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INANCING INNOVATION IN BRAZIL: THE ROLE OF THE BRAZILIAN DEVELOPMENT BANK

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ABSTRACT

This paper presents the role of the National Development Bank (BNDES), the main public development agency in Brazil, in financing technological innovation. The scarcity of financing for innovation has always been considered as a limiters to Brazilian technological development. And, given the characteristics of the innovative process, public funding plays a central role. Therefore, understanding the evolution of the role of the BNDES - one of the largest development banks in the world - in stimulating innovation is essential. **Firstly**, it presents a historical description of the Bank's activities, followed by a brief description of the measures to support innovation in Brazil over the last two decades. In the third section we discuss the evolution of BNDES as a financing agent for technological development, including the instruments offered by the institution and their reformulations over time. In the fourth section, the profile of innovation expenditures carried out by BNDES, according to their origin (instruments used) and destination (sectors and profile of companies supported), is evaluated. Finally, the fifth section presents the final considerations. The differential of this article is to detail, for the first time, the participation of this relevant Brazilian institution in financing innovation. **The analysis has an institutional approach**: it does not present an impact analysis, but it allows the reader to understand the changes in the instruments and in the priorities that the institution has assumed in the last decades. This analysis is essential to understand the logic and evolution of the country's largest development institution.

Keywords: Innovation; Brazilian Development Bank; BNDES; Financing Technological Innovation; Brazilian technological development.

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F INANCIANDO A INOVAÇÃO NO BRASIL: O PAPEL DO BNDES

Resumo

Este trabalho apresenta o papel do Banco Nacional de Desenvolvimento Econômico e Social (BNDES), principal agência de fomento ao desenvolvimento do Brasil, no financiamento da inovação tecnológica. A escassez de financiamento à inovação sempre foi considerada um dos limitadores ao desenvolvimento tecnológico brasileiro. E, dadas as características do processo inovador, o financiamento público tem papel central. Por isso, entender a evolução do papel do BNDES - um dos maiores bancos de desenvolvimento do mundo - no estímulo à inovação é essencial. Em primeiro lugar, o artigo apresenta a evolução histórica das atividades do Banco, seguida de uma breve descrição das medidas de apoio à inovação no Brasil nas duas últimas décadas. Na terceira seção, discute-se a evolução do BNDES como agente financiador do desenvolvimento tecnológico, incluindo os instrumentos oferecidos pela instituição e suas reformulações ao longo do tempo. Na quarta seção, avalia-se o perfil dos gastos com inovação realizados pelo BNDES, segundo sua origem (instrumentos utilizados) e destino (setores e perfil das empresas apoiadas). Finalmente, a quinta seção apresenta as considerações finais. O diferencial deste artigo é detalhar a participação dessa relevante instituição brasileira no financiamento da inovação. A análise tem uma abordagem institucional: não apresenta uma análise de impacto, mas permite ao leitor compreender as mudanças nos instrumentos e nas prioridades que a instituição assumiu nas últimas décadas. Essa análise é essencial para entender a lógica e a evolução da maior instituição de desenvolvimento do país.

Palavras-chave: Inovação; Banco Nacional de Desenvolvimento Econômico e Social BNDES; Financiamento da Inovação Tecnológica; Desenvolvimento Tecnológico Brasileiro.

F INANCIACIÓN DE LA INNOVACIÓN EN BRASIL: EL PAPEL DEL BNDES

Resumen

Este trabajo presenta el papel del Banco Nacional de Desarrollo Económico y Social (BNDES), principal agencia de fomento al desarrollo de Brasil, en el financiamiento de la innovación tecnológica. La escasez de financiamiento a la innovación siempre fue considerada uno de los limitadores al desarrollo tecnológico brasileño. Y, dadas las características del proceso innovador, la financiación pública tiene un papel central. Por eso, entender la evolución del papel del BNDES - uno de los mayores bancos de desarrollo del mundo - en el estímulo a la innovación es esencial. En primer lugar, el artículo presenta la evolución histórica de las actividades del Banco, seguida de una breve descripción de las medidas de apoyo a la innovación en Brasil en las dos últimas décadas. En la tercera sección, se discute la evolución del BNDES como agente financiador del desarrollo tecnológico, incluyendo los instrumentos ofrecidos por la institución y sus reformulaciones a lo largo del tiempo. En la cuarta sección, se evalúa el perfil de los gastos con innovación realizados por el BNDES, según su origen (instrumentos utilizados) y destino (sectores y perfil de las empresas apoyadas). Finalmente, la quinta sección presenta las consideraciones finales. El diferencial de este artículo es detallar la participación de esa relevante institución brasileña en el financiamiento de la innovación. El análisis tiene un enfoque institucional: no presenta un análisis de impacto, pero permite al lector comprender los cambios en los instrumentos y las prioridades que la institución ha asumido en las últimas décadas. Este análisis es esencial para entender la lógica y la evolución de la mayor institución de desarrollo del país.

Palabras clave: La innovación; Banco Nacional de Desarrollo Económico y Social BNDES; Financiación de la Innovación Tecnológica; Desarrollo Tecnológico Brasileño.

SUPPORT FOR TECHNOLOGICAL INNOVATION IN BRAZIL

The relevance of innovation has increased in academic debates and in the political agenda of the Brazilian government in the 2000s. Especially since 2004, when Brazil once again explicitly adopted sectorial policies and increased the resources to science and technology, the support for innovation became an important goal of the federal government. The official documents that established such policies had, to some degree, put innovation as a central part of their objectives.

The Industrial, Technological and Foreign Trade Policy (*Política Industrial, Tecnológica e de Comércio Exterior - Pitce*), launched in 2004, prioritized the promotion of technological innovations, favoring horizontal incentive tools, although some sectors were contemplated. During its term, there was a significant increase in mechanisms whose goal was to foment the many types of innovative activities. Amidst those, the promulgation of the Innovation Law (Law nº 10.973/2004), that, among other measures, aimed to stimulate partnerships between universities and firms and to support innovative activities through the transference of non-reimbursable public resources to the firms. In the same period, the promulgation of Law nº 11.196/2005, known in Brazil *Lei do Bem*, provided tax incentives mainly to research and development (R&D) activities.

In 2008, *Pitce* was replaced by the Productive Development Policy (*Política de Desenvolvimento Produtivo - PDP*), that proposed to largely amplify the contemplated sectors and the support for productive development, by promoting the investment, innovation and foreign trade. Even though it has adopted horizontal actions, it supported almost all the sectors of Brazilian economy.

In 2011, replacing PDP, *Plano Brasil Maior* (PBM) was launched. Its *slogan* – “Innovate in order to compete” – marked the importance that the document, at least theoretically, attributed to the innovation.

