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COUNTRY CASE STUDY SUBMITTED BY BRAZIL*

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CASE STUDY OF BRAZIL

**Submitted by the Government of Brazil for the
third session of the Ad Hoc Working Group on
the Interrelationship between Investment and
Technology Transfer - UNCTAD**

**prepared by Antonio Carlos F. Calvao, Ariel C. Garces Pares,
Arthur Oscar Guimaraes, Eduardo Viotti, Sandra Hollanda -
Planning Department of the Secretariat for Science and
Technology of the Presidency of the Republic**

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BRAZIL'S CASE STUDY

1. INFORMATION ON THE SYSTEM

1.1 General Information about Brazil

- Size: 8,511,965 km²
- Population (1990): 147.3 million
- Currency: Cruzeiro (Cr\$) US\$ 1 = Cr\$ 83.75 (30/09/90)
- GDP (1990): US\$ 406.0 billion

1.2 National Expenditures on Science and Technology (S&T)

In the 1980s, expenditures on Science and Technology oscillated around 0.7% of the Gross Domestic Product (GDP), as shown in table 1. The national effort in S&T followed the economic behavior of the Country in a decade during which Brazil fell short of its historical performance in previous decades.

National expenditures rose from a level of US\$ 2.1-2.6 billion in the 1981-84 period to US\$ 3.0-3.5 billion between 1986 and 1990 (see table 2), reaching their peak in 1987: US\$ 3.46 billion.

Table 3 shows the composition of national expenditures on Science and Technology along the decade. While slight advances were registered in the expenditures of the private sector, funding agencies and state-owned companies, the level of expenditures of the states rose significantly in 1990. Specific budget appropriations provided for in the new Federal Constitution of 1988 were responsible for that change.

Public expenses clearly prevailed as the main source of funds for scientific and technological activities. In fact, the private initiative did not play a prominent role in the scientific and technological effort, particularly in what regards the generation or creation of innovations and the maintenance of research and development activities (R&D).

TABLE 1*
NATIONAL EXPENDITURES ON S&T/GDP (1981-1990)

	GDP (billion US\$)	DNCT (billion US\$)	DNCT/GDP(%)
1981	334	2.40	0.72
1982	335	2.62	0.78
1983	324	2.12	0.65
1984	341	2.15	0.63
1985	368	2.70	0.73
1986	395	3.20	0.81
1987	410	3.46	0.84
1988	410	3.36	0.82
1989	424	3.09	0.73
1990	406	3.17	0.89

Source: Brazil. Secretariat for Science and Technology of the Presidency of the Republic (SCT)-DEPLA and CNPq-COOE

Obs.: Preliminary data. DNCT (National Science and Technology Department).

TABLE 2
NATIONAL EXPENDITURES ON S&T (1981-1990)

	DNCT (billion US\$)
1981	2.40
1982	2.62
1983	2.12
1984	2.15
1985	2.70
1986	3.20
1987	3.46
1988	3.36
1989	3.09
1990	3.17

Source: Brazil. SCT/PR - DEPLA and CNPq-COOE

The expenditures of the Union (Federal Administration) - the most significant part of all national expenditures - clearly tended downward at the outset of the decade, particularly between 1982 and 1984, rose between 1984 and 1988 and declined again in 1989 and 1990. Because of their weight, the expenditures of the Union have shaped the evolution of global national expenditures.

TABLE 3
COMPONENTS OF THE NATIONAL EXPENDITURES ON S&T/GDP
(1981-1990)

	Million US\$				
	Union States	State-Owned	Private	Funding	
		Companies	Companies	Agencies	
1981	1,310	590	220	180	90
1982	1,530	540	290	170	90
1983	1,280	410	230	140	70
1984	1,240	450	190	170	110
1985	1,700	450	300	170	80
1986	1,970	570	350	210	100
1987	2,310	470	360	210	110
1988	2,310	430	330	190	90
1989	1,940	530	330	190	90
1990	1,670	850	330	240	70

Source: Brazil. SCT/PR-DEPLA and CNPq-COOE

Obs.: Preliminary Data.

Table 4 shows the composition of federal expenditures on S&T among some of their main sectorial units and their evolution in the 1987-1990 period.

About 1/3 of the expenditures of the federal administration were channelled to development agencies charged with promoting science and technology activities. In this *sector*, special mention must be made of the National Scientific and Technological Development Council - CNPq, which is more active in the scientific realm, the Fund for Studies and Projects - FINEP, which basically operates as a bank in support of the technological development, and the University-Level Personnel Qualification Board - CAPES, which shares with CNPq the responsibility for supporting the formation of human resources.

R&D activities in livestock/agriculture and in the agro-industrial field ranked second. The military and nuclear sectors, both of which clearly tend to become relatively less important in relation to federal expenditures, ranked third and fourth, respectively. Expenditures on S&T of universities ranked fifth in what regards their own federal budgets; however, they were the principal beneficiaries of funds mobilized by federal development agencies. With a small but growing relative participation, the health sector occupied the last position.

