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)	3.40	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 CGA and Araujo Jr.(1990) for total exports of capital goods.

are simpler and much cheaper in Argentina than in Brazil (Erber, 1989) account for almost half (48.3% in 1988) of the exports of machine tools.

Brazilian capital goods to Argentina are much more diversified and consist mainly of products produced in larger scale and which tend to be heavier and more expensive (e.g. machines for plastic, injection, machinery for the construction industry, electric ovens) (Porta, 1989) but do not inclued NCMT.

Brazil has become the main export market of the Argentinian capital goods industry and such exports have played a major role in sustaining the industry, especially the machine tool branch, in the depressed conditions of investment in Argentina.

For the Brazilian capital goods industry, sales to the Argentinian market are marginal to their total sales, but consumers of such goods have undoubtedly benefited from the supply of Argentinian machinery, especially users of NCMT, which were able to purchase simpler and less expensive models. In 1988 Argentinian NC lathes imports accounted for about 14% of the number of lathes manufactured in Brazil. Argentinian users of capital goods have also benefited from the greater variety of supply stemming from trade with Brazil.

As we saw above, electronic products were excluded from the CGA and Brazil retained her import restrictions on numerical control NCs units in order to protect its infant industry. This generated a flow of exports of NC units to Argentina which, in 1988, was equivalent to 22% of the Brazilian imports of Argentinian NCMTs, and to 11% of total Brazilian NC production, helping the latter to spread its fixed costs at a time the latter are very high due to the infant stage of production.

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 of the two industries.

As originally conceived, the CGA should provide the two industries with a widened market, warranting static economies of scale and economies of scope and specialization, leading to greater technological development and increased productivity on the two sides of the border. In order to fulfill such

expectations, complementarities should be established between the two industries, both at a "horizontal" level, between finished goods, and at a "vertical" level, for the supply of parts and components, breaking away from the pattern of national substitution of imports which characterized the previous development of the two industries.

However, in practice, the common list 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 negotiators and they must approve the inclusion of products in the common list, they are in a privileged position to avoid major competitive threats from the other country. As a consequence, the pressure emmanating 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, partly because both were in a process of tariff reform, but the cost of leaving the relative margins of preference undefined.

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 yet fully designed. It is not clear yet if the new Governments, recently ellected in the two countries, will have the political will to implement such measures.

Given such constraints, it is probable that as soon the obvious comparative advantages of the two sides have been included in the common list, the CGA will loose momentum, following a pattern already observed in other regional schemes of integration such as ALALC. If this comes to happen a major opportunity for industrial and technological development shall have been lost by the two countries.

Interviews made by the author on the two sides of the border suggest that such loss of momentum may already be under way, in part fuelled by the crisis of the two economies and the ensuing very short time horizon of entrepreneurs, afraid of loosing any market share.

A recovery of the CGA and, in fact, of the whole integration movement of Latin America is contigent upon the political will of the Governments of the countries involved to lead the process and to negotiate the adjustments the integration process requires internally. This involves also a loss of autonomy of Governments in the measure the coordination and harmonization of national policies is required.

As Araujo Jr. (1990) has cogently argued, Brazil, because of her weight within the region, should lead such process, eventually by liberalizing her imports from the other Latin American countries unilaterally and accepting that all payments be made under some type of regional-currency not denominated in U.S. dollars or other hard-currency. The Brazilian economy would be a major beneficiary of such process expanding its exports to the region and restructuring some of its productive activities, profiting from both inter and intra-industry trade.

The present Brazilian Government has not addressed such issues yet, but its economic priorities seem to oriented towards the more advanced countries. In such scenario there is little hope that Latin American integration will proceed much further and will be able to provide a respite from the protectionism arising from other regional integrations.

IV. FOREIGN INVESTMENT

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.

Preceding sections have already indicated the stimuli industrial and trade policies provided foreign enterprises to directly partake of the Brazilian market, as well as they described the deterioration of the country's economic and financial conditions over the last decade, which reduced its attractiveness to foreign investors. Therefore, before examining the flows and composition of foreign investment in Brazil, it suffices to briefly review the institutional background to such investment.

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 investment (either as direct investment or in financial form) is the same to be applied to national capitals, forbidding any form of discrimination between the two.

The issue of discrimination between local and foreign capitals is often confused, in Brazil and abroad, with the broader issue of regulation. It is true that the Brazilian economy is highly regulated, as the previous sections have already shown. However, the number of regulations which establish differences between enterprises according to the nationality of their owners is very limited.

The activities to which apply a differential treatment according to the origin of capital can be grouped in four broad categories:

i) activities connected with national security, such as means of communication (TV, radio and newspaper) and establishments located in frontier zones;

ii) activities connected with the exploitation of mineral resources;

iii) supply of some services — banking, insurance and transport (maritime and airborne);

iv) activities with a high technological content — consulting and engineering services, electronic data processing equipment and telecomms 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. The latter rule is more stringent only in the cases of air and maritime transport and informatics, where the percentages are raised to 80, 60 and 70, respectively.

In the latter case the Law of Informatics (7232/84) prescribes not only the maximum share of capital foreign partners can hold but also that the

foreign partner cannot be the supplier of technology. However, the Brazilian market of informatics is reserved only for products which can be produced by locally-owned firms. Thus, foreign subsidiaries operate in upper-end of technology, supplying about 40% of the Brazilian informatics market. The present Government has sent to Congress a proposal of ammendment of Law 7232 which eliminates the restriction on the linkage between equity and technology supply and widens foreign participation in joint-ventures to up to 49% of total equity capital.

In most cases the restrictions apply to the overall operations of the firms, but for consultancy services and sales of telecomms equipment they are enforced only for sales to the public sector, their main market.

Therefore, except for informatics and telecomms equipment, there are no sectors in manufacturing industry where the operation of foreign enterprise is restricted. However, foreign-owned enterprises have their access to credit granted by federal development agencies barred, except for projects deemed to be of "national interest" by administrative decision.

Profits of foreign enterprises can be exported up to 12% of the total registered capital (investment and reinvestment) without additional income taxes. The latter are applied if such remittances are above such limit. For tax purposes the remittances are assessed on a three-year moving average, which makes remittances easier to plan. There are non 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.

In international terms the constraints on payments above mentioned are elastic and they do not seem to have hindered operations in Brazil in any significant way. The ceiling on profit remittances was, for most of the time, below the international interest rate, except during the eighties, when it probably contributed to the increase in Brazilian external debt, since enterprises found more profiable to get resources from their parent companies or associated banks under the form of loans rather than risk-capital.

As regards payments for patents and trade-marks, Barbosa (1979) showed

that 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 behaviour above described seems to confirm that MNCs can be viewed as a "bundle" of assets which are priced differentially, according to specific institutional conditions, subject to the objective of obtaining a reate of return on the total bundle.

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 has increasingly taken the form of debt conversion (Table IV-2), which in 1988 accounted for over three-fourths of gross investment. The share of net investment taken up by profit remittances, which had declined from a half during the sixties to a third during the years 1973/77, 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 above discussed 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, the basis on 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.

Table IV-1

FOREIGN INVESTMENTS AND REMITTANCES - 1960/88

(In US$ Millions)

Year	Net Direct Foreign Investments [1] (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

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

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

SOURCES: Central Bank of Brazil and Bauman (1990).
* Foreign Investment Gross Inflow.

Table IV-3

REGISTERED FOREIGN DIRECT INVESTMENT AND REINVESTMENT IN BRAZIL
1971/88 (*)

(In US$ Millions)

Year	Investment (1)	Reinvestment (2)	Total (3)	(2)/(3) (%)
1971/1980	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

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

If we combine such data on reinvestment with the high debt conversion of the same period, the conclusion is that unfortunately foreign investment has provided very scant relief to external constraint of the Brazilian economy during the recent past, being financed almost exclusively by resources generated internally.

