file for marketing rights.

Country or abroad, in association or not with foreign or Brazilian companies, the latter being defined according to terms of art. 12 of Law No 7.232 of October 29, 1984, and by art.1 of Decree-Law No 2.203 of December, 1964.

Par.1 - In relation to the protection of copyrights, differences are not established between the categories referred to in the heading of this article, which shall be diversified for the purpose of financial funding with public fund, fiscal incentives, marketing and profit remittance, or payment of copyrights to their owners domiciled abroad, as the case may be.

Par.2 - The file which is the subject of this article and the approval of the acts and contracts mentioned in this Law, by SEI, when dealing with programs developed by non-Brazilian companies, shall be conditioned to the ascertainment of the non-existence of similar computer programs, developed in the Country, by a national company.

Par.3 - Beside the dispositions of the heading of this article, the registration which is the subject of this Law is a previous and necessary condition for :

I - the validity and efficacy of any judicial proceeding related to programs;

II - the production of fiscal and exchange effects and the legitimization of corresponding payments, credits or remittances, when such is the case, notwithstanding other requirements and conditions established by Law.

Art.9 - The filing for the purposes established in the previous article, shall be valid for a minimum of 3 (three) years, and shall be automatically renewed by SEI, complying with the dispositions of Par.2 of the above mentioned article.

Sole paragraph - It shall be possible to appeal from the decision of granting or denying the registration application to the National Council of Informatics and Automation (CONIN), complying with the dispositions of Internal Regulations of this Council.

Art.10 - For the purposes of this Law, a computer program shall be considered similar to another when it fulfills the following conditions :

a) be functionally equivalent, considering that it should :

I - be original and independently developed;

II - have substantially the same performance characteristics, considering the type of application to which it is destined;

III - operate in similar equipment and in a similar processing environment;

b) comply with established Brazilian standards, where applicable;

c) VETOED;

d) carry out the same functions, considering the type of application to which it is destined, and the characteristics of the Brazilian market.

Art.11 - A (maximum) period of 120 (one hundred and twenty) days is stipulated for SEI to rule on the filing request, counting from the date of the respective request.

Art.12 - Filing shall be granted to non-Brazilian companies solely to computer programs which are applicable to equipment produced in the Country or abroad, and marketed in Brazil by companies of this same category.

Art.13 - The filing of a computer program shall be invalidated at any time :

I - by a transitted in rem judicatam court decision;

II - by an administrative act, when it is proved that the information provided by the interested party in the filing application is false.

Art.14 - SEI, is allowed to charge a fee for registration (vetoed), according to its own price list, to be approved by the Ministry of Science and Technology.

TITLE IV

Of the contribution quota

Art.15 - The Special Informatics and Automation Fund which is the subject of Law No.7.232 of October 29, 1984, shall be destined to financing programs of :

a) research and development of informatics and automation technology;

b) human resources formation in informatics;

c) equipping Informatics Research Centers, with priority for Federal and State Universities;

d) capitalization of Informatics Technology Centers, created in accordance to the directives of the National Informatics and Automation Plan (PLANIN).

Sole paragraph - The Special Informatics and Automation Fund shall be constituted by

a) budgetary allowances;

b) contribution quotas;

c) internal or external donnations.

Art.16 - VETOED.

Art.17 - VETOED.

Art.18 - VETOED.

Art.19 - VETOED.

TITLE V

Of marketing

Art.20 - VETOED.

Art.21 - VETOED.

Art.22 - VETOED.

Art.23 - The physical medial of computer programs and corresponding packages, as well as the contracts related to them shall be identified in an easily visible way with the number given by the program file and the technical validity period of the marketed version.

Art.24 - The owner of the marketing rights of the computer program, during the technical validity period of his respective version, is obliged to :

I - divulge, without additional charges, the correction of contingent errors;

II - ensure its respective users of the rendering of technical services which are complementary to the adequate functioning of the computer program considering its specifications and the user's circumstances.

Art.25 - During the technical validity period dealt with in the immediately preceding articles, the owner of the computer program rights shall not be allowed to withdraw it from commercial circulation without fair indemnization of contingent losses caused to third parties.

Art.26 - The owner of the computer programs rights and its marketing rights shall be responsable, before the user, for its adequate technical quality, as well as for its fixation or recording quality in its respective physical medium, regressive legal proceeding being allowed against possible previous owner of those same rights.

