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Innovation for Competitiveness in Brazil: An Overview of Recent Performance and Main Government Policies

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5.1 Introduction

Brazil has recently faced its worst recession in history. After two consecutive years of strongly negative growth (−3.8% in 2015 and −3.6% in 2016) and a weak recovery contaminated by the unstable political scenario in 2017 (only 1% increase in economic activity) perspectives are still not very impressive: growth forecast is only 1.34% for 2018.[1]

The opinions expressed in this chapter are the author's own and do not necessarily reflect the view of Brazilian Innovation Agency (Finep).

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The situation seems particularly shocking for Brazilians because it came immediately after the first decade of the 2000s, the most prosperous period since the 1970s. In the first ten years of this century, GDP annual growth rate averaged 3.65%, compared to only 2.6% in the 1990s and 1.7% in the 1980s. Simultaneously, the country experienced a period of sharp decline in poverty and income inequality. Between 2001 and 2011, the income of the poorest 10% grew by 91.2%, while the richest 10% experienced an increase of only 16.6%. That allowed the Gini index to fall from 0.594 to 0.527 and the poverty level to drop from 24% to 10.2% of the general population (IPEA 2012b). Consequently, this period of growth also had a significant social impact because unlike in previous experiences, prosperity was distributed towards the poorest segments of society. However, the simultaneous return of low economic activity and unemployment is endangering the social improvements obtained in the previous decade.

It is not our intention here to discuss exhaustively the recent economic crisis. However, we do believe that such discussion should pass by the poor performance of productivity and the lowering external competitiveness of the economy, particularly of the manufacturing sector, during the economic growth period. Indeed, the average growth of total factor productivity in the first decade of this century (1% per year) was slightly above the OECD average (Aguiar et al. 2013), with labor productivity in manufacturing increasing by an annual average of only 0.4% between 2000 and 2009, according to De Negri and Cavalcante (2014), or −0.6% as measured by IPEA (2012a). Meanwhile, the share of commodities in total exports rose from 37% to 51% between 2001 and 2011 and the share of goods with medium or high technological intensity fell from 36% to only 23% in the period (IPEA 2011).

Different factors are usually pointed as causes for this performance. Macroeconomists tend to emphasize monetary and exchange rate policies as especially unfavorable to domestic production in the period, but other commonly cited aspects are education and human capital, the business environment and institutions, infrastructure, and in a smaller proportion, the innovative performance of firms (De Negri and Cavalcante 2014). In the following sections we will focus on the latter issue and on government policies in place that try to influence innovation in domestic firms. Among the factors mentioned previously, this has been the least emphasized

in the existing political and economic discussions and, at the same time, is the most challenging within the current institutional framework.

This chapter is divided in four sections besides this introduction. In the next segment we explore and compare national innovation indicators to show how innovative performance in Brazil's business sector has stagnated. Section 5.3 explains government initiatives that are currently in place to alter such a scenario, with a focus on support instruments available to private companies. Our brief conclusion comes in Sect. 5.4.

5.2 Innovation in the Business Sector: Low Performance, Wherever You Look

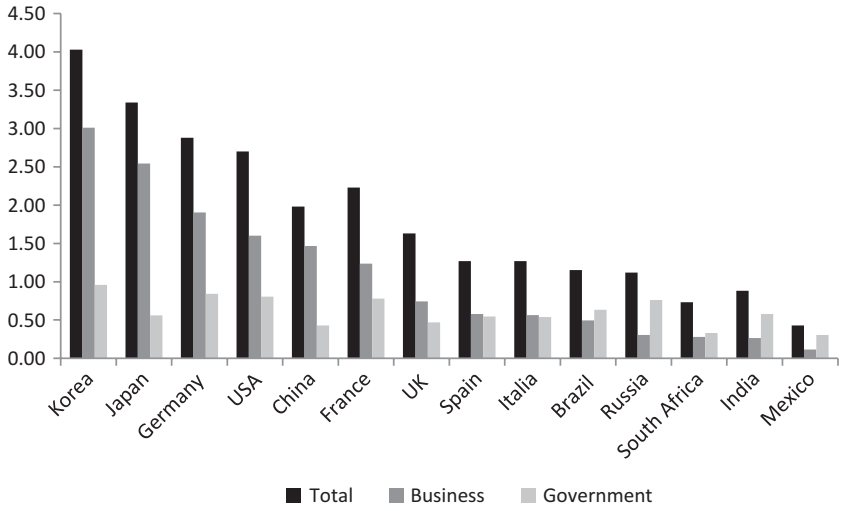
The low performance of the Brazilian industry and its productivity trajectory is well documented. IPEA (2016) provides a comprehensive overview of this process, analyzing the issue using different methodologies, periods, and international databases and indicating unequivocally that productivity is relatively low, has been growing slowly since the 1980s, and that this picture has not changed during the prosperity that marked the first decade of this century.