Nonetheless, foreign enterprises have contributed considerably to easing the foreign exchange constraint by providing a hefty trade surplus. A special study made by Cacex for the period 1978/86 (reported in BNDES, 1988), shows the share of foreign enterprises in Brazilian exports and imports, including as foreign enterprises all firms in which the majority of equity was held by non-residents, i.e., fully-owned subsidiaries and joint-ventures where foreign partners held the majority share.

Table IV-4 shows that during the 1978/86 period foreign enterprises accounted for 27% of total Brazilian exports, 18% of total imports and 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, in order to better assess

the trade performance of private enterprises, we exclude oil imports, the share of foreign enterprises of total imports and of the trade surplus would, respectively, increase to 32% and decrease to 24%.

Table IV-4

BRAZIL
FOREIGN TRADE OF FOREIGN COMPANIES(1) - 1978/86

	EXPORTS - F.O.B.			IMPORTS - F.O.B.(*)		
	TOTAL	FOREIGN COMPANIES		TOTAL	FOREIGN COMPANIES	
YEAR	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

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

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 (using the same Cacex data) were performed under BEFIEX incentives.

Most of such 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, 1988). More recent data, for some sectors such

automobile and informatics, give even higher shares — three-fourths in the first case, in 1985 (BNDES, 1988) and over 90% in the latter (our estimates for recent years, based on interviews).

The trade results reported above are comensurate 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 Wilmore (1987) which worked with 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 enterprises as firms where non-residents held more than 50% of capital, he identifies 794 foreign firms, which accounted for 22.5% of the domestic market and 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 IV-5) that the share of sales held by foreign enterprises increases from 28.7% for the 500 largest to 37.8% for the 25 largest. The same table suggests that during the eighties the share of foreign firms was reduced, which is consistent with the evolution of foreign 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 slightly misleading on two counts. First, the investment is 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%). Nowithstanding the traditional presence of Swiss MNCs in sectors such as the food industry (which absorbs 15% of total Swiss investment), the high share above mentioned can be ascribed to companies registering in Brazil under Swiss nationality, such as part of operations of Fiat. In fact, the automobile industry holds 30% of total Swiss investment.

Table IV-5

BRAZIL

SALES PARTICIPATION OF GOVERNMENT, FOREIGN AND PRIVATE NATIONAL COMPANIES

(%)

COUNTRY'S TOP 25				COUNTRY'S TOP 500			
YEAR	FOREIGN	GOVERNMENT	NATIONAL	YEAR	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				CHANGE			
1985/78	-9.6	2.9	6.7	1985/78	-6.9	1.1	5.8

SOURCE: BNDES (1988).

Second, as regards sectors of investment, almost 10% of total investment is registered under "holding companies", a veritable black box as regards the purpose of investment.

With the above caveats, Table III-6 shows that almost three-fourths of foreign investment in Brazil is on manufacturing industry and, within industry, in the most modern branches: automotive (vehicles and parts) (12.5% of total foreign investment), basic chemical products (9.3%), mechanical (8.6%) and electrical and electronics products (8%). Within services, investment is concentrated on export-import companies (3.8%) and commercial banks (3.1%). Investment in mining activities, although traditional, holds a relatively minor share (2.5%).

As regards countries of origin of investment, the USA holds the main share (29%), followed by the FRG (15.3), Japan and Switzerland, above mentioned. Such four countries hold 63% of total foreign investment in Brazil. The EEC as a group holds 35.9% of total investments, although such share, for the reasons previously stated, is probably underestimated. Within the EEC, the FRG is the main investing country, holding 43% of the total 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, US investments are concentrated on 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%) industries holding 57% of total investment. U.K. investment is heavily concentrated on petroleum derivatives, French investment on chemicals, Italian investment on the automotive and steel industries and Dutch investment on electrical, electronics and communication and chemical industries.

Such patterns of investment reflect the relative strenght of MNCs of the different countries and their perception of the attractiveness of the Brazilian market but it is also very similar to the distribution of trade and foreign indebtedness.

Brazilian trade pattern was analysed above and it is worth recalling the important role played by intrafirm trade. As regards indebtedness, a fourth of the total Brazilian gross external debt is held by US banks, another fourth by the eight main countries of Western Europe and 8% by the Japanese financial system (Bauman, 1990).

As it is well known, the financial systems of such countries hold close links with the industrial and commercial enterprises and the decisions of both

TABLE IV-6 - REGISTERED FOREIGN INVESTMENTS IN BRAZIL BY COUNTRY AND SECTOR - 1988(1) - IN US$MILLIONS AND PERCENTAGE

COUNTRY	AGRICULTURE	ANIMAL HUSBANDRY	MINING	MANUFACTURING INDUSTRY					MANUFACTURING INDUSTRY								TOTA
				STEEL	METALURGY	MECHANICAL INDUSTRY	ELECTRIC & COMUNICATION	AUTOMOTIVE	AUTO PARTS	BASIC CHEMICALS	PETROLEUM DERIVATIVES	DRUGS	TEXTILES	FOOD	TOBACCO	OTHER INDUSTRIES	
F.R.GERMANY	6,977	12,063	90,934	20,085	457,879	657,686	301,282	1,125,934	441,134	310,434	58	308,671	8,718	176,668	19,745	350,238	4,178,
(%)	0.15	0.26	1.93	0.43	9.72	13.96	6.39	23.89	9.36	6.59	-	6.55	0.18	3.75	0.42	7.43	88
BELGIUM	137	415	9,470	4,713	3,823	1,220	-	-	252	173,458	-	79	94	3	-	21,071	200,
(%)	0.03	0.1	2.35	1.17	0.95	0.3	-	-	0.06	43.05	-	0.02	0.02	-	-	5.23	5
DENMARK	-	-	-	-	88	8536	-	-	-	1443	400	1447	-	2,833	-	7,221	21,
(%)	-	-	-	-	0.17	16.45	-	-	-	2.78	0.77	2.79	-	5.46	-	13.91	42
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,
(%)	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
FRANCE	9,290	4,856	4,699	3,442	23,885	46,981	38,111	952	11,205	316,690	75	38,433	21,765	36,312	2,499	194,159	734,
(%)	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
GREECE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
(%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
HOLLAND	6,835	1,068	7,212	5,531	14,166	24,837	254,632	13,184	11	192,731	2,128	39,852	649	2,394	15	119,660	669,
(%)	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
S.IRELAND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
(%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.36	2
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,
(%)	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
LUXEMBURG	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,
(%)	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
PORTUGAL	-	-	-	-	-	-	-	-	-	25	-	3,707	-	-	9,521	418	13,
(%)	-	-	-	-	-	-	-	-	-	0.04	-	6.12	-	-	15.72	0.69	22
U.KINGDOM	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,
(%)	0.25	0.02	6.05	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
TOTAL	31,535	29,526	233,431	261,459	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,
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
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	542,151	59,497	320,482	225,534	1,185,720	7,074,
(%)	1.01	0.01	3.09	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
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,
(%)	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
SWITZERLAND	9,030	11,461	1,222	14,582	35,540	110,629	243,668	839,252	64,361	56,883	4,332	104,829	45,086	414,582	6,166	636,473	2,598,
(%)	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
TOTAL ALL COUNTRIES (%)	150,621	74,348	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	397,185	866,501	309,109	3,245,786	20,187,
	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

IN US$1,000

COUNTRY	SERVICES					NON-SPECIFIED ACTIVITIES	TOTAL	(%) BY COUNTRY
	TRANSPORT	COMERCIAL BANKS	INVESTMENT BANKS	HOLDING COMPANIES	OTHER SERVICES			
F.R.GERMANY	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	
DENMARK	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	
LUXEMBURG	-	-	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.KINGDOM	-	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	50.99	34.00	57.96	42.47	43.63	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	
SWITZERLAND	5,075	15	8,217	79,753	85,558	31,331	2,807,965	9.15
(%)	0.18	-	0.29	2.84	3.05	1.12	100.00	
TOTAL ALL COUNTRIES (%)	42,973	860,210	296,081	2,097,367	1,596,687	447,569	30,703,072	100.00
	0.14	2.80	0.96	6.83	5.20	1.46	100.00	

SOURCE: Central Bank of Brazil

(1)Investment and reinvestments as registered by 9/30/1988.

groups are often interdependent.

