Innovation Policy in Brazil at a crossroads: institutional hysteresis and the need of coordination

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Abstract

The paper discusses the recent developments in the institutional framework that supports the financing of innovation in Brazil. The analysis develops a review of the main institutional changes faced by the innovation policy in Brazil during the last decade, emphasizing the role of key innovation policy institutions, the financial instruments mobilized and the mechanisms of coordination available to increase the effectiveness of that policy. A tendency to a "institutional hysteresis" is stressed, with many actions often being more oriented to the strengthening of the different agencies in the institutional framework of the policies than to the effective needs of the productive sectors involved with innovative efforts. A critical assessment of those instruments is developed, signalizing some adjustments that could be made to enhance the effectiveness of the support. Specifically, the main challenge for the governance of the Brazilian innovation policy seems to be a better coordination of policies and not only the creation of new policies.

Keywords:
Brazil; research policy; innovation policy; innovation financing

Introduction

Considering a broader definition of a National System of Innovation (Edquist, 2004), the innovation policy might be seen as a conjunction of scientific and technological policies with the industrial policy. In this perspective, science and technology policies should be implemented with the objective of providing incentives for innovation and scientific and technological research in order to strengthen the competitiveness of the productive basis and the long-tem dynamism of NSI. A systemic view of innovation underscores the need of sustainable institutional basis and of an appropriate funding to innovative efforts (Hollingsworth, 2000), as well as of innovative networks and training institutions able to integrate complementary competences and to provide qualified human resources.

This articulation is still more relevant in the context of structural heterogeneity - perceived at the productive, social and regional levels - a critical aspect of the Brazilian innovation system (Cassiolato e Lastres, 2008; Erber, 2010).. In this context, the State historically has performed a critical role for the formation of a scientific and technological infrastructure as well as for the industrialization of the country. Until the 90s, the S&T policy in Brazil consisted in a set of actions aimed to built and consolidate an infrastructure for scientific research (Bagattolli,, 2008; Corder, 2006). Sectoral policies more focused were

limited to the support and protection of the local computer industry. From the 90s, there was a reversal of S&T policy, seeking to provide integration with the industrial policy. This trend involves the implementation of technological programs with target focus and the allocation of financial resources towards the development of industrial sectors that amplify knowledge and technological spill-over effects (Canêdo-Pinheiro, 2010; Britto, 2010). Since then, we can observe the dissemination of programs that try to direct the public funding to innovative companies and to the formation of cooperation networks between enterprises and research institutes and universities. In the last decade, the main challenged has been the design of an Innovation Policy that induces the innovation at the productive system and contributes to the reduction of the structural heterogeneity at those levels.

In fact, during the last decade Brazil has faced a positive evolution of several indicators related to the improvement of scientific and technological efforts (Cruz e Chaimovich, 2010; Avellar e Oliveira, 2009). These efforts are reflected in the increasing number of scientific researchers, in the growth of R&D expenses and in the number of post-graduated scholarships, as well as in indicators of scientific publications and, more modestly, patents[1]. However, despite the growth of the scientific production in absolute terms in recent years, which is articulated with relevant improvements in the institutional framework of the Brazilian National System of Innovation (NSI), it appears that R&D investments are still low in Brazil, particularly due to the restrict private investment[2].

The low levels of investments in innovative activities - whether in basic and applied research, researchers' skills and formal R&D – also indicate that industrial firms rarely tend to cooperate and that industry-university relationships are still weak. As a consequence of this pattern, the volume of public resources directed to the funding of innovation in the private sector tends to be limited in favor of the prioritization of university and research centers, causing a low absorption of skilled human resources by the productive sector (Balbachevsky e

[1] At the scientific scene, Brazil published 26.806 scientific articles in 2008, with an impressive growth over the last ten years (12.2% on an average annual basis between 1998 and 2008) representing 1.6% of world scientific articles in 2008, more than the Netherlands, for example. Scientific progress is above average in the fields of photonics, materials science, biotechnology, agronomy and veterinary medicine, physics, astronomy and space sciences, microbiology and plant and animal sciences

[2] Business expenditure on R&D (BERD) is still limited (0.5% of GDP in 2008). There are also success stories of Brazilian companies such as Embraer, Petrobras, Vale, WEG and Natura. Brazilian companies have world-class knowledge in agriculture, forestry, and deep sea oil. Brazil hosts 5% of the world's arable land, with an agricultural success based not solely on preferable location but also on a science base which has remarkably increased productivity. Particularly, sugarcane production is heavily researched, and there are numerous projects on bio ethanol. Brazil is already the only industrialized country which generates close to half of its energy from renewable sources.

Botelho, 2011). In this context, satisfactory results have been obtained in terms of scientific publications, but few results have been generated in terms of patents[3].

Science and technology policies have been implemented with the objective of providing incentives for innovation and scientific and technological research in order to reduce the technological gap faced by Brazilian NIS. This evolution has been reflected both in the expansion of resources, as in the scope of the programs. Throughout this evolution, a systemic view of innovation tends to be progressively disseminated, underscoring the need of an appropriate funding to innovative efforts, as well as of innovative networks and training institutions able to provide qualified human resources. Considering these trends, the paper tries to discuss recent developments in the institutional framework that supports the financing of innovation in Brazil. Two aspects could be mentioned to reinforce the importance of the analysis. The first could be related to the restricted private investments of the Brazilian firms in innovative activities, mainly R&D. In fact, in 2010, preliminary estimations show that the private sector had invested an amount of approximately R$ 21 billion in R&D, which corresponds to only 47% of the total expenditures of the Brazilian economy in those activities. Additionally, there are evidences that the investments of the private sector in innovative activities tend to be strongly based on its own funds, reflecting a scope still limited of the instruments mobilized to stimulate innovative efforts at the level of the industrial policy (De Negri e Kubota, 2008; Vieira, 2008).

The analysis is developed in the six following sections. The fist section develops a review of the main institutional changes faced by the innovation policy in Brazil during the last decade, emphasizing the role of key innovation policy institutions and the mechanisms of coordination available to increase the effectiveness of that policy. The second section discuss how the financing of innovation is approached in the general framework of industrial and S&T policies, considering the new instruments introduced since the approval of the Law of Innovation, the objectives defined by the broader framework of the industrial policy – the called Productive Development Policy (PDP) - and the orientations defined at the level of the Program of Accelerated Growth in Science, Technology and Innovation (“PAC da Ciência”). The third section discusses the evolution of the Sectorial Funds and the mobilization of financial resources to support innovation activities. The fourth section discusses the scope of the funding programs and amount of economic grants to support innovative activities implemented by the two main funding agencies in Brazil - FINEP and BNDES. The fifth

[3] Despite the limited amount of patents per million of the population, the country is increasingly involved in patent development in waste management, water pollution control and renewable energy.

section presents some data collected by the Brazilian Innovation Survey (PINTEC) conducted by IBGE about the use of financial instruments by innovative firms in Brazil. Finally, a conclusive section presents a critical assessment of the instruments deployed, signalizing some adjustments that could be made to enhance the effectiveness of the support.

1. Innovation Policy in Brazil: recent developments and key actors

The systematic funding of the scientific infrastructure in Brazil began in 1951 with the creation of two national agencies, the National Research Council, CNPq – now called the National Council for Scientific and Technological Development – and CAPES (Coordination for the Improvement of Higher Education Personnel), which has the responsibility to coordinate the programs of postgraduate education. The system was consolidated in the late 1960s, 70s and 80s in the period of military rule - despite significant conflicts between the government and the scientific community - with the inauguration of FINEP, Brazil's innovation agency, and the creation of FUNTEC, later FNDCT, the Brazilian national fund for science and technology. Until the '90s, the S&T policy in Brazil was focused on the build of an infrastructure for research activities, mainly performed at the academic sphere. More specific sectoral actions were limited to the computer industry through the "Lei de Informática" ("Computer Law"), with other innovative private efforts being rarely covered. From the 1990s, there was a reversal of S&T policy, seeking a greater integration with industrial policy, including the creation of training programs for technology development and the targeting of resources towards specific industrial sectors.

Some relevant events occurred before the transition to the new century, consolidating the current institutional basis of the S&T policy in Brazil[4]. The broader focus of the innovation policy was validated by the Second National Conference on Science, Technology and Innovation that occurred in 2001 and a general framework of this policy was detailed by the national Innovation, Technology and Trade Policy (PITCE) adopted in 2003, the first step

[4] Among these events, you can highlight: (a) the implementation of the "Program for the Support of the Industrial Technological Capability"(PACTI) in 1992, the first experience of resource mobilization to support S&T activities in a more systematic way; (2) the beginning of venture capital funds structuring through the "Capitalization Program of Technology Based Companies"(CONTEC), established in 1991 and administered by BNDES, (3) the adequacy of intellectual property rights, with the promulgation of the Brazilian Intellectual Property Law in 1996; (4) the implementation of the "Projeto Inovar" (Innovation Project - Development of an Institutional Framework for the Promotion of Venture Capital Investments in Technology-based Companies in Brazil), established by FINEP in 2000; (5) the creation of a set of Sectorial Funds administered by FINEP to support innovation in 1999, mobilizing complementary resources to promote knowledge generation and technological transfer in strategic areas.