Art.27 - The economical exploitation of computer programs in the Country shall be the object of licensing or assignment of rights contracts, freely celebrated among the parties, and in which the responsability for the respective payment of the tributes and taxes that may be levied in the Country shall be established.

Sole Paragraph - Clauses (in these agreements) shall be nullified whenever they :

a) establish exclusivity;

b) limit production, distribution and marketing;

c) exempt any of the contracting parties from the responsibility for contingent legal suits from third parties, as a consequence of flaws, defects, or infringement of copyrights.

Art.28 - The marketing of computer programs, to the exception of the disposition of art. 12 of this Law, is permitted solely to national companies which shall celebrate assignment of rights of licensing contracts with non-national suppliers, in accordance with the dispositions of this Law.
Sole Paragraph - The approval, by the competent agencies of the Executive Power, of the acts and contracts relative to the marketing of computer programs of foreign origin, is a previous and essential condition for :
a) allowing the filing of the program;
b) allowing tax exemptions, according to the dispositions of the specific legislation;
c) making it possible to remit the amounts involved to foreign countries, in accordance with this Law and with the remaining applicable legal dispositions.
Art.29 - Approval and registration shall be granted to acts and contracts relative to programs of external origin which establish remuneration to author, assignee residing or domiciled abroad, at an agreed price per copy and its respective technical documents, which shall not exceed the worldwide average amount charged for the distribution of the same product, payment not being allowed which is calculated as a function of the production income or profit of the assignee or the user.
Par.1 - Non-national companies are excluded from the permission granted by this article, and to them are ensured, as a consequence of marketing - foreseen in article 32, remittances allowed in the disposition and limitations of Law No 4.131 of September 3, 1962 and later legislation.
Par.2 - The legal invoice emitted by the owner of the corresponding rights or their legal representatives as evidence of the marketing of computer programs of foreign origin, shall be sufficient to allow the payment foreseen in the heading of the article.

TITLE VI
General dispositions
Art.30 - The importation and internment shall be allowed, as the case may be, of a sole computer-program, destined to the exclusive utilization by the end user (vetoed).
Art.31 - In the cases of technology transfer of computer programs, registration of the contract in the National Industrial Property Institute (INPI) is mandatory, inclusively for the purpose of payment of the deductible portion of the respective remuneration, and remaining effects foreseen in this Law.
Sole paragraph - For the registration dealt with in this article, besides the absence of a national technological capability, it is mandatory that the supplier furnishes to the receptor of technology, the complete documents, and specially the commented source-code, descriptive memorial, technicla specifications,diagrams, flowcharts and other technical data needed for the technology's absorption.
Art.32 - Companies may deduct up to twice the amount relative to expenses of acquiring computer programs as operational expenses for the purpose of ascertaining profits taxable as Income Tax and Income of Any Nature, when the companies are the first to employ this software, insofar as the program fits the definition of relevant interest in accordance with the dispositions of arts. 15 and 19 of Law 7.23 of October 29, 1984.
Par.1 - At the same time, as an incentive, the utilization of computer programs developed in the Country, by Brazilian private companies, shall be taken into account for the purpose of granting the incentives foreseen in art. 13 or Law No.7.232 of October 29,1984, as well as financing with public funds.
Par.2 - Direct and Indirect Public Administration agencies and companies,Foundationsestablished or maintained by the Government, and remaining Companies under direct or indirect control of the Government shall prefer, in equivalent other conditions, the utilization of computer programs developed in the Country by national private companies, in accordance with the dispositions of art.11 of Law No.7.232 of October 29,1984.
Par.3 - The State's participation in the marketing of computer programs shall comply with the dispositions of sections II of art.2 of Law No.7.232 of October 29,1984.
Art.33 - Legal proceedings for the annulment of the registration or filing, which shall be carried on in secrecy of Court, may be started by any interested party or by the Federal Union.
Art.34 - The annulment of the registration shall cause for defense in civil or criminal court proceedings relative to computer programs copyright infringements.

