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Incentivizing Innovation: A Review of the Brazilian Federal Innovation Support Programs

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Abstract

Innovation is the transformation of knowledge of any kind into new products or services in the market. Its importance as a production factor is widely acknowledged. In the age of the knowledge-based economy innovation became critical for any company or even country to compete globally. Many countries are encouraging innovation through various mechanisms, and one of the most widely used is the provision of special incentives for innovation. This paper investigates incentive systems for the growth of technology companies as a strategy to promote knowledge-based economic development. As for the case investigations the study focuses on an emerging economy, Brazil. The research is based upon the available literature, best practices, government policy and review of incentive systems. The findings provide insights from the case study in a country context and some lessons learned for other countries using incentive systems to boost the innovation capabilities of their technology companies.

Keywords: *Innovation, innovation ecosystem, incentive program, technology companies, knowledge-based economy, knowledge-based economic development, Brazil*

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1. Introduction

For the last two centuries, social production has been primarily understood and shaped by neoclassical economic thought that recognized only three factors of production—i.e., land, labor and capital. Knowledge, education, and intellectual capacity were considered secondary, if not incidental, factors. Human capital was assumed to be either embedded in labor or just one of numerous categories of capital. In the last several decades, it has become apparent that knowledge is sufficiently important to deserve recognition as a fourth factor of production (Carrillo et al., 2014). Knowledge and the social and technological settings for their production and communication are now seen as keys to development and economic prosperity (Yigitcanlar & Bulu, 2015; Yigitcanlar & Sarimin, 2015). The rise of the knowledge-based economy has, in many cases, been accompanied by a concomitant decline in traditional industrial activity (Baum et al., 2009). The replacement of physical commodity production by more abstract forms of production—e.g., information, ideas, knowledge and innovation—has reinforced the importance of knowledge as a basis of economic development (Yigitcanlar et al., 2008a, 2008b; Huggins & Izushi, 2009).

According to OECD (1996) 'knowledge-based economy' is a term created to describe the trends in advanced economies towards a greater reliance on knowledge, information, and highly skilled labor. Knowledge-based economy has added the structural aspects of technological trajectories and regimes from a systems perspective (Cooke & Leydesdorff, 2006). The main novelty of the knowledge-based economy consists of the need to manage an intangible asset that, in contrast to material resources, does not depreciate through use but rather becomes more valuable the more it is used (Lonnqvist et al., 2014). Today's most advanced economies are fundamentally knowledge-based (Cooke & Leydesdorff, 2006; Yigitcanlar & Lonnqvist, 2013). Burton-Jones (2001) notes that the gap between rich and poor nations has been constantly increasing during the capitalist movement, and the new knowledge capitalism could be an opportunity to bridge the gap. According to Huggins (2011), "the evolution towards a knowledge-based economy not only represents a new competitiveness challenge, but a shift in both the nature of organizations and the way in which they devise and implement their strategies. The growing dependency of wealth creation on intangibles is making the global economy more fluid and volatile, and the capacity to access and combine new and existing knowledge effectively has become more important in the context of the competitiveness of companies, regions and nations" (p. 1459). In other words, in the age of knowledge-based economy 'innovation' is critical to be able to compete globally. In the most simplistic way, innovation is the transformation of

knowledge of any kind into new products or services in the market, and presently the perception of innovation as an important factor for knowledge-based economic development are widespread (Cooke, 2001; Fagerberg & Srholec, 2008; Yigitcanlar, 2010). According to De Blasio et al. (2014, P. 25-26), "innovation is commonly invoked as one of the main engines of growth. Accordingly, policy for innovation at national and international levels routinely highlights the role of public support for innovation"