As a consequence, it would probably be convenient for all parties involved to expand debt negotiations to include aspects of trade and foreign investment, instead of keeping them separate as has been the norm so far.

Although the majority of foreign investment in Brazil is performed under the form of wholly-owned subsidiaries, Zoninsein (1985) identified 1420 joint-venture firms operating in Brazil. His data show that European and Japanese firms were more willing to share ownership control than their American 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 partners.[7]

The majority of such joint-ventures was established with Brazilian private firms, 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 until recently automobiles (Fiat of Brazil was partly owned by the State of Minas Gerais). In fact, such activities seem to concentrated the bulk of foreign investment in joint-ventures.

Except for petrochemicals, telecomms equipment and some investment in non-electrical machinery, the role of joint-ventures in more technology-intensive sectors is limited. It is often suggested that joint ventures, especially with foreign partners of small and medium-size, should be a preferred way of setting up the new technology-intensive branches such as biotechnology.

However, an alternative assessment, originally based on the experience of petrochemicals, is that having the foreign partner as the main supplier of technology leads to a very limited transfer of technology (especially as regards innovation capability in terms of basic process and product design)

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[7] Joint-ventures in which there is some combination of European, American and Japanese partners were not computed, but they are few.

and can limit the search for new suppliers of technology, either as partners or as licensors when the firms expand and diversify their lines of production. This assessment was confirmed by the experience of telecomms equipment, where the wholly-owned subsidiaries were obliged, in order to sell to the Government, to become minority capital partners but in practice witheld the control of the joint-venture and did not transfer innovation capability. Such experiences lay behind the provisions of the Law of Informatics which allowed a minority foreign partnership (up to 30% of capital) as long as the foreign partner was not the provider of technology.

The presence of foreign enterprises has undoubtedly contributed considerably to the technological upgranding of the Brazilian system, either directly or through their supplier network. However, such increase in technological skills is circumscribed mainly to the operation of plants and the sale of products, not involving major innovation skills.

Thus, subsidiaries located in Brazil perform mainly minor adaptation of process and products to local conditions and train their suppliers in know-how skills but not on know-why. Although a recent (1988) Law of fiscal incentives for technological development included foreign-owned firms as potential beneficiaries, there is considerable scepticism whether such incentive is strong enough to counter the preferred localization of innovation activities in the more developed countries, where there is a convergence of economies of scale, scope and conglomeration compounded by strong externalities arising from a highly developed scientific and technical infrastructure as well as by reasons of strategic control, entrepreneurial and political.

V. SCIENCE AND TECHNOLOGY

V.1 Brazilian SET in the International Context

The Brazilian contribution to international scientific and technological productions seems to be quite below the role played by Brazil in 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% for world total and

citations of Brazilian authors were only 0.18% of world total in 1980 (computed from BID 1988). As regards patents, out of about 60 thousand patents granted in the US in 1983, only 23 were given to Brazilian residents (BNDES, 1988).

This reflects the low level of R&D expenditures by Brazil, which is less than 1% of its GNP, less half of the share allocated by other NICs such as South Korea and of the level of expenditures by the advance industrialized countries. Taking a National Science Foundation (1988) sample of 66 countries, which accounts for most of the market-economy world, but excludes the socialist countries, Brazil's share of the total R&D expenditures was 0.97% in 1985.

Comparisons with the industrialized countries should bear in mind that in their case such expenditures are made on a long-established system which benefits from all the static and dynamic economies of scale, as well as economies of scope and conglomeration, a system which, in Brazil, as we whall see in more detail below, has been chronically maintained under conditions of underdevelopment. Thus, the contrast is starker with other NICs, such as South Korea, which have attached a high priority to the development of scientific and, especially, technological capabilities.

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. Thus, it was recently estimated that out of the total expenditures for science and technology by the Federal treasury [the main source of founds (for S&F in Brazil)] only 52% were for R&D strictu sensu. (CNPq, personal communication).

V.2 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 Government agencies, either from the Federal Government (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).

Including the enterprise sector, it is estimated that there are about 60 thousand researchers active in Brazil, a ratio of 400 per million of inhabitants. In absolute and relative terms those are low figures, even for NICs. Thus, in South Korea, for instance, the values are respectively 91 thousand and 2000 researchers per million (Garcia et al., 1990).

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 covered by the census reported spendings on R&D and those which do spend perform mainly adaptive technology taks, related mainly to detail engineering and production technology, spending only 0.48% of their earnings for R&D, a percentage much below international standards, bearing in mind that Brazil is the nineth country in the world manufacturing ranking. Their patenting, even in Brazil, is limited too: there fourths of the invention patents requested in the period 1986/88 were by non-residents in Brazil and it is estimated that about half the patents requested by residents were of 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%) — a pattern similar to that observed in other international relationships 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 Association	22	4.7	325	0.6
TOTAL	463	100.0	56,556	100.0

SOURCE: CNPq (1987).

As shown in Table V-2, imports of technology have declined over time, influenced especially by the reduction of "specialized technical services", which are purchased mainly by Federal 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 for R&D) the ratio of local expenditures to imports of technology is 1.8, which shows the heavy reliance of the enterprise sector on imported technology, compared to other countries such as Japan where such ratio is 30.

Tabel V-2

TECHNOLOGY IMPORTS - 1979/88

(in US$ Millions)

YEAR	PATENTS & TRADE-MARKS	LICENSED TECHNOLOGY CAPITAL GOODS IND.	OTHER IND.	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.

As we have argued elsewhere in more detail (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 payments abroad for technology 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, 1979 for a survey). In fact, licensing agreements provide the license with skills of production engineering and detailed design but do not include the transfer of innovation skills necessary for basic product and process design and other R&D activities.

Nonetheless, such transfer, albeit limited, is probably greater than that involved in the purchase of technical services, which are performed at arm's lenght, with much less interaction between the supplier of the service and the use of the latter than is the case in licensing, where long-term relationships tend to be established, conducing 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, where 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 by the enterprise sector on R&D, 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, with the two first sectors with around 15% each of the total, the second two with around 13% each and the last two with about 11% each (see Table V-3).

Within this group of sectors, non-ferrous metallurgy, electronics, metal minerals and basic chemical products present a R&D intensity (measured in terms of R&D expenditures as a percentage of earnings) above the average (0.48) — respectively, 5.18, 2.52, 1.12 and 0.94. The other two sectors, automobile and oil and petrochemicals have a low intensity — respectively 0.55 and, surprisingly, 0.18.

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

Table V-3

R&D SPENDING BY INDUSTRY IN BRAZIL - 1985

Sector	NE(1)	Earnings(2)	%	R&D(2)	%	Average	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	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

NOTES :
(1)Number of enterprises reporting spending on R&D
(2)Values in US$millions. Converted at US$ = 6.20 Cz$
(3)R&D spending as a percentage of earnings

SOURCE: FIBGE, 1985 census, special tabulation, preliminary results.

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 probably 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 surprisingly 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 an important R&D center and its petrochemicals subsidiary is in the course of setting up another.

A similar sectorial pattern emerges from the loans granted by FINEP (Financiadora de Estudos e Projetos), the Federal Government development bank for science and technology, shown in Table V-4. It is noteworthy that although the metal-mechanic groups 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 with the period 1973/78, respectively from 7 to 22% and from 4 to 14%.

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 (1987).

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.