Overall, three basic instruments were currently used by the Brazilian government to stimulate private investments in innovation: tax incentives; financing at preferential rates; and

incentives to partnerships. Part of the instruments had already been created in the 1990's, but their available resources were substantially increased along the 2000's. According to Bastos (2012), between 2000 and 2010, the federal government compromised approximately R\$ 50 billion to support innovation, 55% of which related to tax exemption. In that period, reimbursable financing reached around R\$ 10 billion, of which 42% originated from BNDES, whose participation grew over time. Besides BNDES, another important institution in the public financing of innovation in Brazil is Finep, an organization of the Brazilian federal government under the Ministry of Science, Technology, Innovation and Communication devoted to funding of science and technology in the country. Finep and BNDES presents some overlaps and complementarities. *Inova Empresa* program, which will be presented below, was an example of this partnership. Besides them, other funding agencies are *Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq)* and *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes)*, at federal level; *Fundações Estaduais de Amparo à Pesquisa (FAPs)*, in the subnational level; and *Associação Brasileira de Pesquisa e Inovação Industrial (Embrapii)*, a social organization.

The implementation of new instruments and the expansion of resources could be perceived by the growth of innovative firms that received public incentive to innovate. According to the Brazilian Innovation Survey (*Pesquisa de Inovação - Pintec*), published by *Instituto Brasileiro de Geografia e Estatística (IBGE)*, their participation grew from 18.7% in 2003 to 22.9% in 2008, reaching 34.6% in 2011 (Szapiro, Vargas and Cassiolato, 2014). Financing the acquisition of machinery and equipment appeared as the main instrument, used by 27.3% of innovative firms in 2011. However, despite the increase of public incentives to innovate, the majority of innovative firms still used their own resources in order to finance such activities. 63.1% of them pointed out, among other obstacles to innovate, the “scarcity of sources of financing” (*op. cit.*), perhaps because most of the instruments focused on medium and large companies.

The Brazilian indicators of innovation have evolved, even if modestly, especially until 2008, before the international financial crisis. The innovation rate of the manufacturing industry – the percentage of firms that implemented some kind of innovation – grew from 33.5% to 38.4% between 2003 and 2008, decreasing to 35.9% and 36.3% respectively in 2011 and 2014. R&D expenditures as a proportion of sales increased during the whole period (0.55%, 0.64%, 0.72% and 0.68%). However, total innovative expenditures remained constant until 2014, but decreased in 2011 (2.5%, 2.6%, 2.5% and 2.2%, respectively). Thus, despite the enhancement of innovation policies and the establishment of a legal framework directed to this subject, the results were less expressive than expected.

The traditional mechanisms of supporting innovation, adopted in Brazil from internationally disseminated experiences, have been reviewed in many countries that are recently adopting more complex and sophisticated policies than the tax and financial incentives. According to Cassiolato (2010), these traditional mechanisms mostly support R&D projects; however, the generation of new products and processes also demand other innovative activities (not only R&D). This matter was also raised by Kupfer (2013), who questioned if innovation support in Brazil would be excessively concentrated in R&D projects.

Therefore, a broad approach of innovation would increasingly demand changes in the culture of funding institutions. Innovative activities such as training, acquisition of external knowledge, acquisition of equipment and introduction of the products in the market can be more important than R&D investments (Szapiro et al., 2014). The next session shows the role of BNDES in financing innovation, including the modifications the institution had gone through and their reflexes in its financial instruments. Regarding the period of analysis, the limit was given by the availability of data accessed by the authors.

THE ROLE OF BNDES IN FINANCING INNOVATION

BNDE was founded in 1952 based on a diagnosis that there were insufficient private

financial instruments for long-term investment in Brazil. Since the Law nº 5.662, on June 21, 1971, it became a public federal company with legal personality under private law and individual capital. Its constitutional model allows collecting resources from multiple sources, allocating them among different instruments, even though the directives of its actions are given by the federal government. Until 1967, when Finep was founded, the bank was also responsible for the resources destined to science, technology and innovation (ST&I) (Tavares, 2013).

In 1982, BNDE would include in its name the social dimension, becoming BNDES. BNDES has never been absent from the support of innovation, but this was treated as secondary when compared to the financing of industrial investments (Bastos, 2012). If, before the 1980's, the institution prioritized the "import substitution" model, in the following decade its strategy focused on the macroeconomic stabilization, including privatizations (Tavares, 2013). In the 1990's, actions aimed at the promotion of technological modernization, through the technologies incorporated in equipment. Important initiatives – although sporadic – relating to the promotion of innovation can be highlighted, such as the creation, in 1997, of *Prosoft*, a program aimed at developing the software sector (Costa, 2011; Bastos, 2012).

In spite of specific initiatives, until the beginning of the 2000's the support for technological development had not been entirely incorporated to the strategic agenda of the institution. This scenario changed in 2003-2004, when the bank prioritized the sectors defined as strategic in *Pitce* (Tavares, 2013). Besides the expansion of *Prosoft*, the *Profarma*, a program to support the pharmaceutical industry, was created in 2004, which included a specific subprogram to support research, development and innovation (RD&I) projects.

Innovation in the BNDES agenda

The explicit incorporation of innovation in the BNDES agenda occurred *de facto* since 2005, in line with *Pitce*. According to Tavares (2013), the recent actions of BNDES in the field of

innovation had three periods. The first phase, between 2005 and 2007, marked its incorporation in the agenda of the institution. The second period, from 2008 to 2011, showed the consolidation of innovation as a strategic priority, despite retaining a relatively passive logic regarding the subject. In 2012 BNDES started a more active position relating to the supported technologies.

It should be noted that the actions of the bank were guided by an effort from the entire government to give more visibility to the theme, thus reflecting the goals and objectives for innovation that figured in many official documents. From this perspective, BNDES adapted and improved its instruments, becoming an important player in financing innovation.

In the first period (2005-2007), the actions were marked by their horizontal character. Among them was the creation of *Fundo Tecnológico* (Funtec), a non-reimbursable fund directed at S&T institutions, which were the final takers in cooperative projects with firms. Two financing lines for innovation were implemented in the period: i) *PD&I*, for helping firms in achieving more competitive positions; and ii) *Inovação-Produção*, for supporting incremental innovations and the production and commercialization of the results of innovation. They had the lowest costs charged by the bank – an additional 0% compared to the basic compensation of the institution (Tavares, 2013; Vallim, 2014). Besides, the bank implemented sectorial programs to support the development of digital TV (*PROTV*), in 2006 and aircraft industry (*Pró-Aeronáutica*) and automotive engineering (*BNDES Engenharia Automotiva*) both in 2007 (Bastos, 2012; Vallim, 2014).