TABLE 4
COMPOSITION OF FEDERAL EXPENDITURES ON S&T (1987-1990)

	(%) PERCENTAGES			
	1987	1988	1989	1990
Development agencies	28.89	31.49	34.71	31.64
Livestock/Agriculture/ Agro-industry	15.10	13.86	19.73	20.36
Military sector	17.75	23.58	12.74	17.75
Other sectors	10.56	11.43	10.56	10.58
Nuclear sector	18.13	10.52	9.38	9.04
Universities	6.91	5.11	8.67	7.35
Health sector	2.67	3.92	4.21	3.28

Source: Brazil. SCT/PR-DEPLA and CNPq-COOE

Obs.: Preliminary data related to Funds from the Treasury Department.

1.3 Personnel Engaged in Research and Development

In 1985, about 55,000 persons were engaged in R&D activities in Brazil, including researchers and technical/support personnel. According to a survey carried out by CNPq and CAPES, there were about 50,000 scientists (MSc and PhD) in Brazil in 1988, 35,000 of whom were masters and 15,000 doctors.

More recent estimates of the number of researchers and engineers actively engaged in R&D activities in 1990 indicate a figure of 90,000 distributed as shown in table 5.

TABLE 5
PERSONNEL ENGAGED IN R&D (1990)

Researchers	60,000
Engineers	30,000

Source: Brazil. SCT/PR-DEPLA and CNPq-COOE.

Researchers: MSc and PhD.

Engineers active in R&D; Support personnel not included.

2. LEGAL AND INSTITUTIONAL FRAMEWORK

2.1 Institutional framework

In the wake of the administrative reform carried out by the federal administration in 1990, the highest agency of the Executive Branch in charge of Science and Technology activities became a Secretariat directly linked to the Presidency of the Republic. This institutional decision was made in view of the horizontal nature of the S&T area, which must interact with all the remaining areas where the public power is active.

The task of the Science and Technology Secretariat of the Presidency of the Republic (SCT/PR) is to "plan, coordinate, supervise and control S&T and R&D activities in priority areas and to formulate and implement the computer and automation policy." These functions characterize the SCT/PR as the agency responsible for the strategic scope of the S&T policy, together with other sectors of the federal administration.

The SCT/PR is basically made up of five departments, three national research institutes, the National Scientific and Technological Development Council, the Technological Computer Center and the Fund for Studies and Projects. It also comprises two consultative and deliberative bodies: the National Science and Technology Council - CCT - and the National Computer and Automation Council - CONIN.

Through its planning functions, the CCT plays a central role in the definition and coordination of actions undertaken by the federal administration. The Council is particularly charged with studying and proposing: 1. "guidelines and objectives for the national policy in science and technology and measures aimed at harmonizing it with the remaining policies adopted by the public power"; 2. "federal plans and programs in science and technology"; 3. "the creation and improvement of tools for promoting and stimulating the scientific and technological development and for disseminating its results and making it possible for interested parties to absorb them."

The CCT is a large body comprising several sectorial agencies of the federal administration, representatives of state-level S&T systems and

members representing the scientific, technological and entrepreneurial community.

The CONIN is the highest agency in charge of defining policies in the computer area. Its functions and makeup were modified recently in tune with amendments to the Computer Law for the purpose of modernizing that law and harmonizing it with the guidelines of the Industrial and Foreign Trade Policy.

2.2 The Pluriannual Plan

The Federal Constitution provides for the five-year planning of government actions in all areas within the federal jurisdiction. This Pluriannual Plan, as it is called, must be prepared and submitted to the National Congress for approval within the first year in power of a new federal administration. It establishes the objectives, goals and budget program which will guide the actions of the federal administration during a five-year period. As a basic planning tool, the Pluriannual Plan links the Budget of the Union to commitments and strategies.

According to the Pluriannual Plan approved for the 1991-95 period, the general objective in the S&T area is to modernize the country's technical-productive base in tune with the growing strategic importance of the area for the development of the country.

The Plan is intended to define a coordinated action in the S&T area, seeking news spaces in which to act and creating tools to overcome the serious limitations faced in traditional attempts to stimulate activities in this area, in addition to expanding the range of people performing scientific and technological activities.

This is particularly important in relation to the role played by private expenses in R&D, which are considered insufficient and incompatible with the efforts to modernize the Nation. With the exhaustion of the import substitution process and in view of the technological revolution in course in the main industrialized economies, the Country must define a new development pattern based on growing quality and productivity advances in the productive sector.

In tune with this goal, the Pluriannual Plan determines that the federal administration must concentrate on defining direct mechanisms to stimulate higher investments of the private sector in R&D and on seeking ways to promote greater productive efficiency and innovating capacity.

In the field of science, the Pluriannual Plan recognizes the need to consolidate the effort to set up a national scientific base with the aim of achieving international quality standards in research activities and changing their profile, relatively favoring more applied knowledge areas.