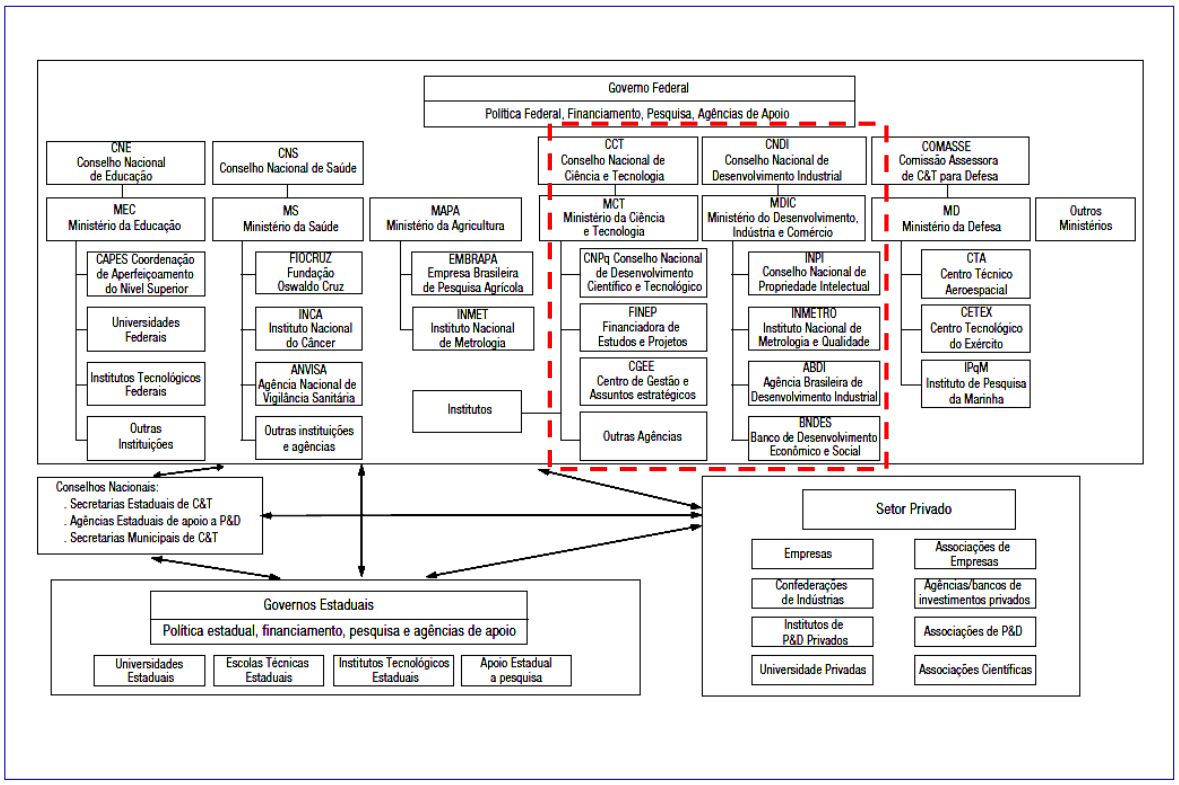
taken by Luis Inácio Lula da Silva's government in terms of a general framework of innovation policy. This policy conceives innovation from a systemic perspective, emphasizing the importance of interactions between the productive sector and academic sphere. It was based on three main dimensions: horizontal lines of action; strategic options to improve competitiveness and strategic activities that lead to the future (biotechnology; nanotechnology and biomass). Despite the relevance of the objectives, some criticisms can be made to the implementation of this policy. Among these critics, we can mention the difficulties to define its guidelines, reflecting some coordination problems that hindered its implementation, and the lack of a more detailed establishment of specific goals and measures.

Articulated to the general framework of the PICTE, a number of policies and regulations had been put in place to strengthen Brazil's science and innovation potential. The Innovation Law (2004) was designed to strengthen the university–industry research relationships, promoting the shared use of science and technology infrastructure by research institutions and firms, allowing direct government grants for innovation in firms and stimulating the mobility of researchers within the S&T system. The transfer of university knowledge to companies would be achieved mainly by means of the obligatory creation of Technological Innovation Nuclei (TIN) at universities and by the release of laboratories and equipment to be shared between science and technology institutions (STI) and companies. Furthermore, for the first time in the country, the public resources could be transferred as non-refundable funds for enterprises, sharing the costs and risks of innovative activities. The enactment of this law thus permitted the creation of the Economic Subsidy Program, created in 2006 and coordinated by FINEP, which provides resources for research and development (R&D) activities performed by industrial firms.

Law 11.196 was enacted in 2005 to reinforce advances of the Innovation Law. It was replaced in 2007 by Law 11.487, which became known as the "Good Law". This Law expanded the incentives for investments in innovative activities, authorizing the automatic use of fiscal benefits for companies that invest in R&D, without many formal requests. The special tax regime and the fiscal incentives for companies created by the Good Law stipulate, among others: deductions from income tax and social contributions on net profits from expenses on R&D (between 60% and 100%); reductions in the tax on industrial products for purchasing machines and equipment for R&D (50%); economic subsidies for scholarships of researchers in companies; an exemption from the Contribution for Intervention in the Economic Domain (CIDE) carried to payments of patent deposits. It also includes funding for firms who hire employees with Masters Degrees and PhDs.

Around the half of the last decade the institutional set-up of agencies engaged with the implementation of the innovation policy in Brazil comprised different actors, illustrated by Figure 1, in which the nucleolus of this set-up has been marked by the red underline letter. The key innovation policy institution is the Ministry of Science and Technology (MCT), led by its innovation financial agency FINEP (Financiadora de Estudos e Projetos). Its basic research agency is the National Council for Scientific and Technological Development (CNPq) and it also has its own network of Public Research Organizations (PROs). Graduate education financing policy is carried by CAPES, an agency of the Ministry of Education (MEC). The Ministry of Development, Industry and Foreign Trade (MDIC) is responsible for the general definition and coordination of Brazil's industrial policy. MDIC has under its purview other key innovation agency, the Brazilian National Economic and Social Development Bank (BNDES). The mobilization of BNDES as a more effective funding source for technological development and industrial R&D constitutes the main recent changes of the institutional framework of the Brazilian innovation policy. MDIC also has its own structure of agencies involved with the support of innovation, including the National Metrology Institute (INMETRO) and the National Industrial Property Institute (INPI). The estimated budget of MCT and other federal state agencies involved with innovation policy measures for the period between 2007 and 2010 reached R$ 41,2 billions (approximately US$ 24,8 billion at an exchange rate of the end of 2010)

Figure 1 - Institutional basis of the innovation policy in Brazil



Besides the policies and programs initiated in the beginning of the 2000s, the creation of two new government entities might be stressed. The Brazilian Agency for Industrial Development (ABDI), tied to the Ministry of Development, Industry and Foreign Trade (MDIC), was founded in 2004 with the mission of promoting Brazilian industrial and technological development by increasing competitiveness and innovation. The other entity is the Center for Management and Strategic Studies (CGEE), which promotes and conducts studies and prospective research in S&T and its relations with productive sectors.

Apart from the entities linked to MCT and MDIC there are also several other ministries that coordinate science budgets, most notably the Ministry of Agriculture and its research institution, EMBRAPA (Brazilian Agricultural Research Company). We can also mention the importance of the Oswaldo Cruz Foundation (Fiocruz), a medical and biological research institute linked to the Ministry of Health, as well as some research institutes linked to the Ministry of Defense, such as CTA (Aerospace Technical Centre), CETEX (Technological Centre of the Army) and IPqM (Research Institute of the Navy).