In this first phase, the resources put available were not significant (Tavares, 2013). Since then, there was a major inflexion in the policies and in the concept of innovation adopted by BNDES. As Kicking and Almeida (2010) pointed out, BNDES turned to support the innovative capabilities of the firms, instead of financing isolated projects. Innovation was treated as a wise concept, including not only R&D but also new forms of organization, marketing and customer interactions. This

change brought great cultural and operational challenges to the institution.

The funding lines mentioned above were extinct and replaced by:

1) *Inovação Tecnológica*, for supporting radical or incremental innovation, as long as they were aligned with the development of new or improved processes and products, in conditions that involved technological risk and market opportunities. The minimum support of the bank was fixed at R\$ 1 million, and the maximum at R\$ 200 million, with interest rates fixed at 4.5%, and execution in up to fourteen years.

2) *Capital Inovador*, directed to entrepreneurial strategy, *i.e.*, to supporting firms to systematically make innovative efforts in a continuous and structured manner. Its cost was composed just by long term interest rates (LTIR) for small firms and for LTIR plus risk compensation for large companies (up to 3.57%). Real guarantees were also ruled out for operations up to R\$ 10 million (Vallim, 2014).

In 2009, BNDES recreated the *Inovação-Produção* program in financial conditions similar to *Capital Inovador*, seeking to support incremental innovations and investments in the implementation, expansion and modernization of productive capacity. With its reactivation, BNDES supported projects with greater technological risk (Technological Innovation), incremental innovations (*Inovação-Produção*) as well as the innovative firms (*Capital Inovador*), with special financing conditions (Vallim, 2014).

In addition to horizontal instruments, sectorial lines were released: i) In 2009, *Proengenharia* replaced the *BNDES Engenharia Automotiva*, to support engineering projects in a wide range of industries (capital goods, defense, automotive, aeronautic, aerospace, nuclear oil and gas); *Proplástico*, in 2010, to support the plastic industry; and P&G, in 2011, to finance oil and gas (Bastos, 2012).

An important milestone of the period was the release, in 2009, of Investment Support Program - *Programa de Sustentação do Investimento* (PSI), whose initial objective was to counterbalance the effects of the international economic crisis. The program promoted a deep

reduction in the cost and an expansion of credit to productive and innovative investment.

A new change in the way BNDES dealt with innovation was seen in 2012. Until then, the sectorial support was available by the bank in a “passive” form, through private demand. From this moment on, the “non-spontaneous” attraction of clients, which until then was used sparingly, became part of the institutional strategy.

The launch of *Paiss*, a program to support innovation in ‘sugar-energy’ industry, marked this change. The BNDES Fuel Department (Debio) studied ways of contributing to the increase of competitiveness of ethanol in the domestic market, concluding that the biomass innovation system was directing its scarce resources to the improvement of ethanol’ first generation, which offered few potential gains in productivity. Therefore, Debio focused its efforts in advanced biofuel from ethanol’ second generation and, together with Finep, drew a financing plan for the development of new technological routes for the production of ethanol (Tavares 2013; Vallim, 2014). In short, the bank became to act in a proactive form rather than on demand.

The considerable demand for *Paiss* resources (above US\$ 1.5 billion), greater than the initial supply (R\$ 1 billion), was an indicator of its success. This result inspired the launch of *Inova Petro* in 2012 to support the productive chain of the oil and natural gas industry. *Paiss* and *Inova Petro* were the base for the launch, in 2013, of a series of programs that were jointly called *Inova Empresa*, which included: *Inova Aerodefesa*, *Inova Agro*, *Inova Energia*, *Inova Saúde*, *Inova Sustentabilidade*, *Inova Telecom*, *Inova Mineral*, *Plano de Desenvolvimento e Inovação da Indústria Química (Padiq)*, *Paiss Agrícola*, *Paiss II* and *Inova Petro II*.

This recent experience was vital for another change in the financial instruments. *Capital Inovador*, renamed as *BNDES Inovação*, became the only financing line of the bank for innovation. It encompassed financeable items of various kinds, among which were the acquisition of machinery and equipment; R&D for new processes, products or services; acquisition,

transference and absorption of technology; and expenses with workforce and intellectual property (Tavares, 2013; Vallim, 2014). BNDES still launched additional financial instruments for the sectorial scope in 2013: *Prodesign* program, concerned with the fashion industry and brand differentiation; *Procult*, for supporting the productive chain of the economy of culture; and *BNDES MPME Inovadora*, aimed at the increase of competitiveness of small firms (Vallim, 2014).

To sum up, from the mid 2000’s, the federal policy to support innovation was strengthened by the incorporation of BNDES as a central agent. The next section evaluates the evolution of BNDES’ expenditures in innovative activities between 2002 and 2015 period, according to instruments used, sectors supported and firms’ characteristics.

BNDES EXPENDITURES IN INNOVATIVE ACTIVITIES: 2002-2015

Methodology

This is a single case study that used secondary data to evaluate the BNDES innovation programs. To analyze BNDES expenditures, the authors use databases from different institutions.

BNDES database of innovative projects took into consideration the bank’s broad concept of innovation, as described in the sections above. Thus, these projects included not only traditional activities, such as R&D expenditures and acquisition of machines and equipment, but also support to R&D infrastructure, marketing *etc.*

The analysis was mainly concentrated in non-automatic operations (NAOs), while automatic operations (AOs) were briefly analyzed. NAO_Innovation refers to the non-automatic operations that supported innovative projects. The available database encompasses information between 2002 and 2015 and includes the following variables: name and national legal entity register (CNPJ) of the clients, modality of operation (direct or indirect), contracting date, contracted value, interests, grace and amortization period, product, financial instrument, objective and sector of the project.

From the CNPJ it was possible to identify the firms' origin of capital and their number of patents. The patent indicators, which include invention and utility model patents, were obtained through the database of Brazilian Patent and Trademark Office (*Instituto Nacional de Propriedade Industrial* - INPI). A database of Central Bank, base year 2010, was used to identify their origin of capital. The following firms must provide information to Central Bank:

- Resident firms that took credit from non-residents, with debit balance in the database of 12/31/2010 equal or superior to US\$ 1 million.

- Firms – including investment funds – with direct participation of non-residents in their social capital in any amount.

Simply put, we classified them as foreign or national. A firm was classified as “foreign” if the sum of the voting power of all foreign individuals equals 50% or more. But information regarding origin of capital presents some limitations. For instance, a firm belonging to a foreign subsidiary is classified as ‘national’.

Therefore, foreign participation in this analysis tends to be underestimated.

Database of NAOs, available at the BNDES website, and the *Pintec* surveys were also used in this analysis.