There is significant theoretical and empirical evidence indicating the importance of innovation for productivity and competitiveness. Innovative firms tend to be more efficient and productive. They are also more likely to export and overcome the sunk costs of entry in foreign markets. Firms that develop new products are more likely to open and consolidate new markets, differentiate themselves from their competitors, and establish technological barriers to the entry of rivals.

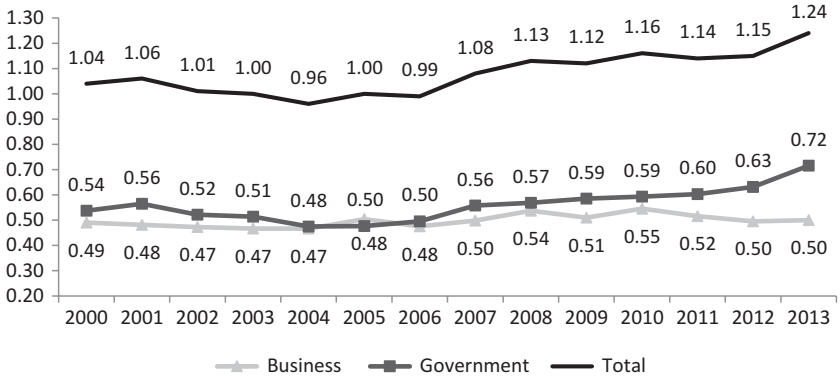
Empirical evidence in favor of a positive causal relation between innovation and productivity is very broad and robust to different periods, countries, and methodologies. Griliches (1998) compiles a set of empirical studies on the strong relationship between innovation inputs, especially private spending on R&D, and total productivity of factors of production at the level of firms, sectors, and countries. Relatedly, the positive causal relationship between innovation and exports is also demonstrated by empirical research. Recent work by Caldera (2010) and Becker and Egger (2013) found better export performance among firms

that engage in product innovations, and the former finds evidence that also process innovations favor exports. Dosi et al. (2014) show the dominance of technological factors over cost factors (wages) to determine the international market share and the likelihood of firms to become exporters, both at the level of companies and at the level of sectors.

The Brazilian reality, however, is not encouraging in this regard. Castro et al. (2005), after analyzing data from the first Innovation Survey in Brazil (the PINTEC 2000), concluded that at the time innovative effort of firms in Brazilian manufacturing was still insufficient to achieve higher growth rates and integration to international trade flows in higher value-added products (Castro et al. 2005). A direct international comparison of the available data indicates that this conclusion remains valid 15 years later. Graph 5.1 provides an international comparison of R&D expenditures by the government and the business sector for several developed and developing nations. It shows that R&D expenditures in Brazil trail OECD levels and China, although stay above important developing countries. Government expenditures seem to be relatively close to other countries, but Brazil lags significantly in terms of business expenditures



Graph 5.1 International R&D investment/GDP in 2012 (%). (Source: Author's elaboration with data from MCTIC)

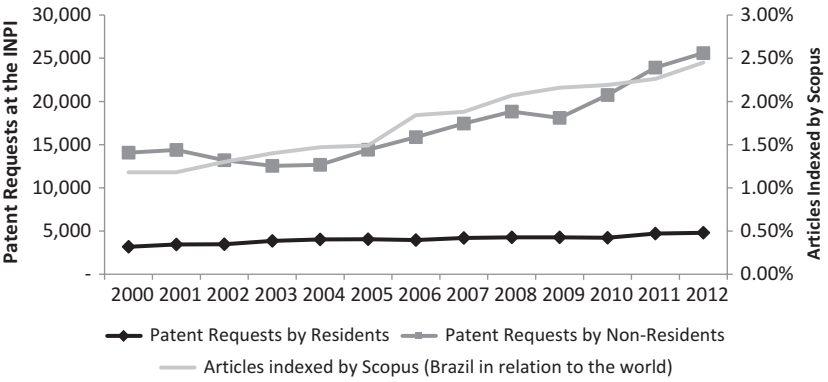


Graph 5.2 R&D expenditures as percentage of the GDP. (Source: Author's elaboration with data from MCTIC. Business and Government expenditures do no sum to the total because of private higher-education expenditures that are not included)

in R&D, which is lower than government expenditures. This pattern is common to other developing countries but is not found in any of the selected OECD countries except Mexico, suggesting a necessity to promote private investment in R&D in Brazil.

Graph 5.2 provides a picture of R&D expenditures in Brazil between 2000 and 2013. An important change seems to have occurred in 2007, especially between 2011 and 2013, when an upward trend in overall R&D expenditure in the country emerged. In 2013, Brazil had its highest R&D investment rate since the beginning of the series, reaching 1.24% of GDP. However, that growth was due exclusively to increases in government R&D expenditures, which jumped from 0.48% in 2006 to 0.72% of GDP in 2013. The business sector depicts very limited evolution, with a small increase between 2007 and 2010, and a subsequent reduction pointing back to the initial level of the series.