The Plan provides for higher funds to be applied in science and technology. According to the Secretariat for Science and Technology, funds for this purpose will grow about 30% a year to be differentiatedly allocated among its programs and projects. Greater emphasis will be placed on projects aimed at promoting the technological qualification of the industry, at mastering strategic technologies, at protecting the environment, particularly in Amazonia, and at supporting research activities and the formation of human resources.

The guidelines provided for in the Pluriannual Plan are the following:

a. General Guidelines:

- to implement S&T actions which, in tune with the remaining policies of the federal administration, may contribute toward the solution of the social, regional and sectorial problems facing Brazil;
- to promote the consolidation of the Brazilian technical-scientific base, particularly by encouraging greater interaction among the several agents involved with Science and Technology activities;
- to promote the scientific and technological development without harming the environment; and
- to promote the growth and diversification of the international interchange according to the interests and needs of the Country in relation to its scientific and technological development.

b. Guidelines for the Formation of Human Resources:

- to expand and improve the formation of researchers, raising their level of qualification and competence, so as to bring the national technical-scientific base closer to international density standards of researchers per population;
- to correct the profile of the technical-scientific base, with emphasis on the differentiated expansion of applied areas, such as base Engineering and Experimental Sciences, in relation to peak technologies and Environmental Sciences;
- to ensure the real value of scholarships by preserving their links to the salaries of professors of Federal Universities, so as to attract the best potential applicants and enable them to fully and exclusively engage in their respective activities; and
- to stimulate the qualification of human resources available at research institutes and corporate R&D centers through cooperation and interchange mechanisms with Higher Teaching Institutions.

c. Guidelines for Supporting Scientific and Technological Research Activities:

- to support individual and institutional research activities with a view to achieving international excellence standards;
- to recover and update the scientific and technological infrastructure, renewing the equipment available at university laboratories, research institutes and R&D centers and ensuring the supply of essential services and materials for their operation;
- to stimulate the development of basic research activities in segments linked to areas and sectors involving new technologies with a higher potential to contribute toward the technological development; and
- to support the organization and implementation of integrated research programs, stimulating interinstitutional cooperation mechanisms and the multidisciplinary approach, so as to

provide solutions to the national problems of a social, regional or sectorial nature.

d. Guidelines for the Technological Modernization of the Productive Sector:

- to stimulate and support actions aimed at technologically updating the productive sector, reducing intraregional and interregional technological gaps, and the development of segments involved with new technologies, particularly Computer Sciences, Biotechnology, Fine Chemistry, Precision Mechanics, New Materials and the Aerospace sector, because of their dynamic effects on the rest of the productive base;
- to support projects related to research, development and introduction of products, production processes and management techniques aimed at improving the productive efficiency and the quality of goods and services, so as to bring the Brazilian competitiveness closer to the standards prevailing on the international market;
- to create means to promote a closer link between companies and universities and/or research institutes, encouraging companies to set up research and development centers; and
- to link measures aimed at promoting the technological qualification of companies to the strategy of exposing the industrial sector to the international competition in planned stages, so as to stimulate its competitiveness and ensure its position on the domestic and foreign market in the long term.

e. Guidelines for the Modernization of the S&T Policy Management:

- to establish a coordinated and effective action in the formulation and implementation of the S&T policy, in tune with the remaining policies of the federal administration;
- to adopt more selective, transparent and simplified policy tools and mechanisms, according to the general aim of creating a more competitive and efficient domestic environment;

- to improve mechanisms for following up and evaluating projects supported by the government, defining ways to ensure greater effectiveness in the attainment of results; and
- whenever possible, to seek the direct involvement of sectors that demand the results of researches in the financing of R&D projects supported by the Government.

2. Industrial and Foreign Trade Policy

In order to attain the large objectives established in the Pluriannual Plan, the Industrial and Foreign Trade Policy relies on two basic mechanisms: the Brazilian Quality and Productivity Program - PBQP - and the Industrial Competitiveness Program - PCI.

The PBQP is intended to support the Brazilian modernization effort by promoting quality and productivity, with the aim of increasing the competitiveness of goods and services produced in the Country. With this purpose in view, five basic and sectorially detailed actions will be implemented:

- i. promotion of the awareness and motivation of different sectors of the society in relation to quality and productivity;
- ii. development and dissemination of business management methods aimed at improving the quality and increasing the productivity;
- iii. qualification of human resources;
- iv. adjustment of technological services to quality and productivity standards (technical rules, quality certificates, metrology, tests and technological information); and
- v. institutional articulation.

As in other countries, action is being taken to progressively define specifications for materials and equipment according to international standards and to create a demand for peak technology sectors, promoting research projects and using the purchasing power of the State.

The PCI adopts three basic strategies to achieve the goal of promoting entrepreneurial competitiveness:

- the development of sectors that generate and disseminate the technological progress related to peak technologies;
- continuous improvement of sectors which have acquired comparative advantages or with a high exporting potential; and
- development of general efficiency and quality standards for the national industry.