This study focuses on manufacturing industry, which represents 73.2% of the NAOs' contracted values directed to innovation in the period. The values differ from those presented in the BNDES Annual Report 2015, since it presented amounts actually disbursed.

BNDES disbursements to support innovation: NAOs

Between 2002 and 2015, the total amount of NAOs reached R\$ 219.5 billion. Of these, 6.5%, or R\$ 14.3 billion, were allocated in innovative projects. This percentage, however, has changed over time: until 2009, such projects represented in average merely 1.0% of available resources. In 2010, it reached 4.5%. Nevertheless, the most relevant leap occurs in 2011, when innovative projects represented more than 8.0% of total resources, reaching a peak of 20.8% in 2013.

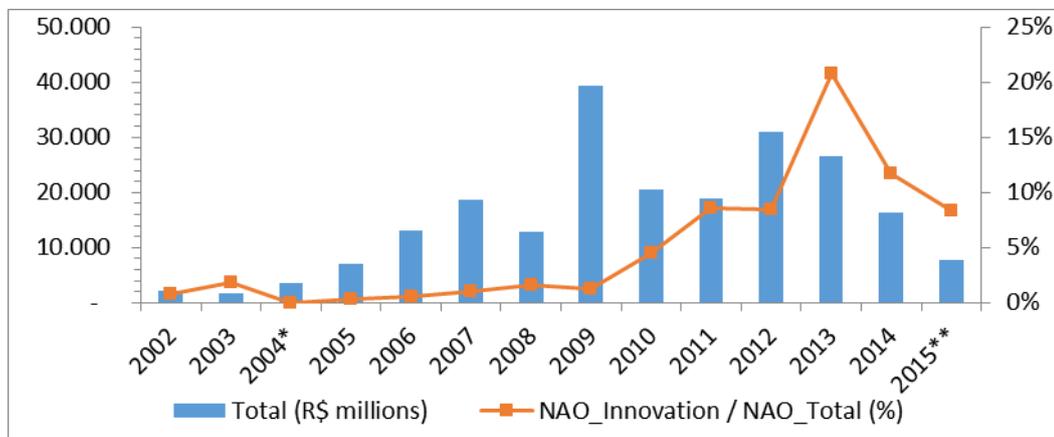


Figure 1 - Contracted value of NAOs in the manufacturing industry: total and percentage for innovation (In %)

Source: BNDES.

Notes: * In 2004, only four operations were found, all in the information and communication sector.

** Data available until 12/17/2015.

NAOs by resource allocation

Even though the amount allocated in innovative projects grew both in absolute and proportional terms, the number of firms assisted through the period was restricted: only 168

firms in the manufacturing industry were contemplated in 362 operations. The average value by operation was R\$ 39.5 million, though the majority of firms (125 of them, *i.e.* 74.4% of the total) contracted less than that.

It is worth mentioning that *Pintec* identified, between 2009 and 2011, 1,006 large companies that invested in innovative activities, and among them, six hundred received some kind of governmental support to innovate. Therefore, investments in innovation through NAOs reached a limited percentage of innovative companies. Besides, 60% of resources,

equivalent to R\$ 8.5 billion, were contracted by ten firms.

Just as the amount of resources, the number of firms, the number of operations and the average value per operation also grew through the years, all of them reaching their maximum levels in 2013.

Table 1 - NAO_Innovation: number of operations and firms per year

Year	Number of operations	Average value per operation (R\$ million)	Number of firms	Average value per firm (R\$ million)
2002	2	8.7	2	8.7
2003	4	7.8	1	31.4
2004*	-	-	-	-
2005	2	11.5	2	11.5
2006	8	9.9	7	11.3
2007	15	12.0	11	16.4
2008	16	12.7	13	15.6
2009	17	27.8	15	31.5
2010	25	37.3	18	51.8
2011	37	43.7	17	95.0
2012	46	57.0	29	90.4
2013	86	64.4	54	102.6
2014	69	28.0	46	42.0
2015	35	18.6	21	30.9
Total**	362	39.5	168**	85.1

Source: BNDES.

Notes: * In 2004, only four operations were found, all in the information and communication sector, which is not part of the transformation industry.

** The total amount of firms is smaller than the sum per year because some firms were benefitted for more than a year.

Table 2 shows the NAO resources to innovation by sector and compares it with the sectorial distribution of expenditures in innovative activities of industrial firms according to *Pintec* 2011. This comparison allows to investigate if NAO resources focused proportionally more in high tech sectors.

Sectors were grouped according to the technological intensity classification used by Organisation for Economic Co-operation and Development (OECD). When comparing the *Pintec* 2011 data and the NAO_Innovation data, one can verify that high tech industries were more representative in the second group: while they represented 11.1% of investments in

innovation made by Brazilian industrial firms (2011), they reached 35% of the BNDES NAO_Innovation expenditures (2009-2011). This is an indicator of the special support directed by the institution to the pharmaceutical, electronic and optical sectors. This comparison contraposes the critics that the institution was essentially financing segments in which the country was already competitive. At least in innovation, high technology sectors received proportionally more support. Besides these sectors, vehicles and oil and biofuels also stood out. Through the whole period, the automobile industry was the one that individually received the highest amount of resources.

Table 2 - Sectorial participation in innovative projects: Pintec and BNDES (ONA_Innovation) manufacturing industries. (In %)