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)	
	NUMBER	EMPL(2)	BP	MN	S	NE(4)	VALUE(5)	INTENSITY(6)	TOTAL	HIGHER EDUCATION
Metal-Mechanic	26	7216	17	1	8	20	54594	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

NOTES:
(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) Average	Min	Max	R&D Intensity (2) 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

NOTES:
(1) In US$ Thousands
(2) R&D expenditures as a percentage of earnings

SOURCE: ANPEI (1988)

Finally, a recent study of leading industrial enterprises (Ferraz et al., 1990) shows that electronics was the sector which tended to spend most on R&D as a share of sales (a minimum of 2.9%).

Imports of technology follow a similar pattern, albeit more diffuse. Technical services are used mainly by process industries — oil (included in "mining" by INPI), metallurgy (especially stell) 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 entreprises of engineering and consulting (see Table V-7).

Licensed technology (which accounts for less than a fourth of total import payments) is used mainly by the capital goods sector, especially custom-built machinery and equipment (44% of total licensing payments) metallurgy, chemicals and informatics.

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 reports.

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 technology, with the first sector alone being 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% largest enterprises accounted for 54% of total R&D expenditures and in sectors where medium-sized firms predominate, such as the non-electrical machinery industry, the largest firms within the sector tend to invest more in R&D (Braga 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 such payments (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 earnings of around US$ 530 millions. As shown in Table V-5 in 1987, 53 of the members invested in R&D circa US$ 173 millions, 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 by ANPEI members varies considerably — from US$ 82 thousands to US$ 32 millions and from 0.1% of earnings to 9.8%. Nonetheless, on average, members spend 1.6% of their earnings on R&D, substantially more than the average of industry.

Such evidence confirms the pattern detected by several sector studies, surveyed in Erber (1980) and is corroborated by census data — the R&D of the six leading sectors (which account for 77% of total industry R&D) is performed by 209 enterprises only.

Most of the large enterprises have their own in-house R&D centers (72% of the firms interviewed by Ferraz et al. in 1989) and most of the medium and small size enterprises have limited R&D activities. Coupled to the under-equipment of research institutes this leads to a limited and constrained relationship between the enterprise sector and the S&T system, with negative 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 consisting 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 mechanical, chemical, metallurgical and electro-electronic industries, confirming the 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, with some institutes, such as the Aeronautics Technological Center, (CTA) performing high-quality tasks in close relationship with the enterprise sector.

Moreover, 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 movement seems to be gathering momentum and is 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 precision mechanics, and in the State of Rio de Janeiro where a biotechnology pole is being established, both based on the Federal Universities of the two States. Such processes, partly Government-sponsored, have not been captured by the statistics on R&D yet.

Moreover, it is important to notice that some enterprise R&D centers, notedly those held by the most technology-intensive State enterprises, such as PETROBRAS (CENPES) TELEBRAS (CPqD) and ELETROBRAS (CEPEL), hold very close links with the rest of the R&D system and with the enterprise sector, mainly with their suppliers of equipment, comissioning R&D projects to the former and transferring product and processes developments to the latter.

Finally, scientific development is also unevely distributed. According to bibliometric data related to citations of Brazilian works (BID, 1988) and to the per capita 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, areas in which there is a strong tradition in the country. BID (1988) data show also that citations for

physics and chemistry are above the average too and, significantly, that citations for engineering and technology have the lowest of all fields of knowledge covered.

V.3 The Role of Government

Both failures and successes of the Brazilian S&T system are heavily influenced by the action of the Government, which has structured the system and most of its links with the rest of the Brazilian economy.

The description above of the Brazilian S&T system shows the major 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, the main exception being the universities of the State of São Paulo.

Within the enterprise group, Federal enterprises play also a major role, both in terms of the complexity of their activities and volume of expenditures.

The overhelming 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 directly out of the Federal Treasury. State enterprises, where Federal enterprises predominate, supply 9%. The treasury 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[8], the S&T system was structured mainly during the seventies, especially during the second half of the decade, when the Federal Government equipped the universities and research institutes, increased the salaries of researchers and teachers, multiplied the number and value of scholarships,

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[8] See Erber (1980) for references on several books and articles on the history of Brazilian scientific and technological institutions.

both abroad and in the country, and stimulated the State enterprises to set up their research centres. The latter enterprises were also encouraged to not only to substitute imports but also to establish purchasing policies which increase the local technological content of equipments and materials. The private sector was provided with subsidized loans for technological activities through a special development bank for S&T (FINEP), which acted also as the coordinating agency for the system of linkages between the State enterprises and their suppliers.

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 Government, State Governments and State Enterprises and on the 1985 census preliminary data on R&D spending by industrial sector.

This effort of structuring an S&T system would have required a continued increase in expenditures during the next decade. However, such process was drastically curtailed during the eighties, reflecting the Government attempts to reduce its spending, the short-term and narrow-minded approach to inflation control and, last but not least, the very low priority attrached to scientific and technological development by the incumbent policy-makers.

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 requires long periods of maturation. Thus, in 1980 Federal treasury final allocation to S&T were around US$ 530 millions (2.25% of total Union expenditures), in the next two years they jumped up to respectively, US$ 1061 and 1305 millions and then declined in the following two years to US$ 797 and 770 millions. Moreover, such oscillations were not only year-by-year but tended to occurr within the year, reflecting the vagaries of budgeting at times of high inflation. To give but an example, in 1987 the initial Union allocation for S&T was US$ 423 millions (3% of total expenditures) but the year ended up with Union S&T expenditures of US$ 1630 millions, equivalent to 4% ot total expenditures.

The reduction of funds was more profound in the main instrument of the Government for supporting new projects or institutions — the National Found 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 its value during the seventies.

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

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. Institutions already established found great difficulties for maintainig their equipment up-dated, faced great obstacles for importing reagents and other inputs and for expanding and even maintaining their staff,

especially in areas where alternative employment was found.

Nonetheless, the worse plight was that of new institutions, even if they had highly relevant projects. The case of the Technological Centre for Informatics project for mask-production illustrates this. The Centre is sspposed to be one of the technological mainstays of the Brazilian informatics policy and its most important project in microelectronics was the setting up of a line of production of masks, which was intended to service the burgeoning microelectronic firms, which have no alternatie source of supply in the country. After laborious negotiations, equipments for this purpose were imported under a turn-key contract with full provisions of training and technology transfer. However, after more than a year it has landed in Brazil, such equipment is still crated because the budget allocations for the necessary civil works were eroded by inflation.

The present Government has recently anounced a Programme of Technological Capability which intends to raise the level of expenditures on science and technology to about 1.5% of the GDP by 1994.

Table V-9 reproduces the estimates of the Programme for the years 1990 and 1994, which do not include the State Governments expenditures. A major feature of the Programme is the great increase in resources chanelled through the Federal development banks, which should grow from paltries US$ 60 million in 1990 to hefty US$ 1440 million in 1994. Spurred by such funds and by fiscal incentives, private expenditures are expected to more than treble over the period. Federal Treasury direct expenditures should almost double and State enterprises increase by about half of their present level.

The programme is heavily biased towards industry, directly through the role of the development banks and industry's own expenditures and indirectly through the Treasury expenditures, where all increments shall be used to create "externalities" to industrial R&D activities and for programmes of improving quality and productivity of enterprises. However, no sector priorities have been established, pending upon the decision about the "industrial competitiveness" programmes already mentioned.

As regards the State Governments, until recently only the State of São Paulo had a significant investment in R&D, through its universities, some

Table V-9

SCIENCE AND TECHNOLOGY EXPENDITURES IN BRAZIL - 1990 AND 1994 - BY SOURCE OF FUNDS - IN US$ MILLIONS AND PERCENTAGE

SOURCE	1990 Value	(%)	1994 Value	(%)	1994/90 (%)
Federal Government Treasury	1414	75	2693	53	190.4
Financial Agencies	60	3	1440	28	2400.0
State enterprises	200	11	293	6	146.5
Private enterprises	200	11	664	13	332.0
TOTAL	1874	100	5090	100	271.6
% GDP	5		1.3		

SOURCE: Programme of Technological Capability.