TITLE VII
Of sanctions and penalties
Art.35 - Computer programs copyright infringement :
Penalty - Detention from 6 (six) to 2 (two) years and fine.
Art.36 - (VETOED).
Artr.37 - Importing, exhibiting, maintaining in storage, for marketing purposes, computer programs of external origin that have been not be subject to filing.
Penalty - Detention from 1 (one) to 4 (four) years and fine.
Art.38 - Criminal actions, for the offense foreseen in arts.35, 36 and 37 of this Law shall be started by a complaint, to the exception of cases when the offense causes damages to Union, States, Federal District, Municipalities, autarchies, public companies, mixed economy companies or foundations under ministerial supervision.
Sole paragraph - Criminal action and preliminary injunctions of search and seizure, for the offense foreseen in article 35 shall be preceeded by an inspection, and the Court may order the seizure of the copies produced or marketed in infringement of copyrights, their versions and derivations which are under possession of the offender or of the party who is exhibiting, maintaining in storage, reproducing or marketing them.
Art.39 - Independent of the criminal action, the aggrieved party may start legal proceeding to prevent the offender from committing the criminal act, with the sanction of a financial penalty in the case of violation of the percept (art.287 of the Code of Civil Procedure).
Par.1 - The proceedings of abstention of commitment of the act may be accumulative with the damages suit for losses incurred as a result of the offence.
Par.2 - The civil proceedings filed on the basis of infringement of the rights relatives to the intelectual property over a computer program shall be carried out in secrecy of Court.
Par.3 - In civil proceeding, the provisional remedy of search and seizure shall comply with the dispositions of the Sole paragraph of art.36 of this Law.
Par.4 - The court may issue a restraining order, prohibiting the offender of practising the criminal act, in accordance with the dispositions of the heading of this article, independent from the preliminary injunction remedy.
Par.5 - The party that starts and files the proceedings foreseen in this article and in the preceeding article in bad faith or in an

emulation spirit, out of capriciousness or gross errors, shall be responsible for damages under the dispositions of arts.16,17 and 18 of the Code of Civil Procedure.

TITLE VIII
Of the final dispositions
Art.42 - This Law will come into effect on the date of its publication.
Sole paragraph - The Executive Power shall regulate this Law within a period of 120 (one hundred and twenty) days, counting from its publication date.
Art.43 - All dispositions to the contrary are hereby revoked.
Brasilia, December 18,1987.

JOSE SARNEY
Luiz Henrique da Silveira

DECREE NO96036 OF 12 MAY 1988 (Free Translation)

Regulates Law No 7.646 of 18 December 1887 which provides for the protection of intellectual property relating to computer programs (software), for the marketing of such computer programs in Brazil, and other provisions.

THE PRESIDENT OF THE REPUBLIC, by virtue of the power granted him under Art.81, item III, of the Constitution, DECREES :

Preliminary provision
Art.1 - For the purposes of these Regulations, the protection of intellectual property relating to software is governed by Law No 5888 of 14 December 1973, as modified by Law No 7646 of 18 December 1987.
Art.2 - A computer program is the expression of an organized set of instructions in natural or codified language, contained in a physical device of any nature, whose employment is necessary in automatic machines for information processing devices, instruments or peripheral equipment, based on digital techniques, so as to make them function in a specific manner and for specific purposes.
Art.3 - For one computer program to be considered similar to another, it must fulfill the following conditions :
I - be functionally equivalent, given that it shall :
a) be original and developed independantly,
b) have, substantially, the same performance characteristics, considering the type of application for which it is intended;
c) operate in similar equipment and processing environment;
II - comply with established Brazilian standards, where applicable;
III - carry out, substantially, the same functions, considering the type of application for which it is intended and the characteristics of the Brazilian domestic market.
Sole paragraph - Analysis of the similarity referred to in this article shall consider application type, Brazilian market conditions and similarity of processing environment, while observing also the following definitions :
a) "have substantially the same performance characteristics, considering the type of application for which it is intended" means that, comparing relevant parameters, the program developed by a national enterprise produces essentially the same effect obtained by the program in relation to which the similarity is being assessed;
b) "relevant parameters", including those which are measurable numerically, comprise memory requirements, processing time and transaction capacity between user and system.
c) "operation in similar equipment and processing environment" means that the program developed by a national enterprise is compatible with the equipment, instruments, peripheral devices and operating systems marketed in Brazil with which the other program being compared is itself compatible, and also allow access to the resources existing in the equipment, instruments, peripheral devices and operating systems marketed in Brazil which the other program being compared permits.
d) "carry out, substantially, the same functions" means to produce equivalent output for a given set of input data, considering those computer program specifications which are public knowledge.
Art.4 - National enterprises are those legal entities dealt with in Art. 12 of Law No7232 of 29 October 1984 and Art.1 of Decree-Law No 2203 of 27 December 1984.
Art.5 - For the purposes of Art.32 of Law No 7646 of 18 December 1987 :
I - Computer programs of special interest are those which satisfy the conditions set in Arts.15 and 19 of Law No 7232 of 29 October 1984, bearing in mind the directives contained in the National Informatics and Automation Plan (PLANIN) and the priorities established by the National Development Plan (PND);
II - primary users of computer programs are those who acquire them directly from the holder of the relevant marketing rights or his authorized representative.
Art.6 - The period when the tutelage of the rights start (Art.3 of Law 7646) - launching - shall be understood at the moment at which the author of the program utilizes it or places it at the disposal of another.