Sectors by technological intensity	Sectorial participation – contracted value (BNDES/NAO_Innovation)				Pintec – Innovation expenditures (total)	Pintec – Innovation Expenditures (large firms)
	2003-2005	2006-2008	2009-2011	2012-2015	2011*	2011
High tech industry	55,1%	46,4%	35,0%	33,4%	11,1%	12,9%
Computing equipment, electronic and optical products	0,0%	21,6%	6,8%	7,7%	4,4%	3,8%
Pharmaceutical products	32,0%	24,8%	10,3%	12,6%	3,7%	4,8%
Transportation equipment other than motor vehicles	23,1%	0,0%	17,9%	13,0%	3,0%	4,3%
Medium-high tech industry	44,9%	29,5%	61,3%	40,7%	30,5%	42,1%
Electric machines, devices and materials	0,0%	1,7%	0,1%	0,4%	3,6%	3,5%
Motor vehicle, tow trucks and bodyworks	43,8%	25,7%	57,0%	29,0%	13,4%	21,7%
Motor vehicle parts and accessories	43,8%	8,8%	1,5%	0,1%	3,6%	4,8%
Chemical products	1,1%	0,8%	3,3%	9,2%	9,1%	9,8%
Machines and equipment	0,0%	1,3%	0,9%	2,0%	4,3%	2,0%
Maintenance, repair and installation of machines and equipment	0,0%	0,0%	0,0%	0,1%	0,0%	0,2%
Medium-low tech industry	0,0%	20,6%	2,1%	17,9%	28,0%	30,2%
Rubber and plastic material products	0,0%	0,0%	0,0%	1,0%	4,4%	2,7%
Coke, oil derived products and biofuels	0,0%	7,6%	1,7%	16,1%	9,1%	13,9%
Oil refinement	0,0%	0,0%	0,0%	7,4%	6,8%	-
Biofuel	0,0%	7,6%	1,7%	8,7%	-	-
Non-metallic minerals products	0,0%	0,0%	0,0%	0,1%	2,5%	1,4%
Metallurgy	0,0%	6,9%	0,4%	0,3%	8,3%	10,8%
Metal product , except for machines and equipment	0,0%	6,0%	0,0%	0,5%	3,7%	1,3%
Low technology industry	0,0%	3,5%	1,6%	8,0%	29,7%	16,9%
Food products	0,0%	0,8%	0,2%	0,8%	15,6%	8,4%
Beverages	-	-	-	-	2,5%	3,5%
Tobacco	-	-	-	-	0,4%	-
Textile products	0,0%	0,0%	0,0%	2,2%	1,3%	0,8%
Clothing and accessories	0,0%	0,0%	0,0%	1,9%	1,2%	0,4%
Preparation of leather and leather artifact, travel gear and footwear	0,0%	0,6%	1,2%	0,5%	2,2%	1,1%
Wooden products	0,0%	0,0%	0,0%	0,1%	9,1%	0,8%
Cellulose, paper and paper products	0,0%	0,0%	0,0%	2,1%	4,0%	1,6%
Furniture	0,0%	2,1%	0,2%	0,0%	0,0%	0,2%
Miscellaneous products	0,0%	0,0%	0,1%	0,3%	0,0%	0,1%

Sources: BNDES and IBGE.

Regarding the firms' origin of capital, among the 362 projects, foreign companies contracted 86, with an average value per project of R\$ 72.2 million, compared to R\$ 29.3 million in the case of national firms. Foreign companies received 43.4% of the R\$ 14.3 billion directed to innovation between 2002 and 2015. The sectorial distribution of resources received by foreign firms showed its expressive concentration in the vehicle sector (79.0%), followed by pharmaceutical products. Together,

they represent 92.6% of the resources contracted by foreign firms.

As we mentioned before, the definition of origin of capital was based on CCE 2010. Given the buying and selling of firms throughout the last decades in Brazil, some firms could have different origins of capital in other years. What can be ascertained is that, based on the criteria mentioned above, 43% of contracted resources were directed to firms that, *in 2010*, were foreign.

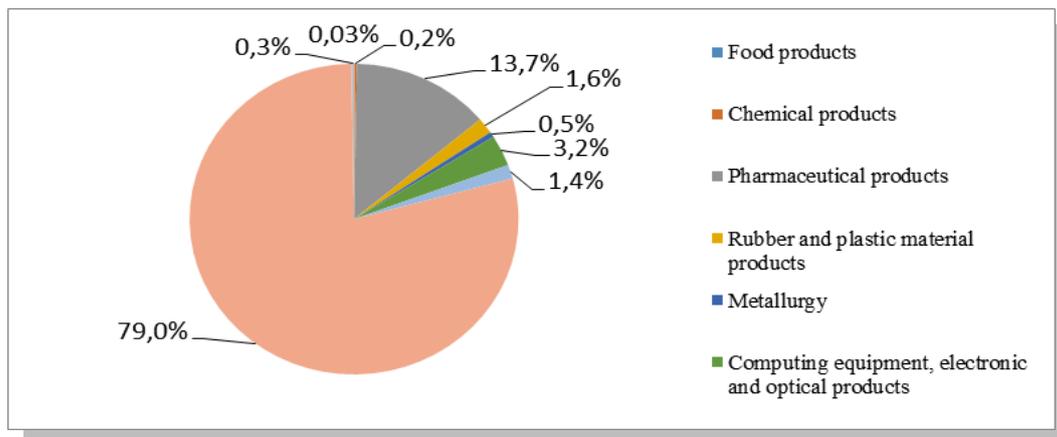


Figure 2 - Sectorial distribution of values contracted by foreign firms: NAO_Innovation (2002-2015) (In %)

Sources: BNDES and Central Bank of Brazil.

We also see that BNDES support to innovation is mainly representative in three sectors: other transport equipment, vehicles and pharmaceutical industry. This is shown in table

3, which presents the proportion between BNDES_NAO_Innovation and innovative expenditures of large firms (2011).

Table 3 - BNDES_NAO_Innovation and innovative expenditures of large firms (2011).

Sectors	BNDES_NAO_Innovation/ PINTEC_large firms (2011)
Food products	0,16%
Coque, produtos derivados do petróleo e de biocombustíveis	0,08%
Chemical products	0,59%
Pharmaceutical products	19,95%
Computing equipment, electronic and optical products	1,05%
Electric machines, devices and materials	0,28%
Motor vehicles, tow trucks and bodyworks	12,15%
Motor vehicle parts and accessories	1,78%
Transportation equipment other than motor vehicles	43,10%
Total	5,58%

Sources: BNDES and IBGE.

Table 4 - Foreign firms by sector (2002-2015)

Sectors	Foreign firms (NAO_Innovation)		
	Number of projects	Contracted value: average per project (R\$ million)	Firms: foreign/total (%)
Food products	1	1,79	1,8%
Chemical products	2	7,46	1,4%
Pharmaceutical products	3	282,47	47,0%
Rubber and plastic material products	6	17,02	98,2%
Metallurgy	2	16,96	43,7%
Computing equipment, electronic and optical products	1	200,00	17,6%
Machines and equipment	7	12,81	35,4%
Motor vehicles, tow trucks and bodyworks	63	77,78	98,3%
Other transportation equipment	1	16,58	0,8%
TOTAL	86	72,17	43,42%

Sources: BNDES and Central Bank of Brazil.

NAOs by origin of resources

After mapping the resource destination, this section evaluates their origin, that is, the financial instruments to support innovative activities. The instruments identified among the NAOs innovation projects were classified in five groups:

- 1) Horizontal lines: instruments directly related to innovative activities (project or entrepreneurial strategy), without differentiation by sector.
- 2) Complementary lines: support to specific activities such as design, engineering and acquisition of capital goods.
- 3) Sectorial programs, such as *Profarma*.

- 4) Non-reimbursable fund, *Funtec*.
- 5) Others: include instruments which aim to promote investments but also gave support to some innovative projects.