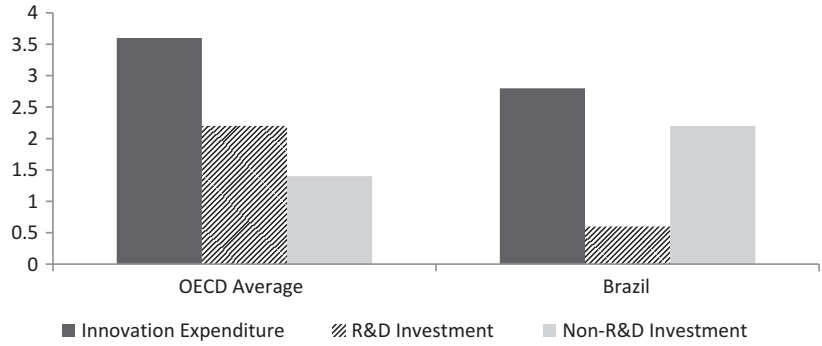
It is worth noticing that the recent increase in government expenditures in R&D seems to provide observable results. In Brazil, virtually all basic research is carried out in public universities or research centers linked to the government; therefore, it is not surprising that some scientific output indicators, such as publications,[2] have evolved rapidly. Nevertheless, the less favorable performance of the business sector made innovation indicators not to move up at the same pace. Graph 5.3 shows



Graph 5.3 Publications and patent requests at INPI. (Source: Author's elaboration with data from MCTIC)

that the Brazilian share of Scopus-indexed articles grew from 1.18% in 2000 to 2.45% in 2012, a very significant result considering many countries also increased sharply the number of published articles in the period. The growth in the number of patents requests in the National Institute of Intellectual Property (INPI), however, grew modestly compared to international trends, moving up only 50% for domestic residents and 81% for non-residents in the period. In this case, and in opposition to the publication of articles, Brazilian participation in world patents has remained almost stable. In 2010, when compared to 75 countries, Brazil occupied the 54th position in patent applications to GDP (1.38 patents per billion dollars) and ranked 55th among 82 countries in terms of patents per capita (13.9 patents per million inhabitants).

The low level of business expenditure in R&D in Brazil can also be observed in the number of researchers currently employed in the country. In fact, Brazil remains significantly below all OECD countries in terms of researchers employed relative to population, alongside technologically less dynamic emerging economies like Mexico and South Africa (OECD 2015). In fact, most researchers and post-graduates from the fields of engineering and science continue to be absorbed by the public sector. For example, in 2012, only 10% of graduated Brazilian physicists worked in private companies and nearly 60% of researchers were working in univer-

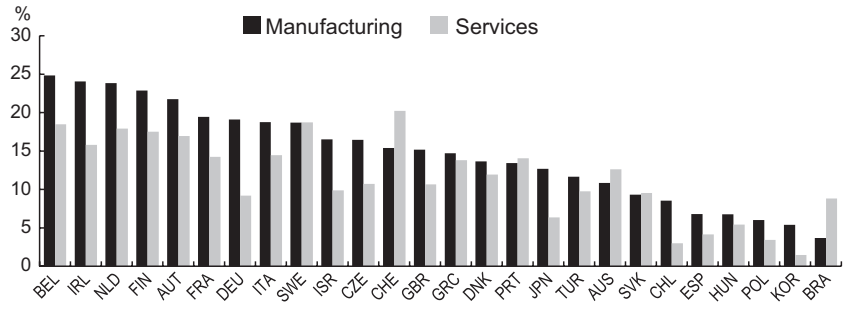


Graph 5.4 R&D investment and non-R&D investments relative to sales in manufacturing (%). (Source: Author's elaboration with data from IPEA 2016)

sities, while in Germany 65% work in the private sector and in the United States that number reaches 75%.

According to Baessa et al. (2005), the innovative activities of Brazilian firms are marked by low absolute investment levels, high relative expenditures in purchase of machinery and equipment, and few human resources allocated to R&D. These characteristics corroborate the view that the national technological system is predominantly characterized by imitation, and technical change is highly restricted to the absorption and improvement of innovations developed abroad. This is further corroborated by Graph 5.4, which compares the division of innovation expenditures in Brazil and the OECD average. It supports the view that the innovation pattern of Brazilian firms is not dynamic when it comes to product differentiation and the generation of new technologies. The strategy of companies seems focused on reducing costs by incorporating new machinery and equipment, with expenditures in R&D activities significantly below more developed countries.

This pattern is reinforced comparing the percentage of firms that declared having performed product or process innovations between 2010 and 2012 (35.6%) with the percentage of firms that declared having introduced new products to the market (3.7%). While the former number is relatively high, surpassing countries like Japan, Korea, and Israel (and is above the level reached in 2001–33.5%), the latter is the lowest in the OECD sample (and below the 2001 level—4.2%). It seems that the



Graph 5.5 Manufacturing and service firms that developed products new to the market (2010–2012). (Source: Author's elaboration with data from OECD 2013a)

innovative efforts of Brazilian companies are focused on simpler, incremental process innovations with low risk and limited impact to firms and their markets. Limited investment is directed to new products, i.e. products that previously did not exist and required higher risk taking and innovative efforts. This patter is depicted in Graph 5.5. In the services sector, this rate rises to 8.8% which is more in line with other countries in the sample.

