

# DECENTRALIZATION OF SCIENCE & TECHNOLOGY POLICIES

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Science and technology are increasingly becoming the basic components of national plans that seek to promote economic development, reduce social inequalities and preserve the environment. Scientific development is no longer limited to an academic accumulation of knowledge about the laws of nature or to attempts of finding solutions for specific problems, but is now rather characterized by the ability to create and use knowledge as a new form of *capital*, enabling every nation to preserve its autonomy and competitiveness in an equilibrium among peers. Solutions for problems of employment, education, housing, health, sanitation, demographic growth and migration are, on the whole, associated with innovations in products and services – which, in turn, are dependant upon research.

Furthermore, modern knowledge society is becoming more and more dynamic, swiftly changing its lines of development – derived from scientific efforts that produce five thousand new publications per day, generating knowledge that is renewed every five or six years and made immediately available through various new means of communication. The number of people who work in the scientific area is growing so rapidly that 90% of everyone who has ever dedicated him or herself to science is active today. Establishing and updating a national science & technology system can no longer be the episodic effort of 50 years ago: today it is a major, continuous and growing requirement whereby production, transfer and utilization of knowledge become the flagship of social and economic development.

If we take the problem of unemployment as an example, we'll see that the labor market has undergone extreme changes when compared with the previous *industrial society*. Among these changes, one may mention *distance working*, which currently accounts for one million jobs in Germany and has led to considerable gains in productivity and competitiveness. Everything seems to indicate that distance working will proliferate rapidly. In developed countries, the number of people employed in the primary sector as a percentage of the total workforce has decreased from 50% to 3% in the 20<sup>th</sup> century. It is estimated that farm and manufacturing jobs in Germany, which until recently accounted for 48% and 30%, respectively, of all jobs, will plunge to 3% and 20% by 2010, while the share of the service sector increases from 10% to 20% and that of information technology from 10% to 55%.

These changes imply a substantial modification of the labor force, namely, the need for ever-higher levels of education and training – a challenge that, in developing countries, is compounded by demographic growth. Growing each year by 86 million people, the world's population will leap from the current 6 billion to 10 billion people in 2050. This increase, concentrated in Asia, Africa and Latin America, is accompanied by expanding urban immigration, which creates even an greater demand for jobs – not to mention housing, sanitation, transportation, water & energy, environmental protection, health services and education.

Developed countries tend more and more to decentralize their capability of producing knowledge and human resources, enabling all of their regions to benefit.

Since the 1980s, France has been decentralizing its science, technology & innovation system, which may now be described as an ongoing process of delegation to research institutes, to agencies responsible for large programs, to the various regions and to OECD programs.

In England and the United States, with sound structures that do indeed plan, fund, assess and follow-up R&D activities nationwide, the various regions have already attained such a level of development that the problem of centralization or decentralization is now off the point.

In Germany, out of a total budget of 80 billion marks for science & technology, the public sector participates with roughly 34 billion marks – 19 billion from the federal government and 15 billion from the sixteen states. In addition, approxi-

mately 350 universities and colleges (*Hochschule*) and 5 organizations<sup>1</sup> provide support for 140 research institutes and almost 300 *divisions, workgroups and nuclei* in the states.

In addition to assuring that each region is self-reliant in research, innovation and competitiveness, the German infrastructure also attracts a host of subsidiaries of multinational companies that each year invest approximately 7 billion marks in R&D, creating nearly 35 thousand jobs (Bundsbericht Forschung, 1996).

In contrast, in Brazil, more than two thirds of the science & technology system is concentrated in the southeast region (See Table 1).

This situation tends to deteriorate, given the difficulty of less favored regions in competing for federal resources, notoriously scarce and uncertain, and in preparing new scientists and placing them in productive activities. This is further aggravated by the local scarcity of qualified, fully-trained professors and researchers.

Today, only 400 of Brazil's 24,000 professors with doctorate live and work in the north and west central regions, which moreover offer only 25 of the nation's 616 postgraduate doctoral programs (See Table 2).

As a factor that contributes to further impair the already poor local training of researchers, new professionals who are trained at other centers of the country or abroad tend not to return to their places of origin, where they lack conditions to fully and continuously exert productive scientific activities.

Thus, less favored regions are prevented from engaging in the kind of applied research that would promote their own development and, given their paltry technological infrastructure and the lack of qualified human resources, are likewise prevented from transferring and incorporating knowledge generated at other centers. In order to reverse this situation, a national science & technology policy must enable all the country's regions to generate new knowledge, incorporate it into their productive system and prepare a workforce qualified to discharge this function. Such an effort must be prolonged and persistent, creating conditions to face up to the various challenges as they emerge, instead of merely improvising emergency measures when a challenge pops up.