The federative states also play a significant role in S&T system in many places, including the financing of innovation through decentralized agencies. According to the 1988 Constitution, each federative state might structure a science funding agency, following the experience of the state of São Paulo. In fact, the São Paulo Foundation for Research Support (FAPESP) remains a key player of Brazilian S&T system, with a budget comparable to that of

CNPq. Among the federative states, some public foundations that support research also fulfill the role of financing innovation in some niches and specific areas, often in partnership with FINEP. Although the development banks owned by federative states had been virtually extinct during the 90s, some regions still have active development agencies. Among the funding agencies with a relevant role in the regional field we can mention the BRDE (Regional Development Bank of Southern), BNB (Bank of Northeast) and the Bank of Amazonia (BASA). These banks usually operates through the transfer of funds from BNDES,

Despite the structure of the national innovation governance system is relatively young, this structure is also pretty complex, requiring the built of specific instances of coordination. Originally, a high-level of coordination of the innovation policy was in the hands of the MCT, informed by the orientations defined by the National Science and Technology Council (CCT). The CCT is composed by 13 representatives of the federal government, 8 representatives of the productive sector and users and 6 representatives of national entities representative of the teaching, research and S&T sectors. This figure changes in 2005 with the establishment the National Council of Industrial Development (CNDI), from which ABDI operates as the Executive Secretary, under the sphere of the MDIC. The industrial policy priorities and programs set by these bodies have an innovation policy component, which is coupled to the infrastructure and strategic goals set by MCT for the country's innovation policy.

The creation of a complex institutional setup, with several instances of overlapping, increases the risk of a “predatory” competition between the different agencies for the conduct of innovation policy, reinforcing the need to coordinate their actions and, in order to pursuit a more rational distribution of resources and incentives, through the definition of priorities and responsibilities. This rivalry has been extended to the policy design level with an institutional competition between the Ministry of Science and Technology (MCT) and the Ministry of Industrial Development and Foreign Trade (MDIC). For example, over the past couple of years, MDIC through its industrial policy agency, the Brazilian Agency for Industrial Development (ABDI) sought to design an innovation policy for the information technology (IT) sector, including software, an area historically under the purview of the MCT. Further, as ABDI sought to establish a high-level governance oversight council for monitoring the PDP, the MCT strived to revive the advisory, presidential Science and Technology Council (CCT). To reduce these problems, we can observe an attempt to create advisory, oversight and orientation committees at different policy and programmatic levels. The Directive Council of the National Fund for Scientific and Technological Development (FNDCT), for example, has changed in 2007, to include, apart from the MCT, representatives of the ministries MDIC,

MEC, Planning, Defense and Finance; the presidents of FINEP, CNPq, Embrapa and BNDES; three representatives of the business sector, three representatives of the scientific and technological community and a representative from workers in the science and technology (S&T) area. A Coordinating Committee of the Federal Sector Funds was also established in the second half of 2009. In 2009, a Permanent Innovation Law Monitoring Committee was also established, formed by representatives of the ministries MCT, MDIC, Finance-MF, Education-MEC and Planning and Budget-MPOG. The joint Executive Committee of the regional associations of FAPs (Confap) and the Committee of the Federative State S&T Secretaries (Consecti) operate since 2006, being oriented to the shape of innovation policy, particularly in regard to its decentralization aspects and dimensions.

Despite these efforts, the superposition of actions adopted by the different institutions responsible for the implementation of innovation policy in Brazil still remains as one of the main characteristics of this institutional design, making difficult the effective integration of that policy with the objectives of industrial and S&T policies. As a result, a tendency to a "institutional hysteresis" might be stressed, with many actions often being more oriented to the strengthening of the different agencies in the institutional framework of the policies than to the effective needs of the productive sectors involved with innovative efforts. At the same time, a bias towards strictly traditional innovations can be identified, prioritizing the support to research and development, in detriment of other important innovative activities, thus ignoring (or neglecting) the heterogeneity of the production structure, which entails very distinct capabilities. Regarding innovative links, a focus strictly based on the partnerships between enterprises and scientific and technological institutions makes difficult the integration of other agents participating in the innovation process. The built of innovative networks mobilizing different actors with complementary competences in a systematic way has rarely been contemplated by the innovation policy, reflecting the persistence of an analytical framework still based on variants of the linear model of innovation. According to this view, the diffusion of technological innovation among the productive system tends to be based on the "transference" of technologies and skills form the S&T infrastructure, mainly from universities, to the industrial sector, making use of different channels (research contracts, recruitment of skilled personnel, provision of technological services, etc) and mobilizing different agents and entities (spin-offs firms, technological parks, incubators, technology transfer centers, etc.). Despite some evidences that this view is changing and that the policy makers have sought to incorporate a broader concept of the innovative process, as

indicated by the recent structuring of Sibratec and more flexible financing instruments for innovation, it still guides the general formulation of innovation policy in Brazil.

2. Innovation Policy: the impact of new instruments and the articulation with the industrial policy

In the last decade, four federal laws have provided tax incentives for business R&D (Table 1). Altogether, taxes waived in 2008 corresponded to US$ 3.643 billion, or 37% of business R&D expenditure. The 2005 law on tax incentives for business R&D (Law 11196/05) constitutes an improvement on previous legislation, simplifying the formalities required to benefit from these measures. Although the 1991 law on tax incentives for information technology R&D (Law 8248/91) is used intensely by firms in the IT sector, non-IT companies use Law 11196/05 to a limited degree. An important criticism by the business sector of this regime of incentives and subsidies is that there is an over-emphasis on the IT sector because of Law 8248/91. This regime is comparable in size to that of OECD countries but, in fact, few sectors are entitled to benefit from it. The difficulty comes from the fact that the IT incentive law actually represents an internal equalization mechanism to compensate for non-R&D incentives offered to IT companies to encourage them to locate in the tax-free region around Manaus. Once the IT incentives are set aside, the incentives generated by subsidies regime correspond to just 13% of business expenditure on R&D.

Table 1 - R&D tax laws and subsidies for business R&D in Brazil, 1991-2005

Focus of law	Year of adoption	Reference	PPP US$	Type of advantage
Tax incentive				
Tax incentives for the IT sector	1991	Law 8248/91	2 236.4	Tax incentives for IT sectors
Tax incentives for business R&D	2005	Law 11196/05	1 085.0	Tax incentives for all sectors
Subsidy				
Subsidies for business R&D in the form of government loans	2002	Law 10332/02	62.9	Interest rate equalization
Subsidies for business R&D in the form of government loans	2002	Industrial Technology Development Plan (PDTI)	34.8	Other subsidy
Subsidies for business R&D	2004	Law 10973/04	224.1	General subsidy
Total				
Total (Incentives + subsidies)			3 643.3	
Business expenditure on R&D			9 946.3	
Share of incentives and subsidies in business expenditure on R&D			37%	

Source: IEDI (2010) *Desafios da Inovação - Incentivos para Inovação: O que Falta ao Brasil*

An update of the impact of tax breaks for the period 2002-2009 is presented in Table 2. There was an increase of over 500% in the value of this renunciation, explained mainly by the values associated with the Computer Law. In 2009, the figures related to this renunciation amounted to over U$$ 2 billion. In the recent period (2006-2009) there was an increase in

incentives tied to the Law of Good, which reach a maximum in 2007. The tax breaks tied to incentives for imports of research equipments by CNPq and to the support of the computer industry in Manaus region also increased since 2006. An evaluation of the impacts of the Good Law over the spending on R&D is presented in Table 3. According to these data, the fiscal renunciation arising from investments in R&D Tax Incentive increased from R$ 229 million in 2006 to R$ 1.383 million in 2009. These benefits were associated with investments in R&D that growth form R$ 2.191 million in 2006 to R$ 8.332 million in 2009.

Table 2 - Impacts of Fiscal Incentives on Innovation

		Laws						
Anos	Currency rate (real/ US$)	Imports of research equipments by CNPq (8.010/90)	Imports taxes exemption or reduction (8.032/90)	Law in support of the computer industry (Lei de informática) (8.248/91 e 10.176/01)	Support to technological upgrade of industry and agricultural setctor (8.661/93 e 9.532/97)	Support to the computer industry in Zona Franca region (8.387/91)	Reduction of taxes to innovative activities (Lei do Bem) (11.196/05)	Total
2002	2,92	38.280	2.230	250.807	5.209	26.566		323.092
2003	3,08	49.386	2.665	312.432	6.390	31.880		402.753
2004	2,93	53.296	3.906	319.423	12.686	30.586		419.897
2005	2,43	74.997	4.017	534.243	14.503	41.810		669.571
2006	2,18	84.212	1.745	935.835	47.210	48.912	102.820	1.220.734
2007	1,95	111.543	2.940	1.414.416	5.301	41.893	434.493	2.010.587
2008	1,83	99.419	2.564	1.008.447	1.384	85.343	139.165	1.336.323
2009	2,00	125.961	2.994	1.636.519	7.189	95.836	157.073	2.025.573

Source: MCT

Table 3 - Impacts of the Good Law over the spending on R&D

Fiscal renunciation arising from investments in R&D Tax Incentive (R$ million)						Enterprises Investments in R&D (R$ million)		
Year	CSLL (9%)	IR (25%)	IPI Reduction	IR Payments abroad	Total Renounce	Capital	Costing	Total Investment
2006	60	165	0	4	229	389	1.803	2.191
2007	226	628	0,3	29	884	558	4.580	5.138
2008	402	1.118	0,3	62	1.582	889	7.915	8.804
2009 (*)	356	990	0,2	36	1.383	217	8.114	8.332

Source: MCT

The use of other traditional instruments to incentive innovation is still limited in Brazil. In addition to tax incentives, government purchasing power through procurement is recurrently used in many countries to foster innovation, especially in defense and health related industries. This type of support for industrial R&D is very limited in Brazil even in defense and health spending. Despite the search for an increased in the local content of the purchases made by state-owned enterprises, mainly by Petrobras, the mobilization of these acquisitions to encourage the intensification of innovative processes is still limited, being concentrated on the deep-water petroleum exploitation. Despite the law on innovation of 2004 includes articles designed to foster the mobilization of the government procurement, the government has come under pressure from representatives of industry to adopt a more pro-active attitude in this direction, and some measures are recently announced to improve these stimulus.