Overall, indicators suggest that innovation remains an important challenge and that the innovative performance of Brazilian firms has been stagnated, at best, in the last 15 years. Innovation has not contributed to increase Brazil's growth rate and has possibly helped position Brazilian firms in a fragile situation against its foreign, more innovative competitors.

Although innovation is still a theme of low relevance in the national political agenda, there are important initiatives under way by the Brazilian government to support the expansion of business activities in the area. In the next section, we present a summary of the current situation and some initiatives that can potentially have a positive influence in this scenario.

5.3 Main Existing Mechanisms to Support Innovation in the Private Sector in Brazil

The international empirical evidence points to the existence of additionality effects in government subsidies for business expenditures in innovation. According to a major survey done recently by Zúñiga-Vicente et al. (2014) with the most relevant empirical articles published in international journals on the effects of government subsidies to innovation, totaling 77 articles, over 60% indicated additionality effects on private expenditures, while less than 20% indicated substitution effects.

The main justification for government intervention to support private R&D activities suggested by traditional economic theory is related to market failures, that is, to the idea that knowledge is non-rival and to a large extent also non-excludable (Hall 2002). Thus, the social return on investments to produce knowledge may not be fully appropriated by the investor, therefore causing knowledge production to be below the theoretical optimal level in an efficient market solution.

Neo-Schumpeterian economists emphasize the role of technological capabilities to explain growth and trade patterns among countries. Therefore, the international distribution of innovative capabilities becomes a fundamental factor in this context and the institutional framework that influences the dissemination of knowledge, including governments, is the main structural variable underlying different international performances.

Another key feature of innovation expenditures is the extreme uncertainty about its results, particularly in the early stages and facing the development of radical innovations. This aspect, coupled with the intangibility of the results generated in most R&D activities, makes financing these projects a complicated issue for financial markets. Consequently, there is a chronic rationing of funds for R&D of new technologies (Zúñiga-Vincent et al. 2014).

Since the late 1990s, when the first sectoral innovation funds were created, the importance of the innovation agenda has been growing in Brazil. Indeed, there is an effort of the Brazilian government, inspired by the experience of technologically more successful countries, to equip the

national innovation system with the same support mechanisms that exist in developed countries. Indeed, the framework of innovation policies evolved in Brazil in recent years and appears relatively complete in terms of the existence of support instruments for innovation activities in the private sector. Currently, Brazil has many of the tools historically used in Europe and the United States to foster innovation, such as: (i) subsidized credit; (ii) mechanisms to support startups and venture capital (VC); (iii) grants for private firms; (iv) tax incentives; and (v) public procurement mechanisms for innovation.

Each of these instruments will be discussed in more detail in the remaining of this section. We will demonstrate the evolution in the existing institutional framework, but also to point out some existing limitations and challenges for these policies to meet the needs of the domestic business sector.

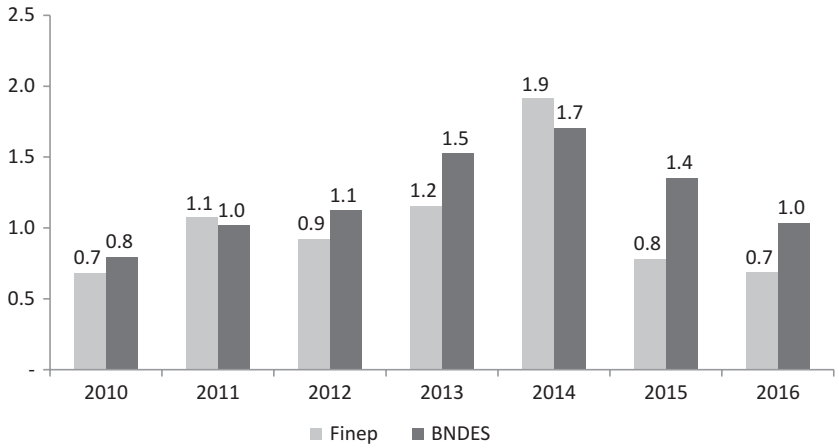
5.3.1 Subsidized Credit

The main (public) institutions that provide credit for innovation in Brazil are Brazilian Innovation Agency (Finep)[3] and National Bank of Social and Economic Development (BNDES).[4] In 2014, Finep disbursed US$ 1.9 billion in this modality. Although direct funding for innovation is not the focus of BNDES, the bank disbursed R$ 1.7 billion for innovation in 2014.