1. Max Plank Gesellschaft, Fraunhofer Gesellschaft, Helmholtz Zentren, Blauen List and federal institutes.

Brazil has developed a weapon to support decentralization, namely, a system of research funding foundations and agencies that was established in 24 states and in the Federal District by the 1989 constitutions<sup>2</sup>. The first of these, FAPESP, came into existence with the 1947 state Constitution of São Paulo: it was established in 1960 and granted its first research aid in 1962. It was followed by FAPERGS in Rio Grande do Sul in 1964, FAPERJ in Rio de Janeiro in 1980, and FAPEMIG in Minas Gerais in 1985<sup>3</sup>. In some states (Sergipe, Tocantins, São Paulo, Santa Catarina and Minas Gerais), their revenues derive from deductions in budget quotas to be transferred to municipal governments. For FAPEPE, deductions are made in at least 9 kinds of taxes, in addition to the education vouchers, transfers from agreements and credit operations<sup>4</sup>. Fourteen states<sup>5</sup> and the Federal District have determined that resources must be transferred in twelfth parts; seven states<sup>6</sup> and the Federal District have limited administrative expenses to 5% of the budget, while one state, Maranhão, limited these expenses to 10%. Seven states<sup>7</sup> provide guarantees that the foundation or agency is the sole manager of resources (See Table 3).

Both the institutional nature and the relationships established by the state constitutions of 1989 vary greatly from state to state (See Exhibit A).

By 1998, 22 states and the Federal District had already created their foundations or agencies (See Exhibit B).

The sources of income also vary widely from state to state (See Exhibit C).

2. Amapá and Roraima attained state status in 1990.
3. In December 1948, the city government of Campo Grande, Paraíba, created the Foundation for the Development of Science and Technics, funded by revenues from a municipal “seal of education and culture” to be deposited monthly in a special account of the Banco do Nordeste.
4. Until 1985, in FAPESP’s case, when in addition to deducting the amounts transferred to city governments, the quotas were never transferred on time and were thus corroded by inflation, the funding was, on average, 0.27% and not 0.5%, as specified in the 1947 state constitution. At present, when computing the 1% established by the 1989 constitution, the 25% quota of state turnover tax transferred to city governments is deducted.
5. Ceará, Pernambuco, Alagoas, Sergipe, Bahia, Rio de Janeiro, São Paulo, Paraná, Santa Catarina, Rio Grande do Sul, Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais.
6. Acre, Piauí, Pernambuco, Alagoas, São Paulo, Mato Grosso, Minas Gerais.
7. Ceará, Pará, Bahia, Rio de Janeiro, São Paulo, Mato Grosso.

According to Ferreira Filho (1993), total resources to be transferred in 1991 by 22 states and the Federal District should have amounted to \$317 million (\$247 million if São Paulo is excluded). In 1992, however, aside from São Paulo, the six foundations and two agencies in operation received only \$21.3 million, or roughly 16.9% of what should have been their revenues in that period.

Still not including São Paulo, the other states continued transferring resources very irregularly, both in terms of amounts and in their distribution along the year. Table 4 shows six foundations that have been operating regularly over the last six years. Excluding FAPESP, which on average received 99% of promised funding, the average for the other five foundations was less than 50%, the lowest ratio being that of FAPERJ, 14.6%. (See Table 4). In the three previous years (1991, 1992 and 1993), the average was 90.7% at FAPESP, 24.5% at FAPERGS, 8.9% at FAPERJ, 25.4% at FAPAMIG and 24% at FAPEPE.

Although data on the other eighteen research funding foundations and agencies don't share a homogeneous time frame, they allow us to conclude with reasonable certainty that of the approximately 240 million *reais* allocated each year from 1997 to 1999 only some 60 million were actually transferred – a significant share of which already earmarked for salaries in some cases.

Over the last years, however, several changes have been made. In Maranhão, FAPEMA was extinguished. In Bahia, a constitutional amendment caused the demise of the still incipient FAPBA and reassigned its functions to CADCT. Paraíba created its research funding agency 1992 only to extinguish it in 1996, and in 1997 launched FAPESQPB, with head office in Campina Grande, and FAPEP, headquartered in João Pessoa. The state of Paraná created the Fundo Paraná, funded by 2% of state tax revenues as determined by the state constitution (a third of which is transferred to the Fundação Araucária, whose structure is inspired in the research funding foundation model). In some states, a large share of resources is set aside for wages and salaries. Mato Grosso do Sul reduced its funding from 1.5% to 1%. The 3% rate in effect at FAPEMIG was reduced to 0.5% in 1995, increasing to 0.7% in 1996, 0.8% in 1997 and reaching 1% in 1998.