CHAPTER I

Juridiction

Art.7 - For the purposes contemplated in Law No.7646 of 18 December 1987, it is among the powers of the :

I - National Informatics and Automation Council (CONIN) to decide, according to its Internal Regulations, on appeals against decisions by the Special Secretariat for Informatics (SEI);

II - Special Secretariat for Informatics (SEI) :

a) to consider and defer the filing of software;

b) to consider and approve acts and contracts relating to the marketing of software developed by non-Brazilian enterprises;

c) automatically renew the filing of soft-ware, in accordance with the provisions of Art.8, paragraph 2, of Law No.7646 of 18 December 1987;

d) consider and approve software development projects;

e) give prior opinion on any importation of software, in accordance with the provisions of Art.8 item VI, of Law No 7232 of 29 December 1987;

III - National Industrial Property Institute (INPI), in consultation with SEI, to consider and approve the register of software technology transfer contracts;

IV - National Copyright Council (CNDA) :

a) to designate a body to file software;

b) to decide, in consultation with SEI, on appeals relating to the recording of software;

c) to issue standards to be published in the regulating procedures for the registering of software;

V - Central Bank of Brazil to authorize the remittance of foreign currency to pay for software imports, including sole copies imported directly by and destined for the exclusive use of the end-user.

CHAPTER II

Of computer program registering (for copyright protection) Federal Register

Art.8 - In order to apply for registering of a computer program, the author shall furnish the following information :

I - title of the computer program (Art.10. Law No.5988 of 14 December 1973);

II - name, date of birth, nationality and domicile of the author;

III - date the computer program was completed;

IV - date and place of launching of the computer program;

V - in the case of a computer program resulting from the modification of, or derivation from, prior technology, an indication of the program modified or derived from, accompanied, in this case, by the authorization document (Law No 7646, Art.6);

VI - whether the program was developed by employee, servant or under service contract (Law No.7646, Art.5, heading and paragraph 2);

VII - programming languages used in developing the computer program;

Art.9 - In all applications for registering of software, the applicant shall provide, in a directly readable form, those sections and other elements essential to substantiating the claim to independent creation and to identifying the program.

Art.10 - Total or partial assignment of software copyright is governed by the provisions of Art.53 of Law No.5988 of 14 December 1973.

Art.11 - Doubts relating to registering shall be submitted to the CNDA which shall decide them in consultation with the SEI.

CHAPTER III

Of computer program filing (for marketing rights)

Art.12 - A File of Computer Program is hereby instituted, with SEI, for Software destined for marketing in Brazil, on whatever basis and in whatever form.

Sole Paragraph - Data which constitute business or industrial secrets shall not be required for the purpose of computer program filing.

Art.13 - For filing purposes, computer programs shall be divided into six categories;

I - Category 1 : those developed in Brazil by individuals resident and domiciled here or by national enterprises;

II - Category 2 : those developed by cooperation between national and non-national enterprises, in projects approved by SEI;

III - Category 3 : those developed by non-national enterprises, where the technology and marketing rights in Brazil have been trasferred to national enterprises, by an appropriate document or contract, registered with SEI;

IV - Category 4 : those developed in Brazil by non-national enterprises;

V - Category 5 : those developed by non-national enterprises, where marketing rights in Brazil have been transferred to national enterprises;

VI - Category 6 : those which fit none of the above categories.

Sole paragraph - To qualify for Category 2, the contract establishing cooperation between the national and the non-national enterprise shall provide;

a) that the national enterprise, through qualified technicians, participate effectiviely in all stages of the design and development of the computer program.

b) final marketing rights in Brazil be exercised exclusively by national enterprises, notwithstanding that the foreign partner may retain exclusive rights in the country of origin or elsewhere; and

c) that documentation relating to the design and development of the computer program, including the source code, be the property and in the custody of the partner enterprises;

Art.14 - Exempt from registration are those computer programs :

I - imported by, and for the exclusive use of, the end-user, in the form of sole copy;

II - imported by, and for the exclusive use of, the end-user, in association with machines, equipment and devices based on digital techniques.