As seen in Graph 5.6, the volume operated by both institutions has grown significantly over the past few years, going from a level of around US$ 1.5 billion disbursed in 2010 to approximately US$ 3.6 billion in 2014. This increase was made possible mainly by government countercyclical actions via the Investment Sustentation Program (PSI), which from 2009 to 2015 offered additional credit lines for investment projects.

The data for 2015 and 2016, however, are well below those of 2014. Some reasons explain this fact, such as the beginning of the economic crisis and the supply of subsidized resources in worse financial conditions.

Internationally, the supply of subsidized credit is not the most popular instrument to support innovation. Most countries prefer to offer grants and tax incentives. The main reason is that credit does not have the most



Graph 5.6 Credit for innovation in Brazil (2007–2014)—Disbursements in billions of USD. (Source: Author's elaboration with data from Finep and BNDES)

suitable characteristics to support high-risk projects,[5] as usually is the case for more innovative technologies. Therefore, it tends to focus on lower-risk innovations that are "closer to market", such as process or product incremental innovations or adaptations of technologies already in use abroad. From this perspective, it is unlikely that credit could have a significant impact on the currently prevailing pattern of innovation among Brazilian companies.

However, authors like Zúñiga-Vicente et al. (2014) indicate that the crowding-in effect of public spending tends to be higher in the case of firms that suffer from credit restrictions to finance promising projects. In Brazil, this dimension is especially relevant given the absence of a private system of long-term financing. Currently, BNDES and other state-owned financial institutions practically monopolize the long-term financial market in Brazil. This situation is caused by the high level of the basic interest rate—the Selic rate, which usually runs above 10% per year—and by its high volatility (Carneiro and Carvalho 2009). In fact, in June 2015, the three main public banks—BNDES, Caixa Econômica Federal (CEF), and Banco do Brasil (BB)—were the main long-term lenders in the country, totaling 92% of market share.

Thus, the existence of a long-term credit market with significantly subsidized rates for innovation has the potential for unlocking private investments in new technologies in Brazil. In fact, at least two relatively recent empirical studies (De Negri et al. 2008; Avellar 2009) indicated additionality effects in credit policies for innovation in the country.

The stabilization of a long-term credit-supply level for innovation, however, has been facing some difficulties. Innovation credit lines of the PSI were not renewed for 2016 by the federal government. At the same time, the other main source of funds for innovation, the[6] National Fund for Scientific and Technological Development (FNDCT), has had its financial capacity significantly reduced since 2014.

The Brazilian government also announced in the begining of 2017 that the supply of subsidized credit in the economy will be further reduced in coming years. This will certainly be a great challenge for national companies that innovate, given the challenges encountered in obtaining funding for these activities in the private sector.

5.3.2 Support Mechanisms for Startups and Venture Capital

Another funding mechanism for innovation activities available in a number of countries is VC, with growing importance to angel and seed investments aimed to finance startups and small companies.

The importance of VC and support of startups is emphasized by several authors. Kortum and Lerner (2000), using US data, demonstrated that the VC has a significant effect on patenting and estimated that each dollar invested by VC is three times more valuable to generate patents than a dollar spent in daily activities of R&D. In addition, patents derived from companies that received VC contribution are cited more often than the others (Kortum and Lerner 2000). Using data from Germany, Tykvova (2000) also finds a positive relationship between investments in VC and patent applications (Hirukawa and Ueda 2011).

Other authors, such as Mazzucato (2013) and Hopkins and Lazonick (2012), relativize the importance of VC. According to them, these funds

usually do not have the patience and risk appetite needed for more radical innovation projects, which are riskier and require more time to mature. Moreover, these funds usually only focus on low-capital intensive sector, in order to ensure the high level of diversification of their portfolios.

Although this debate is under way, internationally, public resources have been an important source, if not the main, for VC. Major centers of entrepreneurship, such as those located in Silicon Valley (the United States), Singapore, and Tel Aviv (Israel), count with a high government presence (Lerner 2010). In the United States, for example, these initiatives began more than half a century ago through the Small Business Investment Company (SBIC), which is still in operation. At state level, more than 44 US states were operating funds that held VC investments at the end of 2006 (Brasil 2014).

Other OECD countries also support VC. In 2013, there were 96 VC funds with the presence of public capital in the OECD, representing 21 of its countries (OECD 2013b). It is noteworthy that, after the 2008 crisis, there was a rise of public capital prominence, especially in Europe, reaching 40% of the funds raised in VC in 2013 (OECD 2013b).

Within this category of VC, the seed and the angel investments[7] are of higher importance because they normally represent the first and riskiest contribution into a new business, and are normally made by angel investors, which in addition to financial resources provide the business knowledge to structure their business plans, leveraging the success of these initiatives and facilitating access to a network for the companies.

Some government initiatives have also sought to develop seed and angel funding in Brazil. Finep[8] operates in the segment since 2001 and intensified action in 2005. In total, Finep has approved eight investments in seed capital funds. In all, the funds landed resources in 39 innovative companies, with total equity commitment of R$ 340.5 million.