Considerable efforts have been made to substantiate the research funding agencies and to improve the relationship between these agencies and the federal system in order to strengthen and decentralize the national research and development system.

FORPESQ (National Forum of Research Funding Foundations, Agencies and Bureaus), envisioned in 1996, is drafting a “National Plan to Strengthen Research Funding Agencies” analyzing their contribution to “promote the harmonious development of a national science & technology policy that strives to converge the actions of three government spheres (federal, state and local) and of representative segments of society (corporate and political sectors), so as to assure that science and technology, by means of an effective National Innovation System, are at the epicenter of sustainable policies for the country’s economic and social development” (FORPESQ, 1999).

According to this plan, it is essential not to lose sight of the fundamental function of the research funding agencies, namely, to help prepare and provide sustenance for researchers, locally creating at least a modicum of conditions for them to do research with efficiency and continuity. Those place where these minimum conditions are not met and enhanced will find it difficult to promote research supportive of innovation and development.

FAPESP, which began its activities in 1962, concentrated for over two decades on scholarships for the education of researchers and on individual research grants. Only in the last fifteen years, when the state’s scientific capability had already been considerably expanded and diversified, did the foundation introduce new models to aid research and development<sup>8</sup>, but even then without discarding the system of

8. As of 1985, in addition to some previous “special projects” (Biochemistry/FAPESP, Microelectronics Laboratory, Programmed Action in Underground Waters, Reservoir Typology, Biotherium Center, Meteorological Radar, ANSP Network), FAPESP implemented the team theme projects program to support interinstitutional and interdisciplinary research. The program includes: restoration of research infrastructure in universities and institutes; establishment of centers of research, innovation and dissemination of knowledge; research in public policies; technological innovation for small companies; technological innovation partnerships between universities and private companies; training of technical personnel with high school or university diplomas; support for education (prosciences and public schools); support to young researchers; electronic library (access to foreign periodicals); “scielo” (electronic dissemination of Brazilian scientific production); study of the genome of the *xylella fastidiosa* (variegated chlorosis in oranges), the *xanthomonas citri* (citrus canker), the sugar cane and human cancer (in cooperation with the Ludwig Research Institute); incentives for scientific journalism; and the Biodiversity Institute (Biota-FAPESP).

individual grants and of scholarships in Brazil and abroad (which totaled, respectively, 17985, 24357 and 1843 over the last five years). Each of the new programs is based on an interdisciplinary network of researchers spread out in various educational centers, for which the first 20 years of scholarships and individual grants based exclusively on scientific merit were crucial.

Other research funding agencies, in addition to providing scholarships and individual research grants, are also developing new programs – in many cases with federal support via CNPQ, CAPES and FINEP. In 1991, FAPERGS had already begun a program to promote cooperation between universities and private companies, with 94 projects approved by 1995. FAPEPI, in Piauí, launched a program for the development of technologies suitable to realities of the region. In 1995, FACEPE introduced a program to technologically enable local companies. In Paraíba, FAPESQ now includes among its programs various cooperative R&D projects with the primary, secondary and tertiary sectors of production. FAPERJ, FAPEMIG and CADCT, among others, participate in FINEP's program of cooperative networks (RECOPE). At PADCT, the participation of the research funding agencies is studied on a case-by-case basis. In all, numerous agreements with CNPQ and CAPES provide scholarships and promote a host of projects (Prociência, Nordeste, Softex, Prossiga, Cetem, PhD na Empresa, and others).

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Brazil, in short, already has instruments to enable the decentralization of the country's science & technology policy in support of innovation and development, fulfilling the needs and opportunities of each region. The research funding foundations and agencies are an essential component of this policy, as long as their autonomy, the regular transference of resources<sup>9</sup> and their management by competent researchers are assured. Their basic function is to provide support for research

9. In some cases, the percentages established by the constitution may seem excessive, resulting in allocations in excess of the state's ability to provide for or use adequately. In such cases, the constitution should be revised, adjusting the amounts to local circumstances, as Minas Gerais has done.

and postgraduate studies by means of scholarships and stipends for research and scientific interchange in all areas of human knowledge, regardless of their immediate applicability, based solely on the qualifications of the applicant and on the merit and feasibility of the proposal. In time, this will establish an infrastructure of research and human resources sufficiently updated and diversified to help the country's developmental efforts.