In developed countries other important incentive to innovation is provided by the presence of a well-structured venture capital industry. This industry is still limited in Brazil, but has grown substantially since the macroeconomic stabilization in the mid-1990s. The National Bank for Economic and Social Development (BNDES) has been active in this area since 1995, whereas relevant government initiatives date back to 1999. In 2000, the Ministry of Science and Technology launched an initiative called Inovar, led by the Brazilian Innovation Agency (FINEP), a federal agency with some investment bank-like attributes. The market responded well to this initiative and several venture forums were subsequently organized to present companies to potential investors. A change in legislation in 2006 had substantially reduced the tax burden on revenue from venture funds for foreign investors. However, most investment in venture funds tends to target ‘non-technology-based’ industries. A 2003 report concluded that 86% of venture operations in Brazil targeted these nontechnology sector industries.

In order do broader the focus of the industrial policy, the Productive Development Policy (PDP) was launched in 2008 with the objective of sustaining the process of economic growth, increasing investment and economic growth rates (see Figure 2). The main challenges

are the expansion of supply capacity in the country, preserving the robustness of the balance of payments, raising the innovation capacity and strengthening micro and small enterprises. Four priorities were established to be achieved by 2010: the increase of investment rate, the expansion of Brazilian exports in world trade, the increase of R&D expenditures and the increase in the number of SME exporters. This policy established 25 priority sectors and three major programs to support these sectors - Programs to strengthen competitiveness, Mobilization programs in strategic areas and Programs to consolidate and expand the leadership of Brazilian companies.

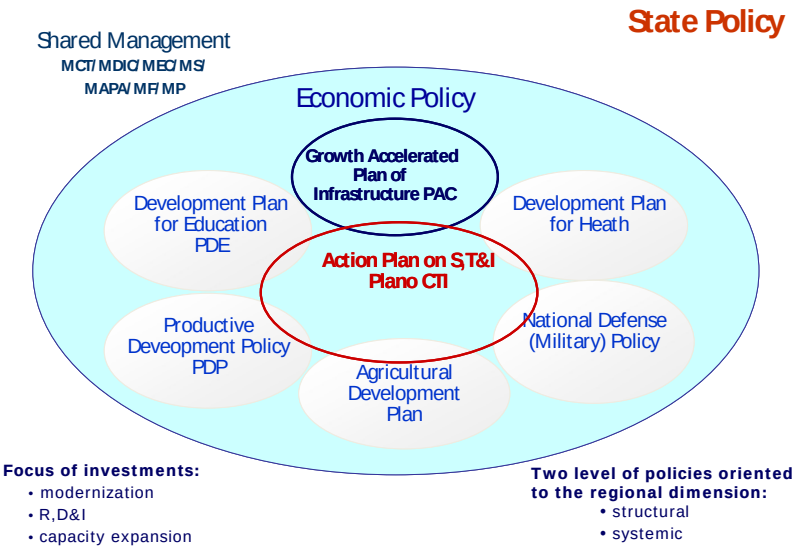
Figure 2 – The targets of the Industrial Policy –PDP

The new industrial policy includes spending targets and tax breaks for key sectors like IT, biotechnology and energy as well as plans to increase international trade from 1.18 per cent in 2007 to 1.25 per cent by 2010, and in particular high tech exports. Targets also include boosting the number of micro and small exporter firms. One of the main objectives embodied in the national industrial policy (PDP) document, although not explicit, is to raise the innovation capacity of the productive sector. In fact, in the document it is not clear what is meant by innovation capacity and no indicators are offered in the policy document to measure the achievement of the objective. The main goal set is to raise private business research and development (R&D) expenditures to 0.65% of gross domestic product (GDP) by 2010, over 0.51% of GDP in 2005. In addition, the accessory objective set is to double the number of deposits in Brazil by Brazilian enterprises of intellectual property rights (IPR) and triple patent deposits abroad.

Connected to the targets of industrial policy, the Growth Acceleration Plan for Science, Technology and Innovation (GAP for STI) was launched in 2007 with actions to be

carried out and objectives to be reached between 2007 and 2010. The objective of the plan is to articulate five policies and programs (Growth Acceleration Plan and Infrastructure, PITCE, Agricultural Development Policy, Health Development Policy and Education Development Policy) that will establish economic policy and economic growth in the country (see Figure 3). The GAP for STI might be seen as a part of the wider PAC growth program, sets out a R$ 41 billion (US$ 20 billion) program of investments until 2010. The Plan also advances in grouping most of the federal initiatives in S&T in a single document, allowing a better understanding and monitoring of the federal S&T system. Its goals include expanding investments in R&D from 1.02% of Gross Domestic Product (GDP), in 2006, to 1.5% in 2010, with an expansion of private expenses to 0.65%.

Figure 3 - The Action Plan 2007-2010 for Science, Technology and Innovation for National Development – Articulation with other Plans



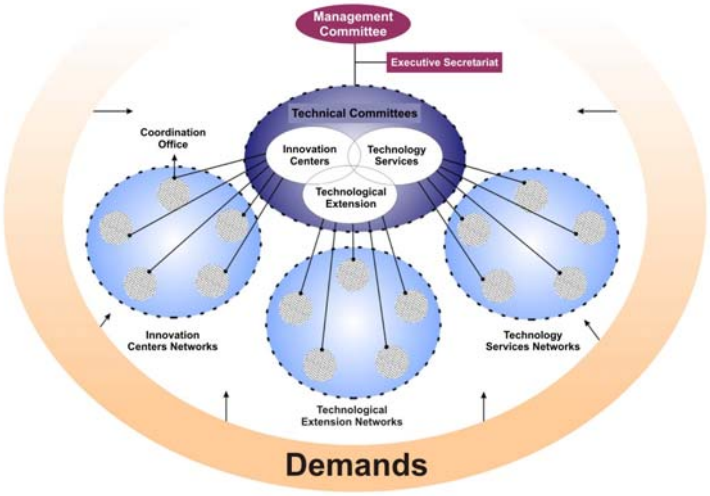
The plan has four general strategic priorities, sub-divided into 21 lines of action. The first priority involves the expansion and consolidation of the National S,T&I System, including actions for institutional consolidation, training and empowerment of human resources and infrastructure and fomenting research in science and technology (S&T). At this level, an important goal is to increase the number of scholarships and fellowships for undergraduates, master's and PhD students, postdoctoral students and senior researchers from 102.000 in 2007 to 170.000 by 2011. The second priority is related to the promotion of technological innovation in companies, creating tools to stimulate, finance and support differentiated technological innovation according to the specific needs of large, mid-sized and small companies and start-ups at incubators and technological parks. One of the aims is to

increase the number of active researchers in the private sector while, in parallel, training human resources and developing a 'knowledge creation culture' in enterprises. The third priority involves the strengthening of Research, Development and Innovation (RD&I) in strategic areas, defining 12 strategic areas for national development that will receive large incentives for research[5]. The fourth priority involves the mobilization of ST&I for social development, stimulating the insertion and dissemination of S&T in society with improvements in teaching, popularizing ST&I in society and using technologies for social development.