BNDES, for its turn, launched in 2007 a seed fund, the Criatec I, with committed equity of R$ 100 million. In 2013 and 2014, BNDES launched two other funds, the Criatec II and the Criatec III, which have a total amount of R$ 386 million of committed equity and provide up to R$ 6 million to each company. Another initiative is the InovAtiva program, of the Ministry of Industry, Foreign Trade and Services (MDIC),

which seeks to provide mentoring and access to a network of contacts to innovative companies with sales of up to R$ 3.6 million.

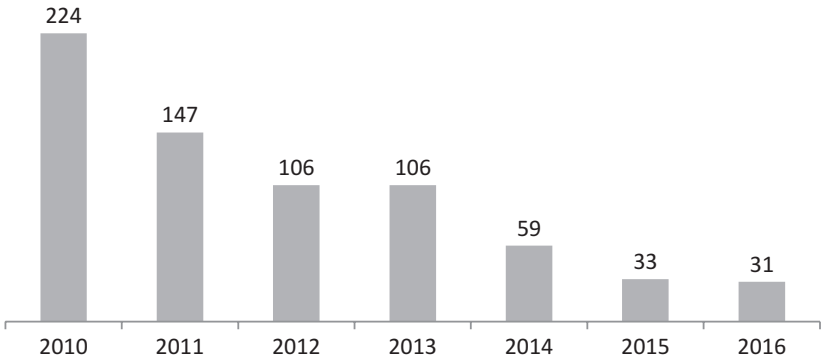
However, the seed and angel capital market in Brazil are still incipient. An example is the stock of angel investments of only R$ 260 million (US$ 70 million) invested by 6500 angel investors in just over 1500 companies, while the United States has a stock of US$ 22.9 billion, from 268,000 angel investors, targeted the 67,000 companies; the European Union has a stock of US$ 7.6 billion, from 271,000 investors (2013 data, for Brazil data is for 2014).

Although there are important initiatives in course, they do not seem to have the scale required to change the low presence of the VC segment in Brazil significantly. Given these and other institutional advances, investments in VC have increased 78% between 2011 and 2013, from US$ 183 million to US$ 326 million (ABVCAP 2014). However, the stock of investments in VC in Brazil in 2013 was the equivalent of 0.015% of the GDP, 40 times less than in Israel, 14 times less than in the United States and 7 times less than in India.

5.3.3 Grants for Firms

The Innovation Law, enacted in 2004, created grants for private companies for the first time in the framework of the Brazilian Innovation System, allowing direct granting of non-refundable money to firms exclusively for innovation projects expenses. This enabled in Brazil an instrument already in extensive use in advanced economies. Grants are one of the most powerful tools to induce high-risk innovation in companies. In Brazil, it is operated only by Finep with FNDCT resources and always preceded by a public call.

Despite its importance, the volume for the economic support has fallen in recent years, as seen in the Graph 5.7. After reaching a level of US$ 224 million in 2010, its volume has been reduced to only US$ 31 million in 2016. The main reasons for this trend are the reduction in available resources in the FNDCT,[9] caused by the fiscal austerity and the reallocation of resources towards other types of expenses.



Graph 5.7 Finep—subsidies for companies—disbursements per year (millions of US$). (Source: Author's elaboration with data from Finep)

In recent years, there was an effort by the government to increase the impact of grants through the Inova Empresa Plan. Grants are aimed at R&D activities, but it is well known that those represent only part of the innovation process. After its development, a new technology generally still has the challenges of scaling up and commercial deployment. Therefore, the success of R&D projects to produce innovations can be leveraged with the provision of other instruments, such as credit and equity.

Thus, the Inova Empresa Plan was designed and operated by Finep and BNDES in 2013 and 2014, with the provision of a set of support instruments such as credit, grants for companies, grants for research institutes, equity, and public procurements for some sectors. The idea underlying the program was to support innovation in its systemic character, that is, to mobilize all companies participating in the production chain with the purpose of solving specific technological problems of the industry.

This initiative was inspired by well-known and successful experiences of countries like the United States in its military-industrial complex, clean technology and semiconductors sectors, as well as Sweden, India, and China, among others. In the health segments, for example, the Inova Empresa Plan managed to combine credit, grants, and public procurement to develop drugs demanded by the Unified Health System, Brazil's public healthcare program.

Although the initiatives promoted by Inova Empresa have been recognized as successful, they have not been continued by the federal government, mainly due to a lack of resources.

Brazil also has other non-refundable support mechanisms for innovation projects targeted at partnerships between research centers and businesses. The most important are the Funtec, operated by BNDES, non-reimbursable FNDCT money for research centers, operated by Finep, and resources from Embrapii.[10] These instruments are targeted at public and private research institutions for joint innovation projects with the business sector. Although these instruments are relevant, our analysis of them is not extended, since the focus of this study is on the instruments of support available directly to private companies.