Various instruments, such as *Capital Inovador*, *Proengenharia*, *ProBK*, among others, were incorporated into the *PSI*, which offered more competitive interest rates. From the R\$ 14.3 billion directed to innovation, R\$ 10.1 billion were contracted from the many modalities of *PSI*.

Tables 5 presents the contracted values per financial instruments while table 6 shows the intersection between the main instruments and the destinies of their resources.

Table 5 - NAO_Innovation: financial instruments by period

Financial instruments	Contracted value (R\$ million)					Total	Number of projects	Average value by project (R\$ million)
	2002	2003-2005	2006-2008	2009-2011	2012-2015			
Horizontal lines	-	-	164,0	1.000,5	3.603,1	4.767,6	177	26,9
PSI Inovação	-	-	-	-	3.417,8	3.417,8	96	35,6
Inovação Produção	-	-	162,5	19,4	26,5	208,4	18	11,6
Capital Inovador / PSI Capital Inovador	-	-	1,5	368,0	-	369,5	17	21,7
Inovação Tecnológica / PSI Inovação Tecnológica	-	-	-	613,1	-	613,1	26	23,6
BNDES Inovação	-	-	-	-	158,8	158,8	20	7,9
Complementary lines	-	-	118,7	1.571,5	6.930,9	8.621,1	115	75,0
BNDES Prodesign	-	-	-	-	195,2	195,2	17	11,5
Engeneering Lines: BNDES Proengenharia/Engenharia Automotiva/PSI Proengenharia	-	-	118,7	1.571,5	3.938,5	5.628,6	69	81,6
Capital Goods Lines: BNDES ProBK / PSI BK/ Aquisição de Bens de Capital	-	-	-	-	418,9	418,9	15	27,9
PSI Projetos Transformadores	-	-	-	-	2.117,9	2.117,9	11	192,5
BNDES Revitaliza	-	-	-	-	260,5	260,5	3	86,8
Sectorial programs	-	22,9	93,1	62,9	54,9	233,9	29	8,1
Profarma	-	22,9	80,7	43,1	54,9	201,6	24	8,4
Prosoft	-	-	12,5	19,8	-	32,3	5	6,5
Non-reimbursable	-	-	35,4	43,8	7,0	86,2	10	8,6
Funtec	-	-	35,4	43,8	7,0	86,2	10	8,6
Other	17,3	31,4	50,9	341,6	143,8	585,0	41	14,3
Capacidade Produtiva	-	-	8,8	335,3	-	344,1	9	38,2
Linha de Apoio (Indústria e Agropecuária)	-	-	-	-	120,5	120,5	4	30,1
Other*	17,3	31,4	42,1	6,3	23,2	120,4	28	4,3
TOTAL	17,3	54,3	462,2	3.020,3	10.739,7	14.293,9	362	39,5

Source: BNDES.

*Includes: Fundo da Marinha Mercante, Programa Fundo Clima, PSI-Projetos Transformadores and others.

Table 6 - NAO_Innovation: financial instruments by sector (In %)

Sectors	Horizontal lines	Engineering lines	Capital Goods Lines	Prodesign	PSI Projetos Transformadores	Fuente c
Food products	1,4%	-	2,0%	-	-	5,2%
Textile products	0,1%	-	-	43,1%	-	-
Clothing and accessories manufacturing	0,2%	-	-	44,5%	-	-
Leather products and footwear	1,9%	-	-	1,6%	-	-
Wooden products	0,1%	-	-	-	-	-
Cellulose, paper and paper products	4,7%	-	-	-	-	-
Coke, oil derived products and biofuels	22,7%	-	53,8%	-	23,2%	5,4%
Chemical products	19,7%	1,4%	12,0%	10,2%	-	-
Pharmaceutical products	9,9%	-	-	-	51,1%	66,4 %
Rubber and plastic material products	0,3%	1,6%	0,4%	-	-	-
Non-metallic mineral products	0,1%	0,0%	-	-	-	2,9%
Metallurgy	1,4%	-	-	-	-	13,5 %
Metal products	1,1%	0,4%	-	-	-	-
Computing equipment, electronic and optical products	10,7%	0,0%	-	-	25,7%	6,6%
Electric machines, devices and materials	0,7%	-	-	-	-	-
Machines and equipment	2,7%	1,8%	2,8%	0,5%	-	-
Motor vehicles, tow trucks and bodyworks	0,4%	77,8%	29,0%	-	-	-
Other transportation equipment	20,6%	16,9%	-	-	-	-
Furniture	0,4%	-	-	-	-	-
Miscellaneous products	0,6%	-	-	-	-	-
maintenance – machines and equipment	0,2%	-	-	-	-	-
Total by sector (%)	100,0%	100,0%	100,0%	100,0%	100,0%	100,0 %
Total (R\$ million)	4.767,6	5.628,6	418,9	195,2	2.117,9	86,2
Total per instrument (%)	33,4%	39,4%	2,9%	1,4%	14,8%	0,6%

Source: BNDES.

The majority of resources (75.1%) were contracted in the 2012-2015 period, in which *PSI* and *Plano Inova Empresa* came into effect. This temporal concentration counts for most instruments, except for the sectorial ones (*Profarma* and *Prosoft*), some horizontal lines (which were created and ended before 2012) and *Funtec*.

Along the whole period, support instruments for engineering activities represented 39.4% of the contracted value (69 projects), standing out as the main instrument regarding the value. Engineering lines (*Engenharia Automotiva*, *Proengenharia* and particularly *PSI Proengenharia*) were mostly used by the automobile sector (77.8%). It stands out that 30.6% of the total contracted values from BNDES NAO_Innovation, or R\$ 4.4 billion, were concentrated in engineering activities for the automobile industry.

The *Proengenharia* line financed: *i)* local engineering activities; *ii)* physical infrastructure for research, development, product engineering, tests and trials; and *iii)* engineering services. Financeable items include: national machines and equipment registered in BNDES; workforce and materials; tests and trials; domestic and foreign expenses regarding the industrial property of the project; civil works, assemblies and installations; domestically developed software; and import of new equipment without a national similar.

In the 69 projects of engineering lines, the main explicit objective was the development of new products, especially automobile models. The improvement of products and processes and the building and modernization of plants and laboratories related to technology also figured among these objectives. 26.1% of the objectives of projects were not identified.

Table 7 - Engineering lines: objectives of projects

Objectives of projects	Number of projects	Participation by project type (%)
Development of new product	21	30,4%
Modernization of plant/improvement of process	11	15,9%
Improvement of product	10	14,5%
Building/modernization/improvement/expansion of R&D, testing, trial, or technological infrastructure laboratory	10	14,5%
Increase of productive capacity	8	11,6%
Social/environmental/cultural Project	7	10,1%
Building of new production unit	5	7,2%
Development of new process	2	2,9%
Working capital	1	1,4%
Increase of competitive capacity	1	1,4%
Relocation of plant	1	1,4%
Support to exports	1	1,4%
No reported objective	18	26,1%

Source: BNDES. Authors' elaboration.