One of the main instruments mobilized to get the objectives of the Growth Acceleration Plan for Science, Technology and Innovation (GAP for STI) is the creation of the Brazilian Technology System (SIBRATEC). SIBRATEC involves a group of entities that helps companies across Brazil to develop their businesses by providing services that include technology transfer and assistance. These services are related to the Basic Industrial Technology (TIB) program and to the increase in the number of business incubators and technological parks. Formally, SIBRATEC is organized in three types of networks (see Figure 4): (i) Innovation Centers; (2) Technological Services; (3) Tecnology Extension. Innovation Centers try to transform scientific and technological knowledge into products, processes and prototypes with commercial viability (generating radical or incremental innovation). These Centers are composed by development units or groups that belong to technological research institutes, research centers or universities, with experience in interacting with companies. Technological Services offer the infrastructure for calibration, tests, analyses and conformity assessment services, as well as standardization and technical regulation activities, to meet enterprises needs, associated to complying to technical requirements for market access. The networks of Technological Services are formed by laboratories and organizations that are accredited or have a laboratory quality management system implemented. Tecnology Extension tries to solve problems related to the gaps of small and medium enterprises in terms of technology management, projects, development, production and commercialization of goods and services.

[5] These areas include iotechnology and nanotechnology; ICT; health; biofuels; energy (electrical, hydrogen and renewables); oil, gas and minerals; agro-science; biodiversity; metrology; the Amazon; climate change; and space, nuclear and defense.

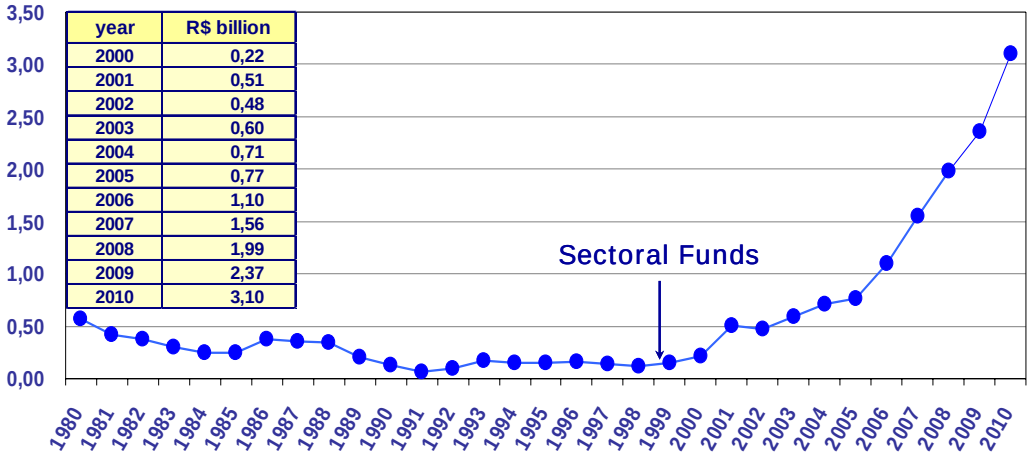
Figure 4 - SIBRATEC - Brazilian System of Technology - Management Framework



3. The mobilization of financial resources to support innovation activities: the FNDCT an the impact of Sectoral Funds

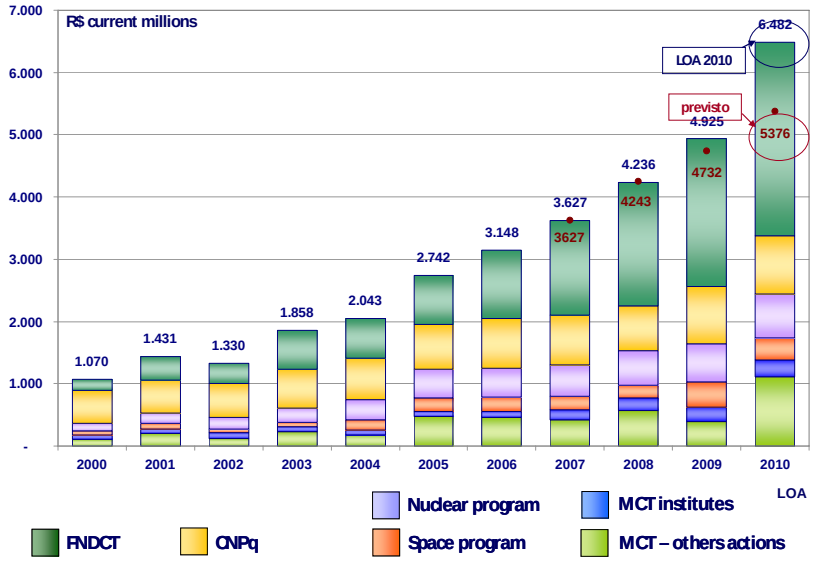
The consolidated of the S&T System in Brazil, is indissolubly articulated to the creation of FUNTEC, later FNDCT, the Brazilian national fund for science and technology. Figure 4 shows the evolution of the FNDCT in constant values during the period between 1980 and 2010. The data stress the instability of the budget between 1980 and 2000, accompanied by an impressive growth after 2000, which can be explained by the impact of Sectoral Funds created in 1999. Between 2000 and 2010 the FNDCT budget growth from R$ 500 million to more of R$ 3 billion. Figure 5 also show that the share of FNDCT in the budget of MCT grow form 15,9% in 2000 to more than 59% in 2008. We can observe the steep rise in FNDCT expenditure after the creation of Sectoral Funds in 1999, which are widely recognized as one of the main innovation in federal R&D funding in Brazil in the past 20 years.

Figure 4 - Evolution of the FNDCT in constant values between 1980 and 2010



Source MCT

Figure 5 - Share of different components in the budget of MCT



Source MCT

The Sectoral Funds for Science and Technology were created in 1999, providing financing tools for research, development and innovation projects. They work as complementary resources for developing strategic sectors, stimulating the generation of knowledge and ensuring that such knowledge is transferred to companies, introducing targets for government-selected R&D projects of benefit to industry and cutting back taxation to a fraction of the revenue of certain industries. They are conceived from the recognition that many of the state-owned companies privatized were strong in R&D, mostly in the fields of telecommunications and energy, and that these activities deserved not only to be protected but also intensified. The funds not only intensified the R&D activities of former state-owned

companies after privatization, but have also redistributed resources for R&D throughout Brazil. At least one-third of each Sectoral Fund must be spent in the less-developed North, North East and Central West of the country. Approximately two-thirds of these funds are used for joint ventures between the public and private sector.

The first sectoral fund was that created for oil and natural gas in 1999. At present, there are fourteen specific sectoral funds[6]. Additionally, there are three cross-sectional funds: Green-Yellow Funds, geared towards university-business interaction; Infrastructure, for supporting improvements in science and technology institution infrastructure; and Audiovisual, for developing cinematographic and audiovisual activities in consonance with federal government programs. The Funds are administered by the Research and Projects Funder (FINEP). Funding for these projects comes mainly from the National Fund for the Development of Science and Technology (FNDCT). Each fund has a steering committee composed by members from academia, government and industry. This committee makes all decisions regarding expenditure, usually keeping a portfolio of projects that are expected to blend research proposals in the basic and applied sciences. However, since these are non-reimbursable resources, only science and technology institutions, that is, universities and research institutes, can receive the funds.

The sectoral funds injected new money into R&D funding in Brazil, even though the federal government decided to confiscate a fraction of the industrial revenue generated in order to meet and exceed its fiscal surplus target. This 'contingency' required by the government has in the past significantly detracted from the amount of earmarked Sectoral Fund money. In this sense, a more detailed analysis of the evolution of financial resources directed to The Sectoral Funds requires a comparison of the resources collected, committed and effectively paid. Table 6 presents the evolution of these three amounts for the period between 1999 and 2010. The amount of resources collected grew rapidly since 2004, evolving from R$ 1,4 billion to R$2,8 billion in 2010. The growth of the resources paid were also very impressive, evolving from R$ 600 million in 2004 to R$ 1,4 billion in 2010. The rate between the amount of resources collected and effectively paid fluctuates around 30%, with a decrease in the period after 2007.

Some analysts have been critical about the current institutional model of the Sectoral Funds. The main critics are related to an excessive emphasis on the funding of basic scientific research, neglecting the use of financial instruments that reduce the financial cost and / or

[6] Aeronautics, Agribusiness, Amazon, Waterway, Biotechnology, Energy, Space, Water Resources, Information Technology, Mineral, Oil and Natural Gas, Health, Land Transportation, Telecommunications

minimize the risk of innovative entrepreneurs in favor of supporting non-refundable research projects with a scientific basis. By concentrating resources on non refundable instruments, the current management of Sectoral Funds requires that innovative companies form partnerships with universities and / or research institutes, as Brazilian law imposes restrictions on the transfer of non-reimbursable funds to companies. These partnerships may involve an increase in transaction costs, discouraging the participation of companies in the projects supported by those funds. Another critic is based on the reported trend to contingency an expressive part of the resources collected which could indicate difficulties to find proper beneficiaries for those funds.