III - resident and integrated into machines, equipment and devices based on digital techniques, as long as these programs are not marketed separately from the products containing them;

Art.15 - Computer programs may be filed collectively when they constitute a set of programs intended for a specific application. In this case, they shall receive a single filing number.

Art.16 - A new version of a program must also be filed, in cases where the functional characteristics and marketing conditions of the version differ from those of the original.

Art.17 - For purposes of computer programs Filed and renovation of such filing SEI shall observe the provisions of Art.8,paragraph 2, of Law No.7646 of 18 December 1987.

Paragraph 1 - At the time that similarity is examined, the paradigm program developed in Brazil by a national enterprise must already figure on SEI's file.

Paragraph 2 - SEI may require that the proprietor of the program filed provide information to assist investigations to determine that a similar computer program, developed in Brazil by a national enterprise, does not exist.

Paragraph 3 - Filing shall be renewed independently of application by the proprietor.
Paragraph 4 - In cases where filing is not renewed, either because there already exists a similar computer program on the File or because some regular requirement is not complied with, SEI shall communicate this decision to the proprietor of the computer program filed at the latest thirty days before the date on which the validity of the filing is due to expire.
Paragraph 5 - The decision denying an application for filing of a computer program, registration of contract or renewal of filing of a computer program must be founded on technical and legal considerations and identify the similar product or the legal requirement not met, as applicable, and must be given within 120 days after the date on which the corresponding application is officially acknowledged, after which period the application shall be considered approved.
Art.18 - In the case of non-national enterprises, filing shall be granted exclusively for computer programs which apply to equipment marketed here by enterprises of that same category, whether produced in Brazil or elsewhere.
Art.19 - The application for filing of computer programs shall be made according to an appropriate application form supplied by SEI.
Art.20 - Decisions by SEI on applications for filing of computer programs shall be published in the Federal Register.
Art.21 - SEI shall charge a fee expressed in OTNs (National Treasury Bonds) for the services of filing computer programs, according to a price list established by the Ministry of Science and Technology and to be levied and collected in accordance with the provisions of Decree-Law No.1755 of 31 December 1979 and further regulations of it.
Sole paragraph - The product of less collected under this Article shall be deposited in the Informatics Activities Fund, instituted by Decree No 84067 October 1979 and contemplated in Decree No.90755 of 27 December 1984.
Art.22 - Within fifteen days after official acknowledgement of applications, SEI shall publish a list of requests for filing and of approvals for documents and contracts relating to computer programs developed by non-national enterprises, including a brief description of each, so that interested parties may, within thirty days after the first is published, advise of the possible existence of similar programs developed in Brasil by national enterprises.
Paragraph 1 - Independently of objections by third parties, SEI may deny applications for filing where it discovers the existence of a similar Brazilian national product.
Paragraph 2 - In any case, the applicant shall be notified, so as to be able to contest, within thirty days, the existence of a similar Brazilian national product.
Art.23 - At SEI's initiative, working groups, composed of representatives of professional associations or other bodies and persons with recognized technical experience, may be set up to advise SEI in its investigation to ascertain that similar computer programs, developed in Brazil by national enterprises, do not exist.
Paragraph 1 - The activities of the working groups to which this Article refers shall be governed by their charters.
Paragraph 2 - Participants in such working groups shall not be entitled to any remuneration.
Art.24 - SEI shall make public such information contained in the File of Computer Programs as may be of public interest.
Sole paragraph - The information of public interest to which this Article refers is comprised of :
a) name of the computer program;
b) functional description of computer program;
c) name and address of holder of marketing rights in Brazil;
d) category, sequential number in the file and period of validity;
e) processing environment;
f) period of technical validity established by the holder of marketing rights in Brazil.

CHAPTER IV
Of acts and contracts for licensing or assignment
Art.25 - Approval by SEI, of acts and contracts for the licensing or assignment of marketing rights for computer programs developed by non-national enterprises shall depend on the non-existence of similar programs, developed in Brazil by national enterprises and filed on SEI's File (Law No.7646, Art.8, paragraph 2).
Paragraph 1 - Acts or contracts for importation of sole copy destined for use exclusively by the end-user are exempt from examination.
Paragraph 2 - With prior consent of SEI, the importation by the end-user and for his exclusive use, of copies of computer programs associated with machines, equipment and devices based on digital techniques, shall be admitted, where these figure on the corresponding Import Licence issued by the Foreign Trade Department of Bank of Brazil (CACEX/Banco do Brasil).