5.3.4 Tax Incentives

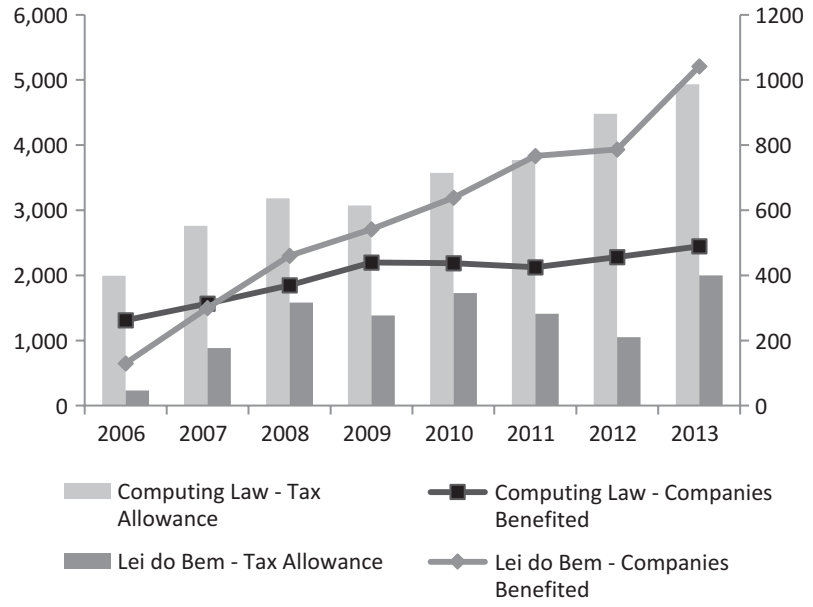
Tax incentives for innovation have become an international trend in recent years. Some authors indicate some features that make them attractive to policymakers: (i) they are flexible, since the decision-making process concerning the development of innovation and how much to spend in it is up to the firm; (ii) they do not discriminate sectors; and (iii) they are readily available to businesses and have low administrative cost to the government (Araújo 2012).

However, tax incentives are subject to a number of criticisms. Firstly, they virtually exclude small businesses in Brazil, since their most common tax system does not allow then to take advantage of these incentives. Secondly, they tend to change the overall composition of the business R&D invested by a given country, since tax incentives stimulate the execution of more profitable innovation projects which are less risky and have shorter time to market, thus leaving aside projects with high social returns, but longer development time required, subject to greater uncertainty and likely more intense spill-over effects (Araújo 2012). Finally, a set of research has pointed to no evidence of actual positive impacts of tax breaks on R&D activities (Mazzucato 2013).

Be that as it may, currently 27 out of 34 OECD countries offer some form of tax incentives for innovation. In Brazil there are also tax mechanisms to stimulate investment in R&D, particularly the Law of Informatics and Law do Bem.

The Informatics Law grants exemption on a portion of industrialized product tax for companies investing in R&D activities and producing computer and telecommunications equipment in Brazil. The Law do Bem was established in 2006 and grants all sectors, except computer and telecommunications, income tax deductions and other tax credits, such as accelerated depreciation on portion of their investments in R&D (Calzolaio and Dathein 2012).

Graph 5.8 shows the evolution in the number of companies benefited from the exemptions and the total tax renounce of these two instruments. As seen, both the number of companies and the total value of the tax



Graph 5.8 Tax exemption and companies benefited by Lei do Bem and the Informatics Law (Data in millions of R$). (Source: Author's elaboration with data from MCTIC)

renounce have increased over the past few years, and the number of companies benefiting from Law do Bem has increased sharply.

Because of these two tax breaks, Brazil occupies an intermediate position in business R&D support via tax incentives. In a 35-country list, Brazil occupies the 19th position (2011 data), with an exemption equivalent to 0.05% GDP.

5.3.5 Public Procurement Mechanisms for Innovation

Another mechanism of public support for innovation still uncommon in the country is public procurement. For a group of authors, such as Edquist et al. (2000), besides providing services, materials, and the equipment necessary for the basic functioning of the state, public procurement can be used to stimulate the technological development of a country.

Broadly, policies based on the use of state purchasing power can be understood as part of the tools defined by Edler (2009) as demand-based innovation policies (DBIPs). The author defines the DBIPs as a set of public measures to increase demand for innovation, improve the conditions for the advent of innovations, or improve the demand in order to encourage innovation and its dissemination.

Several countries have initiatives that prioritize domestic firms in government procurement and many use the tool for technological development. The most emblematic cases come from the US government, particularly the Department of Defense (DoD). Demands from the DoD aimed at strengthening the military apparatus of the United States provided externalities to various branches of the economy, including popular civilian technologies. The development of the internet and the technologies that comprise the iPhone by DoD projects are now widely known cases (Mazzucato 2013).

Although internationally recognized as a key driver for innovation, the instrument is still incipient in Brazil.