Table 4 – Evolution of Sectoral Funds between 1999 and 2010

	Collected	Committed	Paid	Committed/ Collected	Paid/ Committed	Paid/ Collected
1999	107	37	37	34,9%	100,0%	34,9%
2000	245	134	112	54,9%	83,5%	45,8%
2001	461	316	283	68,6%	89,6%	61,5%
2002	918	315	275	34,4%	87,0%	29,9%
2003	1.318	564	450	42,8%	79,7%	34,1%
2004	1.408	594	487	42,2%	82,0%	34,6%
2005	1.617	748	571	46,2%	76,4%	35,3%
2006	1.850	977	540	52,8%	55,3%	29,2%
2007	2.016	1.094	764	54,2%	69,9%	37,9%
2008	2.510	1.112	767	44,3%	69,0%	30,6%
2009	2.639	1.134	650	43,0%	57,3%	24,6%
2010	2.789	1.371	682	49,1%	49,7%	24,4%

Source: MCT

4. Financing innovation: the role of FINEP and BNDES

Regarding the promotion of technological innovation at the entrepreneurial level, it can be stressed the intensification of loans and economic subsidies to innovation provided by the two main agencies: FINEP, traditionally the main agency specialized in the support of innovative activities, and BNDES, the lead agency for the promotion of industrial development in Brazil, which evolves to a more effective mobilization of resources towards the financing of innovation projects. Acting jointly, these agencies have the capacity to provide a set of sophisticated financial instruments well adapted to different stages of the efforts associated with the establishment and consolidation of innovative firms.

FINEP is the main Brazilian Innovation Agency, operating as a publicly owned company subordinated to the Ministry of Science and Technology — MCT, originally created to the financing of studies and projects. It was founded on 1967 with the purpose of financing scientific and technological research and graduate courses in Brazilian universities and research institutions, as well as research and development in companies. In 1971, FINEP became the Executive Secretary of the newly created Funding for Scientific and Technological Development (FNDCT).

The ability to finance the entire Science, Technology, and Innovation System by combining reimbursable and non-reimbursable funds, as well as fiscal incentives, has afforded FINEP a great capacity for inducing innovative activities. S&T initiatives by business in partnership with universities are also strongly associated to FINEP funding. FINEP is also the executive body responsible for the management of the Sectorial Funds. Regarding the promotion of technological innovation ant the entrepreneurial level, it can be stressed the intensification of economic subsidies to innovation, extending the scope of the Economic Grants Program, implemented since 2006, in order to stimulate formal R&D activities. Others lines of action of FINEP, illustrated by Table 5, include: 1) the Pro-Innovation Credit Program designed to firms which revenues exceeding US$ 10,5 million, 2) The program called "Inova Brasil" launched in 2008, including three broad categories of projects: mobilizing projects in strategic areas, projects aimed to the consolidation and expansion of the technological leadership and projects aimed to strengthen industrial competitiveness, 3) Zero Interest Rate Program initiated in 2006 to support innovative projects in micro and small firms, through the mediation of regional partners, which are responsible for pre-qualification of the proposals; 4) support to venture capital through the acquisition of minority stake in small technology-based companies and through the permission to set up a Technical Reserve Fund, designed to provide liquidity for Private Investment Funds in technology-based companies, 5) two programs specifically designed for the capitalization of investment funds in innovative firms: the Incubator of Innovative Funds and the Innovation Seed Fund.

Table 5 -Incentive programs for innovative firms (by size) – FINEP

Categories	Programs	Focus
Loans	Zero Interest rate	Small firms
	Inova Brasil	Medium and high size firms
Venture Capital	Seed funds	New firm
	Venture capital funds	Small firms
	Private equity funds	Medium and high size firms
Subvention	Prime program	New ideas
	PAPPE Subvention	New firm
	National Subvention	Small firms
Others	PNI Program	New firm
	SIBRATEC program	Medium and high size firms
	Fiscal Incentives	Medium and high size firms

Source: FINEP

Disbursements from FINEP for funding innovative activities between 2006 and 2008 totaled R$ 1.6 billion. A series of FINEP disbursements, which runs from 1999 to 2008, indicates an average annual growth rate of 16% recoverable operations. According to the

agency, FINEP and CNPq biddings launched between 2007 and 2010 involves an amount of approximately R$ 6,5 billion, from which R$ 4,4 were provided by FINEP and R$ 2,1 billion by the CNPq (see Table 5). According to the FINEP Management Report (2009) the amount of refundable funds effectively mobilized to finance innovative activities reaches R$ R$ 2,7 billion in 2009, while the amount direct to economic subvention reaches R$ 466 million (see Table 6). The participation of micro and small firms in the subvention programs grew from 41,3% in 2006 to 73,2% in 2009. Concerning the distribution of resources according to the nature of the projects, we can observe a decrease of the amount of resources directed to projects in the area of information technologies and nanotechnology and an increase of the amount directed to Biodiversity, Biotechnology and Healthy.

Table 5– Evolution of financial resources of FINEP and CNPq

	FINEP			CNPq			
Year	Biddings	Proposals Approved	Resources Approved (R$ million)	Biddings	Proposals Approved	Resources provided (R$ millions)	Resources Approved (R$ million))
2007	22	555	771,5	39	11.140	411,0	467,6
2008	17	525	1.108,9	62	10.656	966,0	978,8
2009	20	660	1.300,0	55	7.825	573,1	504,2
2010	21	1.324	1.256,6	50	6.265	695,4	114,8
Total	80	3.064	4.437,0	206	35.886	2.645,4	2.065,4

Source: FINEP

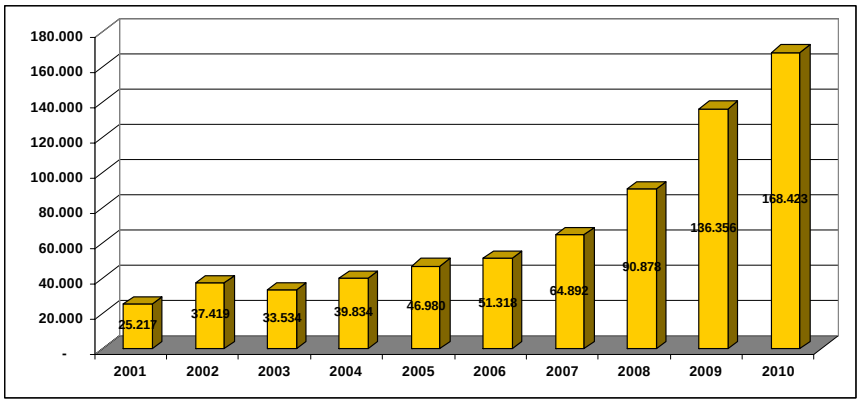
Table 6 – Fundable and non refundable operations in 2009 – FNDCT and FINEP

Operations	FNDCT			FINEP		
	Economic subvention - non-refundable			Refundable funds		
	PAPPE	PRIME	Strategic Areas	Investment	Credit	Total
Indirect operations (Funds/agents)	14	17	-	15	-	
Firms Supported	404	1.381	261	51	74	2.171
Finep resources	123,2	165,7	466	281,9	1.678,90	2.715,70

Source: FINEP

The National Bank for Economic and Social Development (BNDES), formally subordinated to the MDIC, is the other main innovation implementation agency and the largest funding one. The consolidation of BNDES as a funding source for technological development and industrial R&D is relatively recent, constituting the most important boost for industrial R&D in the country for many years. Its overall total disbursements increased from R$ 25 billion in 2001 to R$ 168 billion in 2010 (see Figure 6). Of the planned investment target of the PDP for the period from 2007 to 2010, BNDES will account for one third. BNDES constitutes the main source of long-term financing in Brazilian economy: in fact, considering the sources for investments in manufacturing and infrastructure for the period 2004-2009, we can observe that BNDES is responsible by almost 40% of these funds at the end o f the period..

Figure 6 – Evolution of disbursements of BNDES (R$ Million) – 2001 - 2010



Source: BNDES

The extension of BNDES to the finance of innovative projects involves some adjusts in its operational lines and procedures. The support of innovative activities is complementary to BNDES traditional loans targeted to investments in modernization and / or expansion of productive capacity. Among the evidences of this re-orientation we can mention: 1) Sector-specific programs like Profarma, Prosoft, and the Pro-Aircraft-industry; 2) the review of operational guidelines for the main horizontal line of credit – the Technological Innovation Program - created in 2008 to replace the former Development Program for Innovation (PDI), established in 2006, 3) the establishment of a funding line called Innovative Capital with focus on the characteristics of the firm and not on the project; 4) the consolidation of two complementary lines "Innovation R,D& I" and "Innovation Production"; 5) the mobilization of economic grants through the Technology Fund (Funtec) in order to finance non-reimbursable projects in areas of strategic interest; 6) the Venture Capital Program Criatec, which started in 2007 and seeks to capitalize micro and small innovative firms in early stages with great growth potential. Table 7 tries to illustrate the main areas of financial support provided by BNDES to innovative activities. In the period between 2006 and 2009, BNDES disbursements to finance innovations reached R$ 1.5 billion and had an average annual growth rate of 74%. In 2010, R$ 721.6 million was investment until June, reflecting a growth from the amount of R$ 562.9 million invested in 2009.