CHAPTER V
Of incentives for the acquisition of computer programs
Art.27 - In calculating taxable profit for purposes of tax on income and revenues of any kind, legal entities may deduct, as operating expense, double the disbursements effected in purchasing computer programs developed by national enterprises, when they are the first users of such programs and when the programs qualify as of special interest (Art.5), as long as the provisions of Art.8, paragraph 1, of Law No.7646 of 18 December 1987 and Arts.15 and 19 of Law No.7232 of 29 October 1984 are satisfied.
Paragraph 1 - SEI's decision acknowledging a computer program as of special interest shall be published in the Federal Register, so that the user may enjoy the incentive under this Article.
Paragraph 2 - For purposes of proving entitlement to the incentive, the tax documents relating to the acquisition of the programs must make express reference to the administrative decisions acknowledging that these qualify as of special interest.

CHAPTER VI
Of user warranties on computer programs
Art.28 - The holder of marketing rights for a computer program shall respond for the adequacy of its technical quality, as well as the quality of the recording or fixing in the corresponding physical support medium, to the user, who shall be entitled to regressive action against possible previous holders of those same rights.
Sole paragraph - When one computer program is functionally dependent on another, the individual responsibilities of the respective manufacturers or holders of the marketing rights, as concerns the proper joint functioning of the programs, must be unequivocally described to the user.
Art.29 - In order to formalize the withdrawal of a computer program from commercial circulation, the holder of the corresponding copyright shall notify SEI.

Sole Paragraph - When the computer program is withdrawn from commercial circulation during the period of technical validity, the copyright holder shall publicize this in the press, without prejudice to the provision of Arts. 24 and 25 of Law No.7646 of 18 December 1987.

CHAPTER VII

On registration of technology transfer contracts

Art.30 - When Transfer of technology has been agreed on by the parties, the corresponding acts and contracts shall be registered with INPI, in accordance with conditions and criteria established jointly by INPI and SEI.

Sole paragraph - In cases of computer programs intended for applications in areas of relevant strategic or economic interest, CONIN may require, as a condition for registration of such acts or contracts, that the corresponding technology be transferred.

Art.31 - In establishing and updating the conditions and criteria (Art.30), INPI and SEI may be advised by a working group composed of representatives of professional associations, other bodies and persons of recognized technical experience.

Paragraph 1 - The activities of the working group referred to in this Article shall be governed by its charter.

Paragraph 2 - Participants in the working group shall not be entitled to any remuneration.

CHAPTER VIII

General provisions

Art.32 - The provisions of Decree No.93295 of 25 September 1986 apply to computer programs, as appropriate.

Art.33 - INPI, SEI and CNDA shall be allowed a maximum period of 120 days to express an opinion on matters within their juridictions counted from the date of filing of any such request.

Paragraph 1 - The opinion of such authorities, on matters within their jurisdictions, shall be well-founded and should the period expire without an opinion being expressed, this shall be understood as expressing consent.

Paragraph 2 - Requirements established by a competent authority shall be met within a period of thirty days from the date of notification, failing which the case may be closed.

CHAPTER IX

Temporary provisons

Art.34 - Computer programs previously filed with SEI may, on request by the interested party, be included in the File of Computer Programs, in the appropriate category, as long as the provisions of Law No.7646 of 18 December 1987 and of these Regulations are satisfied, up to 180 days after the date of publication of this Decree, according to an appropriate application form to be supplied by SEI.

Sole paragraph - For marketing purposes, the present file certificates shall be considered, while within their validity period, as equivalent to filing and the File number shall serve as a sequential registration number to comply with ARt. 23 of Law No.7646 of 18 December 1987.

Art.35 - A grace period of 180 days is granted for programs not filed with SEI, but which are being marketed in Brazil, to comply with these Regulations. The date of publication of this Decree marks the beginning of that grace period.

Art.36 - SEI has thirty days to establish the operating procedures called for in these Regulations.

Art.37 - This Decree comes into effect on the date of its publication.

Art.38 - All provisions to the contrary are revoked.

Brasilia, 12 May 1988, 167th of Independence and 100th of the Republic.

JOSE SARNEY

Luiz Henrique da Silveira

LIST OF TABLES
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