State 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 São Paulo, 19 other States have earmarked fiscal resources for S&T. If such provisions were implemented, the States' spending on S&T would reach about US$ 340 millions in 1990, 37% higher than their estimated level of spending in 1985. However, in most States such provisions have not been fulfilled yet, largely because of the resistance of local financial authorities, which seem to hold other priorities.

Foreign sources of funds have played a minor role in S&T financing in Brazil and they have mainly through the Federal Government. In the past, the most important were two loans granted by the IDB to FINEP's programmes of support of technological activities of local enterprises and for the equipment of research institutions, and a US$ 70 million sector loan (PADCT) by the World Bank to support development in some selected scientific and technological. The latter loan has led to substancial controversy because of the arbitrary way in which the areas were selected and the impression that the Brazilian counterpart did not come as an addition to the existing resources but was made at the expense of existing sources, such as the FNDCT. Moreover, the insistance of the IBRD to establish new procedures for analysing projects and implementing the programme led to a cumbersome bureaucratic duplication.

More recently IDB has granted a US$ 60 million loan to the University of the State of São Paulo and IBRD signed a new sector loan of US$ 300 million to be disbursed over the 1990/94 period, entailing an equivalent counterpart from the Brazilian Government for twelve science and technology areas. The Federal Government is also in the process of negotiation a US$ 100 million loan with the IDB.

V.4 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 asked by the National Industry Confederation to write a document on industrial competitiveness and industrial policy. Published the next year (CNI, 1988), the document, widely distributed, emphasizes 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 resources 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 enterpreneurs 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, the most radical change in perception of the sample. The same study shows that the firms interviewed intend to invest considerably in electronics-based automation and 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 interview could be endlessly multiplied. The two above mentioned were selected because they indicate a two-step transformation in course: first 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 protection against imports and warranted by the relative maturity of the Brazilian industrial structure. Second, comes the perception that such increase in productivity must be supported by an increase in the endogenous technological capability, which must involve R&D skills which go beyond the production and detail engineering skills which were required by the import-substitution stage of industrialization.

Actually, there are some indications that such change in perception is being translated into action. The powerful Industry Federation of the State of São Paulo, which accounts for more than half of the Brazilian industrial output, established an advisory committee for technological development and seventy five enterprises (which represent a total of 171 firms) set up an association of industrial enterprises 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 above described.

It is also important to notice that the demand for loans for technological development from FINEP has been highly responsive to resources availability. When FINEP has had resources, such as in the period 1987/88, there was a great demand for funds. Thus, in 1987 when the resources of the levy on petrol and cars was made available to FINEP, its committments for technological development trebled over the previous year, to US$ 180 millions. Moreover, the value of loans requested at the end of 1987 was equivalent to US$ 500 millions. Of course, 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 of the loans given by FINEP to the productive sector. As shown in Table V-10, during

the 1979/84 period, half of such loans were for establishing the infrastructure of R&D, but in the period 1985/87 (the latest for which there is data available) the share of infrastructure projects fell to 26% and the share of process and product development projects increased to, 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 especially of the informatics branch, (where the intensity is at the international level), evidenced by the several studies surveyed above, and the change in the sector composition of FINEP loans suggest that firms respond positively to Government policies designed to foster local technological capability.

The evidence of changes presented above is certainly limited, but the "educated guess" of the author and of other 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 and of c omplementary technology imports.

Table V-10

FINEP LOANS TO ENTERPRISES - OBJECTIVE OF PROJECT
1979/84 AND 1985/87 - NUMBER OF PROJECTS (N)
TOTAL VALUE IN US$ THOUSANDS (V) AND %

	1979/84				1985/87			
TYPE OF PROJECT	N	(%)	N	(%)	N	(%)	N	(%)
INFRAESTRUCTURE OF R&D	314.00	39.70	117.13	50.00	170.00	30.00	67.39	26.40
PRODUCT DEVELOPMENT	249.00	31.50	28.11	12.00	112.00	25.10	78.37	30.70
PROCESS DEVELOPMENT	187.00	23.60	70.04	29.90	90.00	20.10	68.92	27.00
TECHNOLOGY ABSORPTION	30.00	3.80	7.50	3.20	29.00	6.50	14.55	5.70
OTHERS	11.00	1.40	11.48	4.90	46.00	10.30	26.04	10.20
TOTAL	791.00	100.00	234.26	100.00	447.00	100.00	255.27	100.00

SOURCE: Melo (1989)

VI. HUMAN RESOURCES FOR SCIENCE AND TECHNOLOGY

VI.1 The Stock of Human Resources in Brazil

In developed countries the density of scientists (number of professionals with a Master or PhD degree) is around 1/400 to 1/100 scientist per inhabitant. In Brazil this density is approximately 1/4000 scientist/hab. Considering the rate of population growth, the country would need to train 500.000 new scientists in the next decade in order to reach a density of 1/400. This is, of course, quite unprobable since it would demand a large investment which is beyond the country's capacity. Moreover, there would not be enough students with qualification to pursue graduate studies. However, in 1987 the Brazilian Government decided that a major effort should be directed toward the increasing the stock of trained professionals for Science and Technology. It was considered that the following conditions would favor a major programme of human resources training:

a) there exists an active entrepreneurial basis capable of responding to the new demands of goods and services generated by the introduction of new technologies;

b) the advent of 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 the technological lag and find new lines where they can attain international competitivity;

c) there exists a national system of education and research that, since 1975, is becoming increasingly organized and with a critical mass over which it is possible to expand the system.

Brazilian explicit policy of expansion of its human resources base faces a major bottleneck in the configuration of its undergraduate system. About 80% of the undergraduate students are enrolled at private higher education institutions. For economic reasons these institutions tend to invest in courses which have cheaper infrastructure requirements. An obvious consequences is that the distribution of students across the knowledge areas and professions does not meet the necessity for the development of high technology. This distribution is also reflected in the growth of graduate

programs. Over 30% of the graduate programs in Brazil is concentrated in the areas of Humanities, Social Sciences, and Arts. Thus, the country faces not only the problem of increasing its trained human resources basis, but also of correcting the structure of the distribution of its graduate programs.

As shown in Table VI-1, the Brazilian distribution of graduate students according to knowledge areas is substantially different from that prevailing in more industrialized countries, especially as regards the share of students enrolled in Humanities and social sciences (which is larger in Brazil than elsewhere) and Engineering (where the reverse holds).

Table VI-1

COMPARISON OF DISTRIBUTION OF SCIENTIFIC BASE
BETWEEN BRAZIL AND SELECTED DEVELOPMENT 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	------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.

I - Engineering
II - Exact and Geo-sciences
III - Agricultural sciences
IV - Biological sciences
V - Humanities and social sciences
VI - Health sciences

In 1987 the Brazilian Government established the following criteria to direct its human resources training policy:

a) to increase the participation of the several branches of Engineering;

b) to give special emphasis on the training in the priority areas: Biotechnology, Material Sciences, Informatics, Fine Chemistry, and Precision Mechanics;

c) to complement training in the areas where there is low internal capacity in graduate programs.

VI.2 The Brazilian Graduate System

The number of graduate programs leading to Masters and Doctoral degrees at Brazilian education institutions grew from 110 in 1970 to 1226 in 1987 (see Table VI-2) and the number of students enrolled in such programmes increased six-fold between 1973 and 1986 (see Table VI-3) and, presently, is around 70.000. The increase has been especially sharp for candidates to Doctoral degrees, which increased from 434 in 1973 to 9272 in 1986, when they accounted for 14% of the total number of graduate students.

In view of such enormous increase in both the number of programs and the rate of enrollment, the issues of productivity and quality of the system come to the fore.

The average time of completion of a master's degree in Brazilian institutions is 3 years, and 7 years for a doctor's degree far too long by international standards.