Table 7 – Financial Products of BNDES directed to innovative activities

Categories	Programs	Focus
Financing at fixed and variable rates	Innovation Capital (Capital inovador)	Innovative strategies
	Technological Innovation and productive Innovation	Projects
	Sectorial programs: software-PROSOFT; pharmaceutical-PROFARMA; digital TV-PRODTV; aeronautics-Pro-Aeronáutica ; engineering-Pro-Engenharia	Sectors
Equity-share	mutual funds and shares in venture capital (VC) funds, Private Equity investments and seed capital program (Criatec)	Emerging firms; innovative SMEs, mainly in biotechnology, agribusiness, information technology (IT) and medical equipment
BNDES card	small, low-interest credit lines (R$ 1 million per card).	Expenses of SMEs: purchase of capital goods and equipment, software, certification, conformity, IP, R&D and innovation services
Grants (non-reimbursable)	FUNTEC-Technology Fund	research, development and innovation (RDI) projects in national strategic areas

Source: BNDES

5. Innovation policy from the perspective of innovative firms: an analysis of PINTEC

In order to evaluate the impact of the instruments mobilized by the Brazilian innovation policy in the last years, it is important to check how innovative firms have used these new instruments (Tironi, e Koeller, 2006). To discuss this aspect, we can consider relevant information provided by PINTEC, the Brazilian innovation survey carried by IBGE at firm level. PINTEC represents the more structured experience in producing technological innovation indicators for the Brazilian industrial firms as a whole. The survey was carried out three times in the last decade (for the years 2000, 2003, 2005 and 2008) and in the last tree rounds there was a specific question that inquires innovative firms about the use of fiscal incentives and other instruments provided by the innovation policy.

Concerning the enterprises interviewed by PINTEC benefited by some sort of incentive for innovation, the Table 8 indicates that this amount rose from 5.233 firms in 2000 (in this case all of them located in the industrial sector) for 9.214 companies in 2008 (including 8.730 in the industrial sector). Thus, the participation of enterprises that have received any kind of incentive in the total of innovative enterprises rose from 18.7% to 22.3%. Of this total, the incentives that had reached a larger number of companies were those that involve the purchase of machinery and equipment to innovate (used by 13.5% of innovative companies) and other programs of support (used by 7.2% of innovative enterprises). Tax incentives to R&D, economic subsidies to innovation activities and the financing for R&D projects developed by the business sector (alone or in cooperation with universities) tend to be used by a limited number of innovative companies (1,2%, 0,8% and

1,4% respectively). In general, these incentives tend to favor larger companies that are usually well informed about the channels and instruments that might be mobilized to get them.

Table 8 - Enterprises benefited by f incentives for innovation by size – 2003, 2005 and 2008 (source: PINTEC)

Size of the firms (no of employees)	Innovative firms								
	Total	Beneficiaries from the government support, by program type							
		Total	Fiscal incentives		Economic Subvention	Financing			Others support programs
			To R&D activities	Lei de informática (Computer Law)		To projects oriented to R, D&I		Purchase of machinery and equipment used to innovate	
						Autonomous	With universities		
2003									
Total	**28 036**	**5 233**	**204**	**239**			**399**	**3 947**	**1 149**
From 10 to 29	16 776	2 900	94	81			240	2 131	721
From 30 to 49	4 118	809	7	38			36	650	155
From 50 to 99	3 200	580	10	42			36	454	87
From 100 to 249	2 140	418	8	25			12	335	84
From 250 to 499	813	189	21	25			19	135	32
500 or more	989	336	64	28			57	242	71
2003									
Total	**32 796**	**6 169**	**249**	**431**			**450**	**3 883**	**2 129**
From 10 to 29	18 651	2 968	38	160			137	1 703	1 278
From 30 to 49	4 275	818	13	46			27	620	177
From 50 to 99	4 239	815	23	56			47	506	273
From 100 to 249	3 074	674	43	69			59	432	176
From 250 to 499	1 254	368	34	51			51	250	98
500 or more	1 304	525	99	49			130	372	128
2003									
Total	**41 262**	**9 214**	**492**	**748**	**311**	**581**	**383**	**5 559**	**2 981**
From 10 to 29	25 842	5 538	136	497	163	374	170	3 312	1 839
From 30 to 49	5 821	1 247	41	40	13	26	62	879	409
From 50 to 99	4 692	1 081	21	94	32	70	31	710	314
From 100 to 249	2 624	620	42	46	30	25	33	369	207
From 250 to 499	988	254	39	25	13	19	25	141	89
500 or more	1 295	473	212	46	59	67	62	148	122

Source: PINTEC-IBGE

An additional dimension may be related to the regional distribution of companies benefited by these incentives (see Tables 9). In 2008, 52,0% of the innovative firms benefited from these incentives were located in the Southeast region, followed by Southern region with 30.5%. Among the different kinds of incentives, the Southeast region can be highlighted in the case of tax incentives for R&D (with 64% of enterprises benefited) and in the case of financing R&D for autonomous project (with 54% of companies benefited). On the other hand, the South region might be highlighted in the case of economic subvention (with 48% of companies benefited), in the case of incentives related to the Computer Law (with 46% enterprises benefited) and in the case of financing cooperative R&D projects with universities (with 43% of companies benefited). Comparing the regional distribution of companies benefited by those incentives with the general regional distribution of innovative firms in 2008, we can also observe that the North has been relatively more benefit, especially in the case of incentives tied to economic subvention, cooperative projects with universities and other support programs. In contrast, the Northeast has been relatively less benefited, especially in the case of economic subvention and in case of tax incentives for R&D and those tied to the Computer Law.

Table 9 - Enterprises benefited by f incentives for innovation by region –2008 (source: PINTEC)

Country-Region-State	Innovative firms								
	Total	Beneficiaries from the government support, by program type							
		Total	Fiscal incentives		Economic Subvention	Financing			Others support programs
			To R&D activities	Lei de informática (Computer Law)		To projects oriented to R, D&I		Purchase of machinery and equipment used to innovate	
						Autonomous	With universities		
Brasil	**38299**	**8730**	**440**	**704**	**207**	**528**	**323**	**5456**	**2728**
Norte	**1239**	**382**	**13**	**31**	**23**	**3**	**37**	**133**	**263**
Amazonas	449	235	13	31	22	3	36	19	175
Pará	433	74	-	-	1	-	1	48	37
Nordeste	**3618**	**607**	**21**	**16**	**6**	**13**	**49**	**356**	**341**
Ceará	840	78	9	5	1	-	8	48	33
Pernambuco	729	90	7	-	3	4	2	74	22
Bahia	1083	245	4	9	1	3	-	100	157
Sudeste	**20253**	**4544**	**282**	**213**	**68**	**285**	**86**	**3037**	**1370**
Minas Gerais	5208	1407	47	89	14	120	13	978	446
Espírito Santo	953	188	3	1	-	1	1	140	52
Rio de Janeiro	1713	373	16	1	3	2	19	308	109
São Paulo	12379	2576	216	122	51	162	52	1611	763
Sul	**10879**	**2662**	**98**	**326**	**99**	**202**	**138**	**1603**	**635**
Paraná	3641	987	20	16	49	14	43	602	322
Santa Catarina	3209	708	26	144	29	107	13	339	149
Rio Grande do Sul	4029	967	51	166	20	81	83	662	165
Centro-Oeste	**2310**	**536**	**26**	**117**	**11**	**26**	**13**	**328**	**118**
Goiás	1261	453	3	115	2	25	3	321	66
Brasil	**38299**	**8730**	**440**	**704**	**207**	**528**	**323**	**5456**	**2728**

Source: PINTEC-IBGE

6. Innovation policy in Brazil: a critical assessment

The structure of the national innovation governance system in Brazil is young and is well known that the impact of innovation policies on indicators related to innovative performance take time to be materialized, reinforcing the importance of the consistency of the policies over long periods of time. However, it is important to evaluate the effectiveness of policies, identifying whether there are visible impacts generated by national policies or other factors. It is also important to consider the threats derived from the possibility of budget cuts, generate by the pressures to reduce public spending, which can affect the amount of financial resources directed to the targets of innovation policy.