The program intends to act sectorially in selected segments of industrial complexes which were subject to a diagnosis and in connection with which specific operational tools were identified. In this context, those sectors which generate and disseminate the technological progress stand out and will be favored in the identification, selection and occupation of their potential markets.

Because efficiency and competitiveness have become essential objectives, the technological qualification of Brazilian companies has become a crucial requirement for mastering mature technologies or effectively taking part in the development of emerging industries in a modern industrial environment.

3. PROFILE OF THE PERFORMANCE OF RESEARCH ACTIVITIES IN THE COUNTRY

3.1 In the federal realm

Science and Technology Secretariat of the Presidency of the Republic

R&D projects under the responsibility of the SCT/PR are carried out by its Supervising Entities and Institutes, namely:

a. National Spatial Research Institute - INPE

INPE's objective is to promote and carry out scientific research and technological development activities in the fields of spatial science, meteorology, spatial applications, spatial engineering and technology and related realms. Among the main developments registered in spatial engineering and technology, the following ones stand out: The Complete Brazilian Space Mission, aimed at designing, developing, manufacturing, launching and operating in orbit two small satellites designed to collect environmental data; and the Program of the Chinese-Brazilian Satellites for Monitoring Terrestrial Resources, which is jointly developing two medium-sized satellites for monitoring terrestrial resources with the People's Republic of China.

INPE has 1,650 employees.

b. National Technology Institute - INT

The objectives of this institution, established over 70 years ago, are to:

- develop and transfer technologies (products/processes/systems) in fields of consolidated competence, with the aim of providing solutions to technological problems identified in the Brazilian industry as a whole;

- provide specialized technical services, such as dissemination of technological information and analysis reports, opinions and certificates; and
- develop external and internal human resources through specialization courses and professional training.

The Institute has 359 employees.

c. Technological Computer Center - CTI

The institution is active in the following areas: microelectronics; software engineering; high-performance processors; and industrial automation technologies.

Its main objectives are to:

- develop technologies in microelectronics and introduce them into the productive process of new systems and equipment of the electronics industry;
- reduce the costs and improve the quality of the software production process;
- develop computer systems adjusted to several user's profiles; and
- improve the Brazilian technological competence in industrial automation.

The CTI has 222 employees.

d. National Institute for Research on Amazonia - INPA

The INPA is basically engaged in scientific studies on the physical environment and living conditions prevailing in the Amazonian region. Its guidelines are to: promote and carry out studies, scientific research and technological developments related to the natural environment and to the social-economic-cultural systems of the Amazonian Region; carry out extension activities with the aim

of applying scientific and technological knowledge and qualifying personnel to carry out research in the region.

The institute has 367 employees

e. National Scientific and Technological Development Council - CNPq

In addition to stimulating activities and disseminating results and information in science and technology, the CNPq carries out research through its ten Institutes:

- i. National Astrophysics Laboratory - LNA;
- ii. Mineral Technology Center - CETEM;
- iii. Museum of Astronomy and Related Sciences - MAST;
- iv. National Observatory - ON;
- v. Emilio Goeldi Museum of the State of Pará - MPEG;
- vi. National Synchrotron Light Laboratory - LNLS;
- vii. Pure and Applied Mathematics Institute - IMPA;
- viii. Brazilian Institute for Information in Science and Technology - IBICT
- ix. Brazilian Physics Research Center - CBPF;
- x. National Computer Sciences Laboratory - LNCC.

Other Public Institutions

a. Agriculture and Land Reform Ministry

In order to meet the research needs of the agriculture/livestock sector, the country basically relies on the Agriculture/Livestock Research Company - EMBRAPA. Organized in the form of a decentralized research system, the institution operates through 40 units scattered in various states of the Federation and employs 9,942 persons, 2,117 of whom are researchers. EMBRAPA is responsible for creating over 8,000 new agricultural and agro-industrial technologies since it was founded, in 1973.

b. Ministry of Health

In the health area, the Oswaldo Cruz Foundation - FIOCRUZ - deserves special mention. The Foundation has 1,500 employees, 750 of whom are university graduates. In 1990, FIOCRUZ had a budget of US\$ 40.3 million of a total of US\$ 55 million allocated by the federal administration to research and development activities in the health area. Its main programs comprise the development of methods for epidemiological, clinical and social control of diseases and the development of basic inputs for immunobiological products, drugs and hemoderivatives.

c. Military Ministries

Several research departments linked to the arms industry are responsible for R&D activities in the military area, in addition to the research centers of each of the three forces: the Research Institute of the Navy - IPqM; the Technological Center of the Army - CTEX; and the Technological Center of the Air Force - CTA. Basically, all R&D activities in the military area are aimed at modernizing the armamenta, nationalizing military means and preserving a swift defense capacity.

d. Secretariat for Strategical Affairs

The National Nuclear Energy Council - CNEN - is the agency in charge of developing nuclear energy applications in the Country and coordinates several research agencies in this sector. Among them, special mention must be made of the Center for Nuclear Technology Development - CDTN - and the Energy Research Institute - IPEN, which is located at the campus of the University of São Paulo. The main research lines adopted by these agencies include support to the industry of tools and precision mechanics equipment and to the medical-surgical industry, activities related to nuclear medicine, development of new materials, nuclear security and a program aimed at enabling the country to fully

master the nuclear technology for peaceful purposes. IPEN has 513 researchers and its budget in 1990 amounted to about US\$ 50.0 million.