This is mainly due to the lack of scholarships that enable the students to pursue their degree on a full-time basis. Table VI.4 shows the growth of scholarships granted by the Federal Government to domestic training.

Table VI-2

NUMBER OF GRADUATE PROGRAMS OFFERED BY BRAZILIAN INSTITUTIONS 1970-1987
(approximate numbers from 1970 to 1987)

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	880
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 ENROLLMENT 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
1979	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 ENROLLED AT BRAZILIAN INSTITUTIONS - 1976/1988

Year	Doctor's	Master's	Non-Degree(1)	Undergrad(2)	Total
76	668	5 139	1 338	843	7 988
77	762	5 865	1 341	879	8 847
78	888	6 834	1 302	837	9 861
79	938	7 215	1 287	879	10 319
80	961	7 389	1 479	1 077	10 906
81	1 007	7 749	1 407	1 053	11 216
82	1 238	9 522	1 491	1 272	13 523
83	1 420	10 920	1 245	1 176	14 761
84	1 520	11 697	1 356	1 317	15 890
85	1 543	11 871	1 515	1 599	16 528
86	1 638	12 600	1 614	1 509	17 361
87	2 003	14 997	3 057	3 924	23 981
88	2 334	17 481	4 032	5 892	29 739

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

Although in 12 years, the total number increased almost four-fold, especially for doctoral training, less then a fourth of Master students and less then a fifth of Doctoral students receive grants (see Tables VI-3 and 4). Increasing such rates would certainly have a positive effect on the productivity of the system.

Another a major bottleneck is the availability of academic staff holding doctor's degree in graduate programs. Table VI.5 shows that although the rates of growth for 5 years periods are quite significant the absolute numbers of teachers is still below what is needed for the number of students 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% is located at the South and Southeast regions of Brazil (Table VI-6).

At the end of the 70's the Government begun to control the growth of graduate programmes and CAPES started to evaluate their quality. Using grades given by the academic community, its evaluation is considered to be quite reliable. By 1989 it had all graduate programs ranked from "A" to "E" in quality. If we take the programs evaluated at level "A" and "B" ("excellent" and "good")(841 — about two-thirds of the total number) half (47%) are concentrated in only six universities (University of São Paulo-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-EPM), all of them located in the south and southeast. Such concentration confirms the heterogeneity of the Brazilian S&T system previously mentioned and point out the urgent need to strenghten the capability of the other institutions.

As a consequence, in spite of the recent growth of its graduate education system, Brazil will have to depend heavily on training abroad in order to attain a minimum scientific and technological basis and increase the quality of its own graduate programs.

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	1 326	16.9	52.1	1 965	17.5	48.2
2. Biolog.	717	17.6	1 170	14.9	63.2	1 429	12.7	22.1
3. Engineering	518	12.8	707	9.0	36.5	1 169	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	1 422	12.6	109.7
6. Other(2)	1 289	31.8	3 574	45.5	177.3	4 630	41.1	29.5
Total	4 059	100.0	7 855	100.0	93.5	11 260	100	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 DEGREES, BY GEOGRAFIC REGIONS - BRAZIL - 1986

Region	Doctor's		Master's		Total	
	no.	%	no.	%	no.	%
Southeast	8 265	73.4	1 383	44.2	9 648	67.0
South	1 318	11.7	704	22.5	2 022	14.1
Northeast	1 144	10.2	869	27.8	2 013	14.0
Centerwest	407	3.6	88	2.8	495	3.4
North	126	1.1	83	2.7	209	1.5
Total	11 260	100.0	3 127	100.0	14 387	100.0

Source: CAPES.

VI.3 Training Human Resources Abroad

During the 50's about 1170 Brazilians had their graduate training abroad. Of these, about 990 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 make a major effort in sending Brazilians abroad for graduate training.

As shown in Table VI-7 the number of sholarships increased substantially during the second half of the seventies, as a consequence of the priority attached to science and technology by the Government, remained stable during the first half of the eighties and then increased again, as a result of the creation of the Ministry of Science and Technology and its 1987 Training Programme, above mentioned. The present number of scholarships (around 5500), if maintained, will make it possible for the country of reach a density of 1/800 scientist/hab. in a decade, if it is considered the effect of the foreign training on the growth of the domestic system.

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
73	163	124	287	--
74	160	139	299	0.04
75	379	321	700	1.34
76	606	321	927	0.32
77	658	464	1 122	0.21
78	746	484	1 230	0.09
79	1 430	531	1 961	0.59
80	1 432	555	1 987	0.01
81	1 113	646	1 759	-0.11
82	997	911	1 908	0.08
83	1 035	986	2 021	0.06
84	980	909	1 889	-0.06
85	1 173	936	2 109	0.12
86	972	939	1 911	-0.09
87	1 125	1 142	2 267	0.19
88	1 696	1 611	3 307	0.46
89	2 000	3 238	5 238	0.58

Source: CAPES and CNPq.

To the scholarships listed in Table VI-7 should be added the program on Agricultural Sciences that was implemented from 1976 to 1987 by EMBRAPA (the Brazilian Agricultural Research Enterprise, subordinated to the Ministry of Agriculture) that trained about 1000 students in foreign countries. Today, the scholarships granted by the two Federal institutions (CAPES and CNPq) account for over 90% of the total scholarships granted.

The participation of foreign institutions and international organizations in the Brazilian training system is becoming increasingly marginal. In 1988, the system had about 300 scholarships given by non-Brazilian institutions.

The system also shows a high concentration of scholarships in few countries. The United States (40%), Great Britain (24.3%), France (24.5%) and West Germany (5%), are recipients of over 90% of the Brazilians abroad. The distribution by country is also uneven when knowledge areas are considered. France tends to concentrate students in Humanities and Social Sciences (46% of the total), while the percentage in this area falls respectively to 33% in the United States, and 25% in Great Britain. The latter two tend to receive more students for engineering and informatics (see Table VI-8).

Table VI-8

DISTRIBUTION OF SCHOLARSHIPS IN FOUR FOREIGN COUNTRIES BY AREAS OF KNOWLEDGE - 1976

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 & SC	255	117	215	24
Other	80	57	34	6
Total	759	465	468	90

VI.4 The RHAE Program

As mentioned above, in 1987 the Federal Government decided to create a special human resources training program to cope with the need to foster training in priority areas (informatics, biotechnology, precision mechanics, fine chemicals and new materials). Called the RHAE Program, for Human Resources in Strategic Areas, it started to operated 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 content.

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 became to offer. Table VI-9 shows that about 19000 scholarships were demanded by all types of research institutions. It is noteworthy that the majority of the demand refers to non-academic institutions that, up to the moment, did not have access to the main scholarship programs. Enterprises accounted for 13.5% of the demand, especially for informatics (59%) and biotechnology (13%).

The demand by priority areas reflects the level of development of each area in Brazil. While biotechnology and informatics have already a short history of investment both in human resources and research, the other three areas are relatively new in the country. The effort made by the country in the area of informatics explains why the participation of the private sector of this area is well above the other four.

Table VI.9. Demand of Scholarships at RHAE Program by five Priority Areas and by type of Institutions - 1988-1989.

Institutions	Priority Areas										Total	
	Biotechnol.		Informat.		Prec. Mech.		New Mats.		Fine Chem.			
	n	%	n	%	n	%	n	%	n	%	n	%
Enterprises	328	5.9	1 510	23.8	273	13.3	246	8.7	216	9.6	2 573	13.5
Research	3 262	59.2	2 311	36.4	522	25.5	1 262	44.7	727	32.2	8 084	42.6
Academic	1 925	34.9	2 524	39.8	1 253	61.2	1 318	46.6	1 315	58.2	8 335	43.9
Total	5 515	100.0	6 345	100.0	2 048	100.0	2 826	100.0	2 258	100.0	18 992	100.0
% / grand total		29.0		33.4		10.8		14.9		11.9		100.0

Source: RHAE Program, Executive Secretariat.