The horizontal lines represented 33.34% of the amount contracted, distributed between 177 projects. Given their horizontal nature, these lines were used by almost all industrial sectors. The average value of their projects is

lower than the engineering lines: R\$ 26.9 million against R\$ 81.6 million, respectively.

PSI Projetos Transformadores, aimed at developing high-tech sectors with positive technological linkages, accounted for 14.8% of

NAO_Innovation resources. There were eleven large projects with an average value of R\$ 192 million each that included, among others, the implementation of second generation ethanol plants and the construction of biopharmaceutical factories.

Capital Good lines also showed a high sectorial concentration in two segments: oil and fuels and, again, automobile industry. Together, they contracted 82.2% of these resources. *Prodesign*, in accordance with its objective, was concentrated heavily on textiles and clothing (87.6%). Its projects supported investment plans in design and fashion goods (intimate apparel, sports and swimwear) and expenditures in research, developing and marketing for new collections.

Funtec, in turn, focused on medicines and pharminochemical, whose projects accounted for 66.4% of its resources. The remaining ones supported the following sectors: food products; oil and biofuels; non-metallic mineral goods; metallurgy; and computing, electronics and optics. The projects aimed at developing technology for increasing the efficacy of the process of manufacturing ethanol from sugarcane; the implementation of pilot plants for the production of biodiesel; the development of rotavirus, dengue fever and canine leishmaniosis vaccines; the implementation of technological support labs, the production of recombinant human insulin, the development of pozzolanic cement, the harvesting of solar grade silico by means of the improvement of metal purification, among others.

As expected, *Profarma* resources were mostly directed to the pharmaceutical sector (96%); and likewise *Prosoft* exclusively supported the computing, electronics and optics sector.

Innovative performance of NAO_Innovation clients

The innovative profile of firms can be measured, among other variables, by patent applications. Patents are not be the most adequate measure for analyzing the impact of the BNDES instruments, as the bank used a broad concept of innovation, including, as mentioned above, engineering activities, design, marketing and not only activities aimed at generating patentable technologies. Despite it should not be used to evaluate the impact of BNDES instruments, the patent indicators help in the description of the firms' innovative profile.

The patent applications were divided into two periods: 2002-2005 and 2006-2012 (table 8). Between these periods, the number of BNDES NAO_Innovation clients that applied for patents increased from 59 to 81 firms (thirty firms started applying for in the second period, and eight ceased depositing them). It followed a national tendency, as a generalized increase in the number of patents applied for in the country was observed throughout this second period. But the number of patents applied for by NAO_Innovation clients still increased more than the national average: a 64.7% growth, compared to 52.9%. Among the benefitted companies, the foreign ones presented a lower number of patents per year, reaching 0,42 patents between 2006 and 2012.

Table 8 - Indicators of patent applications / applicants

	Patent applications / applicants		
	2000-2005	2006-2012	2000-2012
BNDES' clients (NAO_Innovation)			
Number of applicant firms	59	81	89
Foreign	8	12	14
Number of patents	550	906	1,456
Applied for by foreign firms	39	80	119
Number of patents: yearly average per firm	0.55	0.77	0.67
Applied for by foreign firms	0.24	0.42	0.34

Sources: INPI, BNDES and C.

Additional Funding: AOs

In the case of AOs, information is available from March 28th, 2002 to December 30th, 2015. The contracted amounts in innovative projects were significantly lower - a total of R\$ 973.2 million, half of which were invested in agriculture. The manufacturing industry represented only 18.2% of contracted values and 4.9% of the number of projects.

The AOs resources also increased throughout the period. Specially, a great leap in volume of resources, number of operations and

attended firms was seen from 2011 on. 89% of the amounts were contracted between 2011 and 2015.

Among the manufacturing industries, medium-low and especially low technology sectors were proportionally more contemplated by AOs with, respectively, 26.3% and 15.2% of resources. NAOs' highly representative sectors, such as vehicles and pharmaceuticals, lost presence among AOs, except for energy industries (oil and biofuels industry) (table 9).

Table 9 - AO_Innovation: sectorial distribution (2002-2015)

Sectors	Number of projects	Contracted values (R\$ million)	Participation in the contracted values (%)
High technology industry	14	32,9	18,6%
Computing equipment, electronic and optical products	12	28,9	16,3%
Pharmaceutical products	2	4,0	2,3%
Transportation equipment other than motor vehicles	-	-	-
Medium-high technology industry	28	70,8	39,9%
Electric machines, devices and materials	5	7,2	4,1%
Motor vehicle, tow trucks and bodyworks	4	1,5	0,8%
Chemical products	3	23,5	13,3%
Machines and equipment	15	37,8	21,3%
Maintenance, repair and installation of machines and equipment	1	0,9	0,5%
Medium- low technology industry	8	46,6	26,3%
Rubber and plastic material products	3	3,7	2,1%
Coke, oil derived products and biofuels	1	27,0	15,2%
Non-metallic minerals products	1	0,6	0,3%
Metallurgy	1	0,5	0,3%
Metal product , except for machines and equipment	2	14,8	8,4%

Low technology industry	13	27,0	15,2%
Food products	1	1,3	0,8%
Textile products	2	2,7	1,5%
Clothing and accessories	1	1,0	0,6%
Preparation of leather and leather artifact, travel gear and footwear	1	1,7	1,0%
Wooden products	2	5,4	3,1%
Cellulose, paper and paper products	2	5,9	3,3%
Furniture	3	6,2	3,5%
Miscellaneous products	1	2,7	1,5%
TOTAL	63	177,4	100,0%

Source: BNDES.

Regarding instruments for supporting innovation, horizontal lines stand out with 76.3% of contracted values, followed by support for

capital goods. Micro, Small and Medium firms (MSMF)' instrument also appear, even though with little significance (1.0%) (table 10).

Table 10 - Financial instruments of AOs aimed at innovation

Financial instruments	Number of operations	Contracted value (R\$ million)
Horizontal lines		
PSI Capital Inovador	6	71.7
PSI Inovação	31	63.7
Complementary lines		
PSI BK	4	22.1
Sectorial lines		
Profarma	1	1.0
Others		
MSMF	4	1.7
Others	17	17.2
Total	63	177.4

Source: BNDES.

Therefore, in comparison to NAOs, the distribution of AO resources is more uniform; the average values are lower and the horizontal lines, compared to the others, are more relevant.