3.2 Productive Sector

As mentioned in item 1.2 of this work, R&D activities in the productive sector fell short of what would be desirable, considering the stage of development of the Brazilian productive sector. The technological qualification of the industry was based on a process of "technological learning," which emphasized less complex development activities and neglected research efforts, which could have produced nobler results. Essentially structured around the import substitution model, the Brazilian industry mostly relied on the absorption of technologies generated outside the Country to grow, developing and adapting them to the national productive environment.

In certain niches of the Brazilian industry, this effort produced some considerable advances which provided their respective goods and services with international levels of competitiveness. In some cases, it even led to successful native innovations and involved endogenous research efforts of the national technical-scientific base.

Because of their outstanding role in connection with the infrastructure of the Country and in the production of basic inputs and considering their size and active participation in the productive system, there is no doubt that state-owned companies are influential and dynamic agents in Brazil's innovation process.

In 1990, projects assigned to and carried out by the research centers of the main state-owned companies accounted for about 11% of all national expenditures on R&D.

In this context, the Leopoldo A. Miguez de Mello Research and Development Center of PETROBRÁS - CENPES - deserves special mention. Relying on the work of about 650 researchers, CENPES is the principal body

in charge of research in petroleum exploitation, production and industrialization. Its contributions ensure an outstanding international position to PETROBRÁS in the offshore production of petroleum.

The Electric Energy Research Center - CEPEL - of ELETROBRÁS develops and applies technologies for the production of electric equipment and systems. CEPEL employs 300 persons, 141 of whom are researchers. In 1990, a budget of US\$ 33.5 million was allocated to the Center. It is mainly active in the development and application of technologies for the production of electric equipment and systems and provides services to companies that generate and distribute electric power, equipment manufacturers, engineering companies, consulting firms and electricity users.

The Research and Development Center of TELEBRÁS- CPqD - is the main source of technologies for national telecommunications companies. Created in the mid-1970s, in 1987 it had concluded 461 contracts for transferring technologies in the fields of electronic switching, digital transmission, optical communications, satellite communications and data communications. Of a total of 1,556 employees, 684 are researchers. Its budget in 1990 amounted to US\$ 72.6 million.

3.3 Research in the Universities

In Brazil, research activities are predominantly carried out at the so-called higher education institutions - IES, particularly in public universities, with greater participation of the federal units. On the other hand, private universities offer more postgraduate courses. Altogether, there are 1,477 postgraduate courses available in the Country, involving 48,415 students and 27,121 professors (permanent, visiting and guest professors included), 20,633 of whom are doctors (see table 6).

Regarding the actual scientific production, traditional indicators such as the number of articles and publications highlight the importance of the research carried out at the universities by field of study (see table 7).

TABLE 6
DISTRIBUTION OF POSTGRADUATE STUDENTS BY FIELD OF
STUDY (1990)

Engineering	14.6%
Exact and Biological Sciences	21.0%
Health	15.1%
Agro-Industrial Sciences	7.7%
Human/Social Sciences and Literature	41.6%

Source: Brazil. Ministry of Education/CAPES

TABLE 7
POSTGRADUATE COURSES 1990. SCIENTIFIC PRODUCTION:
PUBLISHED TITLES BY VEHICLE AND FIELD OF STUDY

Areas	National			International		
	Papers	Chapters	Books	Papers	Chapters	Books
Exact and Biological Sciences	1,860	63	60	2,227	204	31
Engineering	312	29	49	222	17	5
Health	2,567	611	137	738	39	14
Agro-Industrial Sciences	1,446	73	52	216	19	10
Social/Human Sciences and Literature	4,218	850	911	700	216	118
Total	10,403	1,626	1,209	4,103	495	178

Source: Brazil. Ministry of Education/CAPES

3.4 Participation of the States in the Generation of R&D Activities in the Country

During the 1960s and the 1970s, the governments of more developed states set up technological centers to support the productive sector.

The creation of the Technological Research Institute -IPT - in 1899 was the landmark for the establishment of these centers. Regarded as the largest state-level research center in the Country, the IPT is presently engaged

in 785 projects in the following areas: civil construction, sanitation, agro-industry, energy generation, metal-mechanics and computer sciences. It employs 1,013 university-level and 1,056 medium-level technicians. In 1990, its budget amounted to about US\$ 57.0 million.