However, there are also some government initiatives emerging. The most important is the program of Productive Development Partnerships (PDP) of Ministry of Health. This program can be defined as a partnership involving cooperation between public institutions and private

entities for the development, transfer, and absorption of technological capabilities in strategic products to meet the demands of the Ministry of Health. The Ministry of Health has already articulated at çeast 90 PDPs, resulting in the development of 64 medicines, six vaccines, and estimated savings of R$ 3 billion to the government.

Another recent case of success in using this instrument in the country is the acquisition by the Brazilian military of the KC-390 cargo plane from Embraer. The aircraft prototype was developed under demand of the Air Force of R$ 4.9 billion. However, public procurement for new technologies is still a relatively incipient in Brazil.

5.4 Conclusion

The performance of the Brazilian economy in the past decade was paradoxical: on the one hand, there were relatively high economic growth and an accelerated reduction of social inequalities. On the other, economic productivity had a modest performance compared to other countries and, in the case of the industry, possibly regressed. The competitiveness of Brazilian exports also decreased, in a context of increasing concentration in primary products and reduced complexity.

Several reasons are commonly cited to explain this situation, particularly the slow evolution of infrastructure, the business environment, the level of education ("human capital"), and the innovative performance of Brazilian companies. Without entering in a discussion about the relevance of each variable, we highlighted in this chapter the importance of innovation and tried to indicate through international comparisons that the innovative performance of Brazilian companies is not comparable to the most advanced economies in the world or to more dynamic developing countries like China and South Korea. Accordingly, we assert that the lack of innovation in the business sector is a major contributor to the reduction of productivity and international competitiveness of the Brazilian economy.

At the same time, it should be noted that innovation policy in Brazil has become increasingly complex in recent years. Although the theme still has low relevance in the political agenda of the country, there has

been undeniable progress since the late 1990s. On the one hand, government spending on R&D increased significantly, reaching levels comparable to countries of higher income per capita. On the other hand, there was an effort to improve the regulatory framework and offer different mechanisms to support the private sector. In this sense, it is possible to say that the main instruments to support innovation in the private sector are now present in the national innovation framework.

However, there is no evidence to date, to the best of our knowledge, that these initiatives have been able to significantly affect the overall picture of innovation in the Brazilian private sector. On the one hand, it is possible that other variables have reduced the effect of innovation policies on the private sector, such as the macroeconomic situation, the business environment, infrastructure, and educational performance. On the other, we believe that innovation policies lack the size and the institutional stability necessary for its effects to spread through the production chains of the Brazilian economy.

Indeed, there are indications of discontinuity in policies implemented in recent years, with reductions or more unpredictability in resources for subsided credit, grants, and government procurement programs. International historical experience and recent domestic performance advise Brazil to reverse this situation in the coming years. Otherwise, it might be giving up some of the main mechanisms available to promote competitiveness and finally achieve a sustainable growth rate for the domestic economy.

Notes

1. As forecast by the Central Bank of Brazil, 15/10/2018, available at: http://www.bcb.gov.br/pec/GCI/PORT/readout.asp
2. It is important to have in mind, however, that the quality of Brazilian publications still needs to be improved. Although Brazil is the 14th most published country between 2003 and 2012, the percentage of these publications among the 10% most cited is only 6.7%, a rate similar to China, a country known for the poor quality of its publications.

3. A state-owned company under the Ministry of Science, Technology, Innovation and Communications, focusing on supporting the whole innovation chain, from basic research in universities to innovation projects in companies.
4. A state-owned company under the Ministry of Planning whose main objective is to provide long-term financing for investments in all segments of the economy.
5. The credit instrument has contractual financial costs that are independent of the time taken to develop the technology and its eventual success, and it demands financial guarantees that prevent the sharing of risk between the entrepreneur and lender.
6. National Fund for Scientific and Technological Development (FNDCT), created in 1969, is the main national fund for the financing of scientific and technological research, both in the academic and in the business sectors.
7. Investment forms intended for startups and other smaller firms, where in addition to financial resources the investors contribute with knowledge and networking, among others.
8. In addition to the support for the seed and angel capital industry, two of the venture capital (VC) subcategories, Brazilian Innovation Agency (Finep) and National Bank of Social and Economic Development (BNDES), also supported sharply the structuration of the VC industry in Brazil. To date, for example, Finep has invested in 32 funds of VC, that have invested in 135 companies. BNDES and Finep also invest directly in innovative companies.
9. Law 12,858/2013 removed the main source of revenue for the FNDCT, which was oil royalties. At the same time, expenses unrelated to innovation such as the educational program Science Without Borders have been transferred to FNDCT, further reducing its budget availability.
10. Inspired by the operating model of the Fraunhofer Institutes in Germany, the Embrapii is a social organization under the Ministry of Science, Technology and Innovation (MCTI) that promotes cooperation projects between domestic companies and research institutions, focusing on the pre-comercial phase of the innovation process.

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