The federal government must formulate and develop a science & technology policy that, to quote words from FORPESQ, "strives to converge the actions of three government spheres (federal, state and local) and of representative segments of society (corporate and political sectors). In no small measure, the success of such a policy depends on how state foundations and agencies fulfill their part in promoting local development. With no loss to their autonomy, the integration with actions and programs of the federal government should be intensified, both in terms of implementation and of financing (at least when local resources are insufficient to fund priority actions in support of scientific and technological development).

The time taken to pass from research results to innovation to competitive gains is getting shorter and shorter. The renewal of knowledge and priorities is happening at a faster and faster pace. The infrastructure that supports exact and experimental sciences seems to live increasingly on borrowed time and with higher and higher costs, while the education of scientists and the evolution of research centers continue to be slow processes, with no leaps and bounds.

Countries that hope to attain a high level of economic and social development will have to continually face up to these challenges with medium- and long-term perspectives. The speed with which research results are incorporated into product and service innovations may fluctuate. But whether to respond to the spontaneous demands of the production system *as they occur* or to encourage new demands, research centers will have to keep themselves permanently active, updated and diversified both in the production of new knowledge and in the education of new researchers.

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## Tables and Exhibits

Indicator	Southeast's share of total (%)
Postgraduate courses, master's degree	64
Postgraduate courses, doctor's degree	80
Postgraduate professors	71
Scholarships, master's degree (CAPES)	63
Scholarships, doctor's degree (CAPES)	80
Scholarships, doctor's degree (CNPQ)	86
CNPQ resources (financial aid)	63
PADCT II resources	66
FINEP: number of operations without return	65
FINEP: investment in operations without return	71
PRONEX: no. of projects approved in 1996/97	79
Number of research groups	69
Number of companies with R&D activities	80

TABLE 2 Regional distribution of college professors with doctorate and total number of postgraduate doctoral courses (%)				
	Professors with doctorate		Postgraduate doctoral programs	
Region	Public schools	Private schools	Public schools	Private schools
North	1.8	0.7	1.4	—
Northeast	12.7	2.2	5.9	5.6
Southeast	66.1	74.3	80.2	77.8
South	14.2	20.1	9.8	16.6
West Central	5.2	2.7	2.7	—
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

TABLE 3 Minimum percentage of revenues earmarked for science & technology funding foundations or agencies, according to the 1989 constitutions of 22 states and the Federal District <sup>1</sup>	
Percentage	State
0.3	Pará <sup>2</sup>
0.5	Maranhão, Sergipe, Tocantins
1.0	Pernambuco, Piauí, São Paulo
1.5	Mato Grosso do Sul <sup>3</sup> , Rio Grande do Sul, Bahia
2.0	Alagoas, Ceará, Mato Grosso, Paraná, Santa Catarina, Rio de Janeiro <sup>4</sup>
2.5	Espírito Santo, Paraíba
3.0	Amazonas, Goiás, Minas Gerais <sup>5</sup>

1. The constitutions of the states of Acre, Rondônia and Rio Grande do Norte did not define a percentage.  
 2. Established as 0.4%.  
 3. 0.5% in the first year, 1% in the second, 1.5% from the third year on.  
 4. 1.5% in 1990 and 2% from 1991 on. In the first five years, one third of the funds must be transferred to FATEC (Fund to Support Technological Development).  
 5. In 1995, it was changed to 1%, but the percentage granted were 0.5% in 1995, 0.7% in 1996, 0.8% in 1997 and 1% form 1998 on.

EXHIBIT A Institutional models and relationships for foundations and agencies, as established in the state constitutions	
Institutional model	State
Public foundation	Alagoas, Ceará, Maranhão <sup>1</sup> , Piauí, Pernambuco, Rio de Janeiro, São Paulo, Rio Grande do Sul, Minas Gerais, Rondônia, Mato Grosso, Federal District, Santa Catarina, Bahia <sup>2</sup>
Agency conjoined with the State Science & Technology Board	Rio Grande do Norte, Goiás, Mato Grosso do Sul, Sergipe
Agency conjoined with the State Science & Technology Board and one foundation	Amazonas, Paraíba, Pará
Only State Science & Technology Board	Tocantins
Specific agency	Paraná <sup>3</sup> , Pará <sup>4</sup>
Undefined	Espírito Santo
<p>1. Foundation extinguished in 1998.</p> <p>2. Activities performed by FAPBA were recently reassigned to CADCT.</p> <p>3. In 1998, Fundo Paraná was established and Fundação Araucária and Paraná Tecnologia foundation were authorized.</p> <p>4. In 1995, the State Science and Technology Agency was established with 0.4% of the state's budget revenues.</p>	