Among other outstanding examples of such centers, the following ones can be cited:

- Science and Technology Foundation - CIENTEC, set up by the government of the state of Rio Grande do Sul. It has 130 university-level and 320 medium-level technicians. In 1990, it had a budget of US\$ 14.1 million. It is mainly active in the following areas: mineral coal - by-products and industrial applications, agro-industry, civil construction, sanitation and environment;
- Technological Center Foundation of Minas Gerais - CETEC, an agency linked to the government of the state of Minas Gerais. It has 521 university-level and 128 medium-level technicians. In 1990, its budget amounted to roughly US\$ 2.10 million. It is mainly active in the following areas: mining, metallurgy, natural resources, civil construction, energy and food;
- Research and Development Center - CEPED, linked to the government of the state of Bahia. It employs 182 university-level and 164 medium-level technicians. Its budget in 1990 amounted to about US\$ 5.70 million. It is mainly active in the following areas: natural and mineral resources, agro-industry, petrochemical catalysis, energy, housing and environment;
- Industrial Technology Foundation - NUTEC, subordinated to the government of the state of Ceará. It employs 171 university-level and 86 medium-level technicians. Its budget in 1990 totalled about US\$ 1.40 million. It is mainly active in the following areas: water and mineral resources, electrotechniques and civil construction; and
- Technological Institute of the State of Pernambuco - ITEP. It has 93 university-level and 85 medium-level technicians. In 1990, its budget was about US\$ 4.70 million. It is mainly active in the following areas: agro-industry, natural and mineral resources and civil construction.

4. MAIN LINES TO STIMULATE THE SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

Brazil has a significant set of financing lines for research and development. The Secretariat for Science and Technology is responsible for allocating the most significant part of the funds derived from them.

There are other ministries and secretariats of the federal administration which are almost exclusively provided with funds for directly performing R&D activities in their own laboratories. The Ministry of Economics, Finance and Planning is an exception to that rule, as it provides specific credit lines for S&T activities through some of its financial agencies.

Important advances were also registered in other states of the federation that are beginning to consolidate actions to stimulate their S&T activities.

Table 8 provides a picture of the ~~main~~ official financing lines adopted in the 1980-90 period.

4.1 Financing Lines for Academic Research

The specific lines mentioned hereunder are mainly intended to support university-level teaching and research institutions and are not reimbursable. They are the only sources of funds for basic research and are managed by the Secretariat for Science and Technology and its agencies: the National Scientific and Technological Development Council - CNPq - and the Fund for Studies and Projects - FINEP.

CNPq's Financial Support to Research

CNPq's financial support to research constitutes a traditional financing line for means and tools aimed at promoting research activities in S&T Institutes and Universities in many different areas.

TABLE 8
PRINCIPAL LINES FOR STIMULATING S&T ACTIVITIES (1980-1990)

	US\$ million				
	FNDCT	FINEP	FINANCIAL AID	PADCT	TOTAL
1980	169.3	103.8	17.2	-	273.1
1981	112.7	106.4	16.4	-	219.1
1982	103.6	91.3	27.1	-	194.9
1983	60.6	76.5	21.2	-	137.1
1984	41.3	51.1	16.6	1.3	96
1985	45.3	54	30.8	10.4	131.1
1986	90.8	52.2	38.2	32.3	207.6
1987	73.2	163.6	38.4	26.8	290.6
1988	85.4	95.3	37.1	34.5	249.7
1989	68.1	45.7	26.6	28.7	171.2
1990	47.8	23.6	52	44.4	160.2

Source: Brazil. SCT/PR-DEPLA and CNPq-DAD-COOE.

Obs.: Scholarships excluded.

Through mechanisms such as the "Individual Support to Research" and the "Integrated Support to Research," the CNPq finances:

- the purchase of material goods and services required by research projects;
- means for the national and international interchange of researchers
 - Visiting Researchers - among research institutions;
- congresses, short courses and seminars;
- the participation of researchers in scientific events abroad and in Brazil;
- the acquisition, recovery and expansion of scientific collections;
- the publication of magazines and books of a relevant scientific and technological interest;
- scholarships linked to research projects.

National Scientific and Technological Development Fund - FNDCT

Created in 1971, the National Scientific and Technological Development Fund - FNDCT - is supervised by the National Science and

Technology Council- CCT - and operated by FINEP. The FNDCT is aimed at stimulating research programs and projects carried out by Research and Postgraduate Centers of Universities and Technological Research Institutes. The Fund is mainly intended to finance research programs and projects, including the purchase of research equipment or tools and lab facilities in priority areas thus defined by the CCT.

Scientific and Technological Development Support Program - PADCT

The Scientific and Technological Development Support Program - PADCT - was created in 1984 as a complementary tool of the Brazilian development policy in the S&T area. Created as a result of a loan agreement between the Brazilian Government and the World Bank (IDB), the PADCT financed projects amounting to US\$ 180 million during its first phase (1984-91) and has US\$ 300 million available for the 1991-95 period.