In the last years, Brazil has continued to strengthen its innovation policy by increasing the volume of expenditures on research and development (R&D)[7], giving continuity to flagship programs such as the Economic Subsidy for Innovation , creating new programs to finance technology-based start-up firms (such as the Prime Program) and reinforcing the role of the Brazilian Development Bank (BNDES). Policy measures for direct support of business R&D, as both grants and loans, have continued to be expanded in the volume of resources through BNDES and FINEP. Measures for research infrastructure have grown and new instruments based on technology transfer offices and training of support staff have emerged. New institutional arrangements to reinforce the connection between scientific and technological infrastructure and the needs of the business sector have also been provided,

[7] Gross expenditure on research and development (GERD) increased 76% between 2003 and 2010, reaching R$44 billion; while GERD intensity increased by 0.3 percentage points to 1.3%

such as the SIBRATEC system. The indirect support to business R&D, especially those based on tax incentives, has increased and been refined recently. There is also a policy shift from funding purely academic research towards public–private collaboration and industrial R&D. The federal government has also continued to decentralize innovation policy towards the sub-national states through specific programs, such as the PAPPE Subsidy and the growth of the 17 state research support foundations, consolidating a federative pact in the STI area that had permitted the reservation of a share of expenditures (about 30%, which recently increased to 40% in some cases) to the less developed regions. The dissemination of local "Innovation Laws" to the federative states, well adapted to the conditions of regional systems of innovation also reflects this trend.

Despite these advances, the results generated in terms of the increase of the innovative performance of the Brazilian economy are less than expected. Between 2002 and 2008, the intensity of gross domestic expenditure on R&D (GERD) increased by just 10%, from 0.98% to 1.09% of GDP. Over the same period, GDP increased by as much as 27%, from R$ 2.4 trillion to R$ 3.0 trillion. In other words, Brazil's R&D intensity progressed more slowly than the economy as a whole. The plans to raise the GERD/GDP ratio to 1.5% by 2010 seems not to be achieved, inasmuch as preliminary evaluations indicate that this ratio was no more than 1,3%. The state governments' expenditures in R&D grew 68% between 2005 and 2010 (from R$ 13,8 billion to R$ 23,2 billion) but the intensity in relation to GDP grew only from 0,48% to 0,69%.

On the other hand, private expenditures on R&D remain limited, evolving from R$ 14 billion in 2005 (0,49% of GDP) to R$ 20,0 billion in 2010 (0,62% of GDP), representing an increase of 50%. In this sense, the largest gap with the OECD countries concerns business spending on R&D, where the OECD average (1.58% of GDP) is three times that of Brazil (0.48% of GDP). Catching up to the OECD would involve raising private R&D expenditure from US$ 9.95 billion in 2008 to US$ 33 billion. Despite the dynamism of some world-class industries, in the fields of oil, agribusiness, ethanol, jet planes and the flex-fuel cars, the Brazilian business sector registered only 103 patents at the United States Patents and Trademark Office (USPTO) in 2009. In this sense, while Brazil's innovation performance is fast improving—leading in deep-water oil exploration technology and in the production and use of renewable fuels—it is far from entering the ranks of top international innovators.

The structural weakness of the Brazilian innovation is also related to the fact that Brazilian companies do not show interest in long-term strategies and are more focused in short-run gains, resulting in limited efforts to innovate and to built technological

competences. Despite the increased interest of foreign companies to invest in Brazil, they have not really undertaken innovative projects there. According to official statistics, foreign companies usually use less money for R&D than domestic companies in Brazil. This posture may change according to a new wave of investments of these companies in the country, but that possibility is still uncertain At the same time, local entrepreneurs usually argue that the complex taxation system discourage risked investments, specially in innovation activities. They also complain about the focus on academic research provided by the innovation policy, which only recently has been reoriented to stimulate collaboration between science and technology. The lack of investments in R&D could also be explained by macroeconomic volatility and high interest rates, which does not encourage companies to take risks. The lack of competitive pressure on the home market has also affected the eagerness of some Brazilian companies to invest in innovation activities, especially in the case of unsophisticated markets. Simultaneously, it is important to promote the emergence and growth of start-ups and small technology-based firms in strategic fields, such as nanotechnology, promoting angel investment and networks.

In this context, the efficacy of innovation policy tends also to be hampered by some structural weaknesses. Explicit goals for innovation are rarely identified and the target subjects of most measures are not based on detailed studies of demand or on needs assessments. At the same time, local firms are usually unaware of the incentive mechanisms and channels to access the benefits defined by the innovation policy The Brazilian innovation policy also devotes little explicit attention to acquiring foreign knowledge or to the dissemination of strategic knowledge among industrial activities.. The need to better qualify the demand to submit project proposals for grants or loans are still largely lacking and the bureaucratic barriers to obtain funding remains high, typically taking from 12 to 18 months on average, from proposal submission to receiving funds. The quality of related services provided to innovative firms is still limited, adversely affecting small firms' early growth trajectory. At the governance level of the innovation policy, a programmatic rivalry between the main agencies still remains, generating a duplication of programs and sector targets. The necessary coordination can also be hampered by the threats of budgetary cuts, especially under the pressures to reduce the public budget.

The improvement of human resources might be based on an upgrade of professional education and on the restructuring of training infrastructure, expanding the number of technical schools, strengthening national engineering and related areas and stimulating the formation of talent and entrepreneurship. The expansion of graduate education and of the

number of researchers and technicians might also be articulated with a process of regional decentralization, being connected to the effective needs of the productive sector. The revitalization of the innovation policy can also be facilitated with the consolidation of innovative regionally-based clusters, tightly-coupled to the current needs and future perspectives of the regional economy. Another challenge is related to definition of technological priorities according availability of local competences and resources. In order to connect the implementation of the innovation policy with the reduction of regional heterogeneity, it is important to maintain and improve the mechanisms that reserved a share of expenditures (about 30%, recently increased to 40% in some cases) to the less developed north, northeast and centre-west regions. At the academic level, it is important to develop and internationalize its best universities to turn them into world-class centers of excellence. Simultaneously, it is necessary to spread the scientific excellence beyond São Paulo, Rio de Janeiro and other major urban centers to less privileged regions, such as the Amazon and the Northeast.

Another general issue involves the improvement of the interconnections between the targets of the innovation policy and the foreign trade and industrial policy, enabling the strengthening of innovative capabilities and industrial competitiveness. Specifically, it is important to expand the exports of more sophisticated items - avoiding an excessive reliance on commodities - and to reduce the dependence on import of strategic items, making local production more competitive, by strengthening the innovative efforts. In this sense, the strengthening of the national innovation system becomes a critical issue of a policy of systemic competitiveness, requiring the mobilization of both the public and private enterprises. Enterprises that produce goods and services must necessarily deepen their commitment to the development of new technologies, financing and conducting R & D to further basic and applied research. The efforts of the public sector should be seen as complementary and as a contribution to the generation of externalities for the search tasks performed by the private sector. Public policy should reinforce measures and programs formulated in association with the private sector, to address market failures in the long-term financing of innovative projects, providing the accumulation of technological capacity, the access to technological knowledge and the business management training of skilled human resources. The innovation policy must arbitrate the means to induce the development of institutions, strategic synergies and complementarities within the productive system in order to accelerate the spread of relevant innovations with a broader impact. In this sense, government action might be oriented to the developing of a shared vision, articulating

heterogeneous economic actors and undertaking a regional development project based on research and innovation.

The focus and the operating mode of the innovation policy should be adapted to a new perspective. Specifically, the main challenge for the governance of the Brazilian innovation policy seems to be a better coordination of policies and not only the creation of new policies. This challenge is not due to a lack of resources or entrepreneurial capacity, being associated with the need to integrate disparate government, university and business in order to produce tangible products, services and processes. It seems also necessary to intensify business R&D, in order to drive innovation and competitiveness, through the creation of an environment conducive to those activities, enabling a reciprocal interaction between the innovative firms and business research communities. A demand driven focus of the innovation policy might also be pursued, adjusting its mechanisms to attend specific needs of innovative firms. At the level of state agencies, officers have to undergo the appropriate capacity building to define local innovation policy objectives based on empirically-founded diagnosis. They might also become more sensitive in order to map the potential beneficiaries of the incentives defined at the level of innovation policy, incorporating a criteria of cost-benefit analysis to evaluate those impacts. In this sense, a fundamental challenge to be faced involves the monitoring and evaluation of innovation policy and programs at federal and state levels. Although over the last few years there has been an increase in the number of evaluations carried out in the broad area of S&T; they have been far apart from each other, presenting very diverse and ill-defined objectives and often lacking methodological rigor and analytical coherence. Policy monitoring and evaluation, complemented by learning-inducing institutional arrangements, ought to be developed in a systematic fashion.

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