FINAL CONSIDERATIONS

The political agenda of the Brazilian government included innovation as an important issue in the 2000s. Especially since 2004, when sectorial and ST&I policies were reintroduced, the subject became relevant for the federal

government. New legislations and instruments were launched, as well as an expressive increase in resources directed to technological development.

During this period, BNDES became an important institution in supporting technological development. As showed in the previous sections, the BNDES action in the field of innovation went through three periods. The first one, between 2005 and 2007, marked its incorporation in the agenda. In second period, from 2008 to 2011, the innovation was consolidated as a strategic priority and the bank

incorporated a broader and more structural view of innovation. In 2012 BNDES started exercising a more active attitude regarding technologies to be developed. *Paiss* represented an important change by defining the technological segment to be supported (second generation ethanol) (Tavares, 2013). Due to its success, important ramifications were created, culminating in the launch of *Inova Empresa*, which aimed to replicate the *Paiss* experience to other sectors.

As a result of these changes, there was a significant increase in contracted amounts of innovative projects, especially from 2011 on. The 2012-2015 period, in which *PSI* instruments and *Plano Inova Empresa* were in vigor, concentrated 75.1% of the resources deployed throughout the whole period.

It was also noted an increased importance of innovation' projects in BNDES expenditures. In the whole period, the NAOs reached R\$ 219.5 billion, with an average of 6.5% of this value directed to projects related to innovation. This percentage, however, presented major modifications with time: until 2009, these projects represented, in average, just 1.0% of contracted amounts. In 2010, it reached 4.5%. Still, the most significant leap happened from 2011 on, when innovative projects achieved more than 8.0% of total contracted resources, including the peak of 20.8% in 2013.

Even if the resources allocated to innovative projects have grown as much in absolute as in proportional terms, the number of firms attended in the period remained limited. NAOs contemplated just 168 firms of manufacturing industry in 362 operations. Among these 362 projects, foreign companies contracted 86 projects with an average value of R\$ 72.2 million each, significantly superior to the R\$ 29.3 million average of the national ones. Of the R\$ 14.3 billion invested in innovation by the institution, 43.4% were contracted between 2002 and 2015.

BNDES innovative projects supported specially high technology sectors. This indicator opposes, to a certain degree, the critics that the institution essentially financed sectors in which the country was already competitive: at least in the field of innovation, high tech industries

received comparatively more resources. However, it is important to point out that relevant innovations may occur in low tech sectors, and *Paiss* is an example of that: it proposed to solve a technological bottleneck in a low tech segment in which the country was losing competitiveness.

Among the instruments, the ones aimed at supporting engineering activities represented 39.4% of the contracted values, standing out as the main instrument (if value is the criteria). Next came the horizontal lines, with 33.4% of the amount contracted in the period, which were used by many industrial sectors.

Despite the growing relevance of BNDES as a player of innovative policies, some points should be considered.

Firstly, many instruments were launched and closed over time. This was certainly part of the learning process of the institution; however, the excessive number of changes, especially until 2010, may have confused the (potential) clients. In addition, an excessive number of instruments with little or no use seems to have been launched. *Proplástico* and *Pró-Aeronáutica*, for instance, barely appear in the assessed database. Only *Profarma* and *Prosoft* stood out among the sectorial instruments that supported innovative projects in manufacturing industries. Therefore, a more cautious evaluation of technological bottlenecks would be necessary before the launch of instruments to avoid under-use of them.

The representativity of the motor vehicle sector in contracted values is also worthy of notice. This was, by far, the sector with the greatest support by the institution. While it represented, in 2011, just 13.4% of innovative expenditures of the Brazilian manufacturing industry, it received, between 2002 and 2015, 30.9% of NAO resources for innovation (R\$ 4.9 billion). The major part of this industry is foreign, excepting some segments, such as autoparts.

One could question which segments should be supported by innovative polices: high tech sectors, due to their potential technological externalities; smaller firms, given their limited resources; or, yet, technological and social bottlenecks, notwithstanding the size or sector

of firms. However, does the motor vehicle industry attend some of these criteria to be especially benefitted? An internationalized industry needs such large amounts of national resources to finance itself? Among the problems the country must solve, is the matter of vehicles, particularly those destined to individual transport, so relevant? Do they promote so many externalities? What is the return, in innovative terms, brought by this industry to the country? Given the amount of resources received by automobile firms, it is necessary to seriously consider these questions.

BNDES seems to have given an important leap in terms of learning and use of its instruments until at least 2015. The plans and instruments created from 2002 to 2015, especially in final years of this period, are an example of that. To generate the expected returns, it is vital that the institution (and the country) have a clear idea of what problems we should solve, where are our bottlenecks and what kind of innovation we should and must finance. Otherwise, great amounts of resources may be invested, and even if they generate interesting innovations and increase the lucrativity of companies, their spread through society, as well as the solution of the main national problems, will remain inexistent.

ACKNOWLEDGEMENTS

The authors thank Larissa Pereira for the precious help in the data elaboration and BNDES for sharing information regarding their operations involving technological innovation.

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APPENDIX

CATEGORIES OF OPERATIONS ADOPTED BY BNDES

Operations

- Direct: operations larger than R\$ 20 million that do not involved other financial agents (brokers) and are necessarily non-automatic;
- Non-automatic indirect: operations larger than R\$ 20 million, with other financial agents acting as brokers and whose credit concession depends on previous analysis by BNDES;
- Automatic indirect: sums up to R\$ 20 million, intermediated by other financial agents without interference of BNDES in the credit analysis.

Products

The instruments analyzed in this paper were included in the BNDES products described below.

Fixed income non-automatic operations:

- BNDES Finem: finances investments for the implementation, expansion, recuperation and modernization of fixed assets in projects whose value is equal or superior to R\$ 20 million;
- BNDES Limite de Crédito: financial support to low risk firms or economic groups for current or RD&I investments;
- BNDES não reembolsável: non-refundable credit operations.

Fixed income automatic operations:

- BNDES Automático: financing investment projects whose value is equal or superior to R\$ 20 million by means of authorized financial institutions. It finances the implementation, expansion, recuperation and modernization of fixed assets as well as RD&I projects;
- BNDES Financiamento de Máquinas e Equipamentos (BNDES Finame): financing, by means of authorized financial institutions the acquisition of new machines, equipment and computing made in Brazil and accredited by BNDES.

To each product there is one or more associated credit lines with specific characteristics and conditions, such as financial cost, maintenance fees, spread, guarantees and grace periods.

“Programs”, on the other hand, had predetermined resource endowment and duration that could be extended. Programs had characteristics and financial conditions similar to the “financing lines”, although they could work together with more than one product.