The PADCT aims at expanding and consolidating the national technical-scientific competence in universities, research centers and companies. The Program funds larger integrated projects that can have a significant impact on strategic areas for the Country's development. In addition, the PADCT is intended to strengthen the infrastructure of essential services for the scientific and technological development.

The Program is active in the following areas: Chemistry and Chemical Engineering; Geosciences and Mineral Technology; Biotechnology; Tooling; Education in Science; Information in S&T; Planning and Management in S&T; Basic Industrial Technology; Equipment Maintenance; Provision of Essential Inputs; New Materials; and Environmental Sciences.

The program was conceived in a particularly original way in relation to previous Brazilian experiences: it is operated through edicts and managed by the Secretariat for Science and Technology, in cooperation with CNPq, FINEP and CAPES (University-Level Personnel Qualification Board of the Ministry of Education).

The edicts indicate priorities for each of the twelve subprograms. These priorities are defined by Technical Groups made up of outstanding members of the scientific and technological community and representatives of relevant government agencies. Following a competition arrangement, the projects are simultaneously judged by committees composed of "peers," that is, specialists from each area in question.

4.2 Financing Lines for the Technological Development of Companies

The Industrial and Foreign Trade Policy relies on two particularly important strategical tools for expanding the participation of productive companies in the national technological development effort: the provision of significantly higher funds and fiscal incentives for technological qualification projects.

With this purpose in view, measures have been taken to strengthen the Fund for Studies and Projects - FINEP, the main Brazilian agency in charge of financing the technological development of companies. In addition, the official banks have been encouraged to support S&T activities. At the other end of the line, a bill is about to be approved by the National Congress which provides for the granting of fiscal incentives to industrial or agro-industrial companies engaged in technological qualification projects.

Support to the Technological Development of National Companies - ADTEN

In addition to managing the funds provided by the FNDCT, FINEP operates its own financing lines, among which the Support to the Technological Development of National Companies - ADTEN - is the most important one.

The ADTEN is the principal means used by FINEP to fund projects for the development or improvement of productive technologies and processes adopted by national companies.

These projects can be carried out by technical teams of the companies themselves or through national engineering and consulting firms, universities and research institutions in general.

The funds are available for projects in the following areas: basic engineering with technological development; implementation of research and development centers; development of products and processes; purchase and absorption of technologies, in Brazil or abroad; quality and management; and innovative trading.

Other Lines Provided by Banks

The National Economic and Social Development Bank - BNDES - the main source of funds for the Country's industrialization process, has redefined its priorities and is now concentrated on modernizing the Brazilian economy. With this strategy in view, the BNDES was instructed to provide different financial services for technological qualification purposes, such as financing to companies or shareholders; suretyship and guaranties; guarantee of subscription of securities and stock-sharing.

The role played by the BNDES in the technological qualification of companies is organized in three specific lines:

- Technological Qualification Subprogram, aimed at funding corporate expenses with qualification efforts and the development of products and processes;
- Quality and Productivity Subprogram, aimed at assisting efforts for stepping up the productivity and improving quality, including modern management and product organization techniques and the implementation of automated and integrated production processes; and
- Subprogram for the Capitalization of Technological Companies, with the aim of supporting companies in the start-up, expansion and development phases.

Banco do Brasil (Bank of Brazil) and regional development banks such as Banco do Nordeste (Northeast Region Bank) and Banco da Amazonia (Bank of Amazonia) have also increased their efforts to promote the technological qualification of Brazilian companies.

4.3 How the States of the Federation Stimulate S&T

In the chapter dealing with science and technology, the new Brazilian Constitution of 1988 provides that the states of the federation and the federal district can allocate part of their budget revenue to promote teaching and research activities in science and technology.

Today, 21 of the 27 units of the Federation have included provisions in their state constitutions for the purpose of applying a certain percentage of their revenue in S&T activities. These percentages range from 0.3 to 3.0%.

However, these provisions have not been fully regulated and institutionalized in most of the states.

With the adoption of this mechanism for the appropriation of revenues and its effective implementation, the states have begun to play an important role in the funding of S&T activities.

5. FORMATION OF HUMAN RESOURCES

The CNPq and CAPES are the main agencies in charge of supporting the formation of human resources. Both of them carry out various programs aimed at training and forming human resources for scientific and technological activities. They also meet the demand of private companies through the Program for the Formation of Human Resources for Technological Development (RHAE).

This line of operation is selectively directed to priority areas in the technological development field, with the aim of improving the quality and performance of the national productive system. Its role is to support institutional qualification programs both in Universities and research companies and centers.

Regarding postgraduate courses, the CNPq and CAPES were jointly responsible for the approval of 21,234 scholarships to MSc and PhD courses in 1989. The latter played a more prominent role in this regard, as it provided about 60% of all those scholarships.