EXHIBIT B	
Year that foundation or agency was established <sup>1</sup>	
Year	State
1960	São Paulo
1964	Rio Grande do Sul
1980	Rio de Janeiro
1985	Minas Gerais
1990	Pernambuco, Goiás
1991	Mato Grosso do Sul, Maranhão <sup>2</sup> , Ceará <sup>3</sup>
1992	Bahia
1993	Paraíba
1994	Alagoas, Acre, Piauí, Federal District
1995	Sergipe
1996	Mato Grosso, Pará, Espírito Santo, Rio Grande do Norte
1997	Santa Catarina, Amapá
1998	Paraná

1. No information available for Amazonas, Rondônia and Tocantins.
2. Extinguished in 1998.
3. Statutes were only ratified in 1994.
4. In 1994, article 287 of the state constitution was annulled, and CADCT took over FAPBA's responsibilities.

EXHIBIT C	
Sources of potential income as established by state constitutions	
Source	State
Tax revenues	Amazonas, Bahia, Goiás, Mato Grosso, Rio de Janeiro, São Paulo, Sergipe, Tocantins, Mato Grosso do Sul, Paraná
Budgetary revenues	Federal District, Espírito Santo, Pará, Piauí, Paraíba, Pernambuco, Rio Grande do Norte
Current revenues	Maranhão, Minas Gerais, Santa Catarina
Income from taxes	Ceará
Net income from taxes	Rio Grande do Sul
Estimated revenues	Alagoas
Undefined	Acre, Rondônia

**TABLE 4**  
Resources allocated and transferred to research funding foundations  
between 1994 and 1999 by five states and the Federal District (in reais x1000)

State	Resources	1994	1995	1996	1997	1998	1999	Total
São Paulo	\$ allocated	77,037	141,732	181,573	184,598	190,280	204,943	983,163
	\$ transferred	77,037	139,985	178,650	187,271	188,204	197,596	968,743
	ratio (%)	100	98.7	98.4	101.4	98.9	96.4	99.0 <sup>1</sup>
Minas Gerais	\$ allocated	90,049	23,405	42,500	50,838	55,587	55,567	317,945
	\$ transferred	5,560	13,438	35,497	28,833	33,773	16,000 <sup>3</sup>	133,101
	ratio (%)	6.2	57.4	83.6	56.7	60.8	28.8	48.9
Rio de Janeiro <sup>4</sup>	\$ allocated	15,842	79,716	92,667	208,547	247,032	152,366	796,170
	\$ transferred	3,402	6,223	11,245	15,168	12,026	36,415	84,479
	ratio (%)	21.5	7.8	12.1	7.3	4.9	23.9	12.9
Rio Grande do Sul <sup>5</sup>	\$ allocated	24,463	40,034	45,977	46,948	52,771	n.a.	210,193 <sup>8</sup>
	\$ transferred	5,121	5,071	10,500	10,717	13,644	n.a.	45,053
	ratio (%)	20.9	12.7	22.8	22.8	25.9	—	21.0
Pernambuco <sup>6</sup>	\$ allocated	6,872	17,000	11,349	10,948	10,728	11,000 <sup>9</sup>	66,897
	\$ transferred	1,425	1,700	2,625	3,135	2,187	907	11,979
	ratio (%)	20.7	10.0	23.1	28.6	20.4	8.2	18.5
Federal District <sup>7</sup>	\$ allocated	9,782	9,155	10,325	8,267	17,753	20,864	76,146
	\$ transferred	9,528	4,158	1,921	4,692	3,777	909	24,985
	ratio (%)	97.4	45.4	18.6	56.8%	21.3	4.3%	40.6

1. Average of annual percentages.
2. Percentage altered in 1995. See note 5, Table 3.
3. Until December 23, 1999.
4. In addition to transfers from the state, it obtained resources from the federal government and from its own sources of income. These are not included in the table and totaled, from 1994 to 1998, 32,655,000 *reais*.
5. As in note 4, totaling 15,364,000 *reais*.
6. As in note 4, totaling 7,489,000 *reais*.
7. As in note 4, totaling 6,080 *reais*.
8. Averages from 1995 to 1998.
9. Estimate based on the three previous years.