It is worth noting that, for all areas, the demand is concentrated in domestic training (73% of all the demand) (Table VI-10) suggesting that the perception of the research institutions about the quality of domestic training is positive and that effort to implement a crash program to train Brazilians abroad will face the expectation that the training should be given in Brazil.

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	4 098	29.6	74.3	1 417	27.7	25.7	5 515	29.0
Informatics	4 401	31.7	69.4	1 944	37.9	30.6	6 345	33.4
Precision Mechanics	1 588	11.5	77.5	460	9.0	22.5	2 048	10.8
New Materials	2 016	14.5	71.3	810	15.8	28.7	2 826	14.9
Fine Chemistry	1 766	12.7	78.2	492	9.6	21.8	2 258	11.9
Total	13 869	100.0	73.0	5 123	100.0	27.0	18 992	100.0

Source: RHAE Program, Executive Secretariat.

Table 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	1 081	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	1 036	417	621	419	3 489	48.5
Row Percentage	28.5	29.7	11.9	17.8	12.0	100.0	---
Domestic	525	664	221	337	258	2 005	27.9
Foreign	471	372	196	284	161	1 484	20.6
Undergraduate Schol.	374	448	337	339	171	1 669	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)	2 074	1 774	1 069	1 466	807	7 190	100.0
Row Perc. (total)	28.8	24.7	14.9	20.4	11.2	100.0	---
Domestic	1 394	1 361	837	1 129	608	5 329	74.1
Row Perc. (domestic)	26.2	25.5	15.7	21.2	11.4	100.0	---
Foreign	680	413	232	337	199	1 861	25.9
Row Perc. (foreign)	36.5	22.2	12.5	18.1	10.7	100.0	---

Source: RHAE Program, Executive Secretariat.

VII. THE BRAZILIAN CRISIS AND COOPERATION FROM THE EEC

We have argued above that Brazil faces a crisis which has two main economic aspects. On the one hand, it is a crisis of its finance structure, where the external and internal indebtdnesses of the public sector became enmeshed with high inflation rates and a private banking sector geared only to short term operations. Although the internal side of this vicious, cumulative circle may be broken by the measures recently taken by the Brazilian Government, without a renegotiation of the Brazilian foreign debt economic recovery will not be achieved.

On the side of productive forces for development, we have argued that import substitution has exhausted its capacity to lead the industrialization of Brazil, which, from now on, must be based on technical progress and interindustrial links. Although the industrial structure inherited from the import substitution period is very integrated, it is undeveloped in the sectors which presently are the engines of technical progress (electronics, fine chemicals, precision mechanics, new materials and biotechnology). Moreover, the Brazilian economy suffers from a structural weakness in terms of scientific and technological capabilities which was deepened during the last decade.

As with the financial crisis, overcoming the defficiencies of the Brazilian industrial, scientific and technological structures is primarily a task to be undertaken internally, but where international cooperation can be an important aid.

We have shown that the international context has contributed considerably to the Brazilian crisis, as regards, for instance, the evolution of the terms of trade, flows of finance and direct investment and the processes of regional integration under way, at a time in which a world-wide technological revolution brings to the fore the weaknesses of the Brazilian industrial and technological structures.

The assumption of the following suggestions is that the EEC is willing to play a major role in changing the international constraints to Brazilian development, while, at the same time supporting the internal changes which are needed to set the country on a new path of development.

Such assumption implies that the Community is decided to change its attitude towards Brazil, which, so far, has been, at best, of "bening neglect" and, actually, of discrimination, if compared to other developing countries, such as the ACP and Mediterranean economies. In fact, the remarks here presented apply to Latin America as a region.

At a time in which the Western European countries are taking a major step in the international scene through their economic integration, it would be a serious geopolitical mistake to overlook a continental country such as Brazil, of which they already are, as the Community, the main international partner, au pair with the U.S.

On the other hand, as shown above, the economic relations of the Community with Brazil are marginal to the EEC, much below the potential offered by the Brazilian economy. Such scope stands to be substantially enlargened if the Brazilian economy resumes a stable course of growth, benefiting Brazil and the EEC.

We have also argued above for an integrated approach as regards the flows of finance, investment and trade between Brazil and the EEC. At the very least, the latter's policy-makers should take due notice of the trade-offs between such flows: under present circumstances it is impossible to increase Brazilian imports from the Community, which is highly desirable from the point of view of industrial and technological development and, at the same time, to maintain the level of payments of the external debt.

It is true that the economic actors involved in such flows are different, but it is precisely because of such difference that a coordination which goes beyond market mechanisms, based on a strategic perception of international macrodynamics and on a political view of the latter, is necessary.

If such approach is shared by the Community policy-makers, i.e. if they are willing to take the leadership in solving one of the major international economic and social problems of the present time, they could act directly through the Community policy instruments (e.g. the Lomé Convention) and, indirectly, through the policy instruments of the member-countries.

Such strategic framework is, obviously, just sketched. Within it, we can suggest some specific forms of cooperation with Brazil, based on the preceding Sections.

As regards the payment of the foreign debt, the present Brazilian Government has not put forward the terms under which it intends to negotiate the resumption of payments yet, neither is the purpose of this study to propose another scheme for solving the debt problem of LDCs.

So far the Community's approach to the debt of countries such as Brazil, has been that it is a problem of the member countries and not a problem of the Community as a group. Proposals, such as the European Guaranty Fund, put forward by Spain to reduce the debt of countries of medium-level of income were not pursued. The gist of the argument here presented is that such attitude must be changed.

Considering the constraint put by the external debt on Brazilian industrial and technological progress, the role played by several large banks of Community members as major creditors of Brazil and the role of the Community Governments in negotiations of the Paris Club, it seems that the latter, under the auspices of the EEC Council of Ministers, could set up a working group with the major private creditors to look at the debt payment from the development point of view.

The latter would start from the facts that, even with the giant trade surpluses of the recent years, the Brazilian debt has proved to be unpayable and that it is to the interest of all concerned parties, including the private banks, that Brazil expands its trade and investment operations, for which it is necessary to reconsider the debt payments. If a satisficing solution is reached the Community would have made a major contribution not only to the Brazilian development but also to other developing countries as well, proving itself capable of exerting a true international leadership.

Complementing the renegotiation of the debt, the Community could use resources from the European Development Fund and the European Development Bank to supply long-term soft loans for the changes in the productive and technological structures of Brazil — a truly restructuring operation.

As discussed above, the general perception of the effects of the EEC92 in Brazil is that, as regards trade, it will lead to a worsening of the present situation, which is already biased against Brazil. It is possible that the end of the export fiscal and credit incentives in Brazil may lead to a reduction of non-tariff barriers and countervailing duties against Brazilian exports, although by no means certain, given the rising tide of protectionism against third parties of the Community — which must be countenanced by the latter's policymakers if they want to extend the benefits of the enlargened market to developing countries such as Brazil.

Notwithstanding the importance of the reduction of the above mentioned barriers, probably the most positive action the EEC could take in terms of increasing its imports from Brazil and other Latin American countries would be to extend to the region support schemes similar to those granted to the ACP and Mediterranean countries.

Such negotiations could take place either bilaterally, e.g. between Brazil and the Community, or regionally, taking as a starting point the contacts between the Latin American Group (GRULA) and the Community's Latin America Directorate, recently created.

Eventually, some compensation to the ACP and Mediterranean countries would be required if part of their trade with the EEC was diverted to Brazil. However, part of such compensation could come from Brazil itself, both in terms of increased imports from such countries or under technical assistance for manufacturing and agricultural activities. Thus, a by-product of this new EEC policy would be to increase South-South links. If the policy were structured along regional lines, a probable outcome could be an increase in the cooperation between Latin American countries.