The 1980s were characterized by substantial efforts to increase the number of scholarships to postgraduate studies. In the 1980-89 period, the average growth rate was about 8.6% a year, but as from 1985 that rate hit the mark of 14.6%. This rise allowed the offer of scholarships to postgraduate studies to practically double at the end of that period.

TABLE 9
SCHOLARSHIPS FOR POSTGRADUATE STUDIES IN BRAZIL-
Secretariat for Science and Technology and Ministry of Education (1980,
1985 and 1989)

Institution	MSc			PhD		
	1980	1985	1989	1980	1985	1989
Capes	6,220	5,702	9,985	887	1,830	2,959
CNPq	2,463	3,957	6,601	485	819	1,689
Total	8,683	9,659	16,586	1,372	2,649	4,648

Source: BRAZIL. Secretariat for Science and Technology-CNPq/APJ/COOE and Ministry of Education/CAPES.

This expansion, however, was differentiated and sought to favor the formation of doctors, a fundamental step toward the career of any researcher. For this reason, the number of scholarships to PhD courses tripled in relation to 1980.

During the 1980s, there was a relatively larger increase in the number of scholarships to postgraduate courses in relation to the total number of enrolled students, particularly in what regards PhD courses. While in 1980 the offer of scholarships met 25.13% of the demand for MSc courses and 31.05% of the demand for PhD courses, in 1989 those figures rose to 37.22% and 62.94%, respectively.

TABLE 10
STUDENTES ENROLLED IN POSTGRADUATE COURSES AND
NUMBER OF SCHOLARSHIPS (1980 and 1989)

Item	Master's Degree (M)		Doctor's Degree (D)		(M)+(D)	
	1980	1989(*)	1980	1989(*)	1980	1989(*)
STUDENTS	34,550	44,557	4,419	7,385	38,969	51,942
SCHOLARSHIPS	8,683	16,586	1,372	4,648	10,055	21,234
SCHOLARSH/STUDENT	25.13	37.22	31.05	62.94	25.80	40.88

Source: Brazil. Secretariat for Science and Technology - CNPq/APJ/COOE and Ministry of Education/CAPES

Obs.: (*) Figure estimated according to the average growth rate of the number of enrolled students, based on a historical series consolidated in the 1976-86 period.

Presently, the mean age of graduate doctors in Brazil is about 40 years, which means that the potential return of investments in qualification was significantly reduced. This profile indicates the need for improving the present postgraduate model and making better use of scientific initiation tools, with the main purpose of revealing new talents and shortening the average formation period.

Although they are restricted to the CNPq, the figures presented below confirm the significant increase registered in the number of scholarships to studies and research granted in different areas, particularly since 1985. The

average growth rate in the 1985-90 period was 19.3% a year for scholarships in Brazil and 23.2% a year for scholarships abroad.

The growth pattern of the program of scholarships abroad affected the three main knowledge areas in a differentiated way. The relative participation of Exact, Earth and Engineering Sciences dropped sharply from 63.2% in 1980 to 39.8% in 1990, while that of Biological Sciences grew from 19.4% to 29.2% over the same period. However, areas related to Human and Social areas were the ones that grew most in the 80s, as they rose from 17.4% in 1980 to 31.0% in 1990.

The set of countries to which Brazilian holders of scholarships usually go remained practically unaltered during the decade. Although the range of options was expanded in recent years, the United States of America, Great Britain and France absorbed 77% of all scholarship holders in 1989, against 87.5% in 1980.

Presently, it is estimated that Brazil has about 400 thousand engineers, or 6 engineers for each group of 100 inhabitants of the economically active population, against a rate of 15 in France and 25 in Japan. The offer of scholarships to advanced qualification studies in areas related to Exact, Earth and Engineering Sciences, which are intended to improve the qualification of an already small contingent of technicians, is very small in relation to other areas. Scholarships to advanced qualification courses in the three main areas are distributed as follows: 11.5% for Exact, Earth and Engineering Sciences, 59.2% for Biological Sciences, and 29.3% for Human and Social Sciences.

Regarding the regional distribution of scholarships provided by CNPq in Brazil, it clearly concentrates on the Southeast Region, where most academic and research centers of the Country are located. In 1988, this region alone offered 66.2% of all MSc courses and 86% of all PhD courses, which were favored with 69.5% of all scholarships to MSc studies and 90.5% of those to PhD courses. The states of São Paulo and Rio de Janeiro kept the largest share of these scholarships.

The solution to the imbalance caused by the concentration of postgraduate courses, of the number of researchers and of their level of

training lies in the offer of better material conditions for more updated and competitive research activities and in the provision of training opportunities to less favored regions.

By Antonio Carlos F. Galvão, Ariel C. Garces Pares, Arthur Oscar Guimarães, Eduardo Baumgratz Viotti, Sandra Hollanda.

Planning Department of the Secretariat for Science and Technology of the Presidency of the Republic.