The change above suggested would lead the Community to a much broader international outlook in terms of relationships with developing countries, further beyond the old colonial boundaries and the immediate geographic sphere of influence. As argued above, this is the outlook compatible with the international standing of the EEC, especially after 1992.

As regard direct investment from the Community enterprises into Brazil, we have argued above that a resumption of such investments, especially of "new

money" beyond debt conversion and reinvestments, depends very much on stable and satisfactory macroeconomic conditions. Since the latter depend in turn on a proper solution of the foreign debt, we find once again the need for an integrated approach to the relations between Brazil and the EEC and the trade-off between interests on the debt and profits and dividends from other activities.

In spite of the strutural limits on investment in R&D by MNCs in countries such as Brazil, such companies could expand their expenditures on technological activities substantially, compared to their present level, inclusively strenghtening their links with the S&T system. If properly negotiated, debt conversion could be used for such purposes, to the benefit of all parties.

Moreover, some Community special programmes, such as EUREKA, RACE and ESPRIT offer a promising scope for joint ventures between Europe and Brazilian irms.

As previously remarked some large Brazilian firms are already investing in the EEC, mainly as a preemptive move against protectionism. Participation in the programmes above mentioned would provide them with important technological and entrepreneurial learning. Moreover, programmes such as EUREKA provide scope for joint ventures between medium and small-sized enterprises from Brazil and the EEC.

However, presently there are several obstacles to the establishment of such joint ventures, some of which stem from the rules governing the programmes (such as the rigid bottom-up approach in EUREKA) and others from lack of mechanisms for establishing the rapport between Brazilian and European enterprises.

Thus, in order to foster such joint ventures, it would be necessary to improve information channels between enterprises and to set up funds for financing feasibility studies of the joint ventures accessible to Brazilian and EEC enterprises.

Some steps in this direction have already been taken, such as the establishment of a EEC Information Centre in Brazil and a Business Council of

Brazilian and EEC enterprises already operating in Brazil. International agencies, such as the World Bank have indicated their willingness to study ways of financing the participation of LDCs such as Brazil in the Community programmes and other agencies, such as UNIDO and UNCSTD, manifested their interest to cooperate in this area.

At a recent seminar on the EUREKA programme ("Advanced Technologies for Developing Countries", organized by Italian Government last May) it was reported that only some projects (between 10 and 15% of the total) would presently be available for Brazilian participation, concentrated on specific areas such as vaccines, transport, energy and environment preservation. However, to use such opportunities and to broaden the scope for joint ventures the changes above sketched seem to be necessary. In order to do so, it would be convenient to establish a working group between the EEC (including the Programme authorities), the Brazilian Government and the international agencies, assuming that the Community is politically commited to such course.

We have previously identified the undevelopment of scientific and technological capabilities as one of the major structural weaknesses of the Brazilian economy. Cooperation from the EEC could play a major role in structuring such capabilities.

Such cooperation could follow two complementary approaches. The first would aim at strenghtening the basis of the scientific and technological system, by supplying the institutions which produce human resources, basic research and technical services (information, standards, etc) with the equipment and personnel they need.

This line of cooperation would probably involve the supply of equipment and personnel (the latter on a temporary basis) from the EEC countries, combining thus technical assistance with trade.

The second approach would aim at specific projects, involving not only research but also development. Priority should be given to projects related to the "new technologies" — electronics, biotechnology, new materials, fine chemicals and precision mechanics — where the Brazilian industrial structure is weakest, especially in terms of technological capability.

Therefore, this second line of cooperation would aim at involving industrial enterprises as well as academic institutions, both from Brazil an the EEC, leading to trade and investment besides technical and scientific colaboration.

The Basic Agreement between the EEC and Brazil already includes technical and scientific cooperation as one of its targets. However, the cooperation here suggested would probably require complementary instruments.

Funds lent on soft, long term conditions, but entailing a Brazilian counterpart, could be set aside for a special programme, covering the two lines of cooperation. Part of such funds could come under the form of debt-conversion.

However since the actors involved in the two lines of action would be different, such differences should receive their due attention in setting up the cooperation mechanisms. In the first case, we can assume that the Brazilian institutions already have some knowledge of their EEC counterparts and of the Community supply of equipment, so that the cooperation could operate in a decentralized form.

In the second line, mainly at the begining, more organization would probably be required, especially to establish links between Brazilian and EEC enterprises. The Community's high tech programmes previously mentioned could provide an useful institutional framework for such purpose, provided some alterations are introduced to contemplate the objective of technical and scientific colaboration with Brazilian enterprises and academic institutions.

It would probably be convenient to establish a light superstructure to oversee the cooperation, composed by Brazilian and EEC representatives, but the implementation of the programme (e.g. disbursement of funds, project evaluation etc.) could be managed by the existing institutions, so that the bureaucratic overhead could be minimal. In fact, the Brazilian S&T development agencies are fully equipped to process such a programme and the experience of other international programmes to try to develop an alternative institutional structure has been counterproductive.

More specifically, as regards the development of human resources, the

number of Brazilian students in graduate programs in Europe is quite substantial in absolute terms, although concentrated in three countries: France, England, and West Germany. Their large majority is fully supported by Brazilian Government scholarships. The number of scholarships offered by European Countries or by the EEC is marginal in relation to the total number of scholarships provided by Brazilian agencies. However, they represent an important channel to kindle interinstitutional relationships.

A mere increase in numbers of scholarships offered would not contribute, in itself, to improve the cooperation in training human resources. With the exception of the programs operated by CNPq with the French institutions, the other major source of scholarships (British Council and DAAD) face difficulties in fulfilling the small amount of scholarships offered each year. Two major reasons can account for the problems faced by existing training programs.

First, these programs are usually run by the cooperating foreign agency in a way parallel to the main scholarships programs in Brazil. They set their own independent system for applications, selection of students, and stipends. As a consequence, it becomes harder for the foreign agency to channel into their programs part of the large demand for foreign training that is directed toward the Brazilian agencies. Since the Brazilian agencies, for budgetary reasons, cannot support all the qualified applicants, a large number of qualified prospective students miss the opportunity to be trained abroad. The most successful programs are the ones that have worked with Brazilian agencies and delegated to the latter part, or all, of the process.

Secondly, it is important to note that applicants tend to select foreign institutions on the basis of their own previous personal knowledge of professors or departments abroad, or on the knowledge or recommendations of their former teachers. This has the advantage to strengthen linkages between foreign and local institutions on the one hand, but, on the other hand, it perpetuates the flow toward a limited amount of foreign institutions. The foreign agencies would have a role, presently not properly fulfilled, to disseminate better information on foreign institutions. This could lead to a more universalistic placement process, disconcentrate applications toward a broader number of institutions and countries, and enable students to make choices that would fit better their specific interests. Such a role should be

complemented with the participation of the foreign agency in the placement process: help to find the right place for the right person. Placement usually becomes a major problem if one desires to be trained at a private enterprise or at a R&D center.

With some exceptions (mainly the PADCT and RHAE programs), both Brazilian and foreign agencies have in large part faced human resources training as an individual problem. Selection is a process to choose among individuals that enter into a contest for schlarships in an area of their own interest where his/her qualification and of the host institution are the sole criteria for decision. This is perfectly acceptable in a large scholarship program. However, it does little to improve interinstitutional linkages, much less to create new ones. If scientific and technological relationships between the EEC and Brazil are to be improved, it is paramount that human resources training becomes part of a broader program. Therefore to build medium and long term joint research projects as suggested above, which would include training in the participating institutions, should be a top priority.

Therefore, to sum it up, there is substantial scope for increasing the cooperation of the EEC to Brazil. Such cooperation can have significant impacts on Brazilian industrial, technological and scientific development and benefit the Community's members in economic, commercial and financial terms. However, fulfilling such hopes depends on modifications of some of the existing mechanisms of cooperation and, above all, on a political decision of the Community to incorporate Brazil as a partner of its process of development.

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