There are numerous ways to support innovation (see Fagerberg et al., 2006; Cooke et al., 2011; Lundvall et al., 2011; Pancholi et al., 2014). For instance, the university-company integration is an important factor to generate innovation as well as public-private-academic sector cooperation in the form of so called triple-helix model partnership (Etzkowitz, 2003). Public policies, in many parts of the world, encourage this type of collaboration and knowledge exchange to generate innovation and knowledge-based economic development (see Benneworth & Charles, 2005; Smith & Bagchi-Sen, 2006; Huggins et al., 2008; Yigitcanlar & Sarimin, 2011). Huggins & Strakova (2011) say that an effective innovation policy targeting competitiveness should be focused on the following areas: "Making finance available to companies to expand research and development (R&D) and other knowledge-based activities; Improving the physical infrastructure allowing companies to locate in better equipment premises, and; Creating better networks with universities and R&D performing organizations" (p. 969). Furthermore, they also assert that policymakers need to support the intermediary organization to induce more active innovation collaborations between knowledge creators and small and medium-size enterprises (SMEs) through incentive programs.

It is apparent that in the era of global knowledge-based economy economic development is directly associated with innovation, entrepreneurship and technology development (Zhao, 2005; Yigitcanlar et al., 2014). Knowledge, creativity, innovation and competitiveness are the foundations of companies. Companies need knowledge and creativity to innovate and lead the market, and thus become more competitive. The national and regional innovation systems literature recognizes the role of innovation for growth economies (Huggins & Izushi, 2013). To be able to keep up-to-date and innovating in their markets, or sometimes in order to create new markets, companies seek support and funding. Governments encourage and reassure innovation and knowledge-based economic development by offering companies various incentives, such as tax, production, export, and employment subsidies, and direct grants in the form of financial assistance, and no or low interest rate loans (Scotchmer, 2004; Von Hippel & Von Krogh, 2006; Yigitcanlar, 2009; Wu et al., 2014). At the same time governments, by taking risk, become a

partner in the success or failure of innovation efforts (OECD, 2010).

This research explores existing policies and practices in order to provide insights on addressing the question of 'how to promote innovation in the context of an emerging economy?' With this question in mind, the paper aims to comprehensively review and analyze incentive programs and systems available for the growth of technology companies' innovation capabilities as a strategy to promote and foster knowledge-based economic development. The study places incentive systems as part of the innovation ecosystem of a rapidly emerging economy from the developed country context under the microscope. For the analysis Brazil is selected as a case investigation locality. The reasons for the selection are, Brazil: (a) Being mainly a strong natural resource-based economy; (b) Targeting to diversify its economy and move towards knowledge-based economy excellence due to high risks of reliance on natural resource economy-based growth; (c) Having assistance mechanisms for innovation such as support and incentive systems, and; (d) Representing the characteristics of an emerging economy from the developed country context. Furthermore, Brazil is an interesting case for investigating innovation support mechanisms as: Brazil is a developing nation with a strongly emerging economy ranked 7th in the globe. It has a vast area of 8,515,767 km^2 that makes Brazil the 5th largest country in the world. Its gross domestic product (GDP) for 2014 was estimated at US$ 3 trillion. Although Brazil is one of the largest national economies, it encounters many societal challenges ranking the country internationally 77th in per-capita income and 79th in the Human Development Index (HDI). However, in Brazil there has been an increasing recognition of the importance of science, technology and innovation (STI) policies for the development of the country in these areas since 1990s. Consequently, the promotion of innovation has become explicit in Brazil's public policies during the last several decades. Nevertheless, the companies, which are fundamental to the processes and agents of innovation, are not yet integrated into the system of STI satisfactorily and completely.

2. Brazilian Federal Innovation Support Programs

This study adopts a methodological approach mainly based on review and analysis of the literature, best practices, government STI policies, and innovation incentive systems and programs. The research employs these methods in the context of our case study of merging economy, namely Brazil. The investigation and its reporting take place through the steps presented next. Firstly, the governance of innovation in Brazil from the post-WWII era up until today is placed under the microscope. Then, Brazil's STI policies are thoroughly examined

chronologically. Afterwards, Brazil's innovation incentive programs are explored in detail. Lastly, based on the analysis results numerous learning and insights are discussed along with potential directions for Brazil to further promote innovation in the country in order to establish and further strengthen its knowledge-based economic development foundations.

2.1 Governance of Innovation in Brazil in a Nutshell

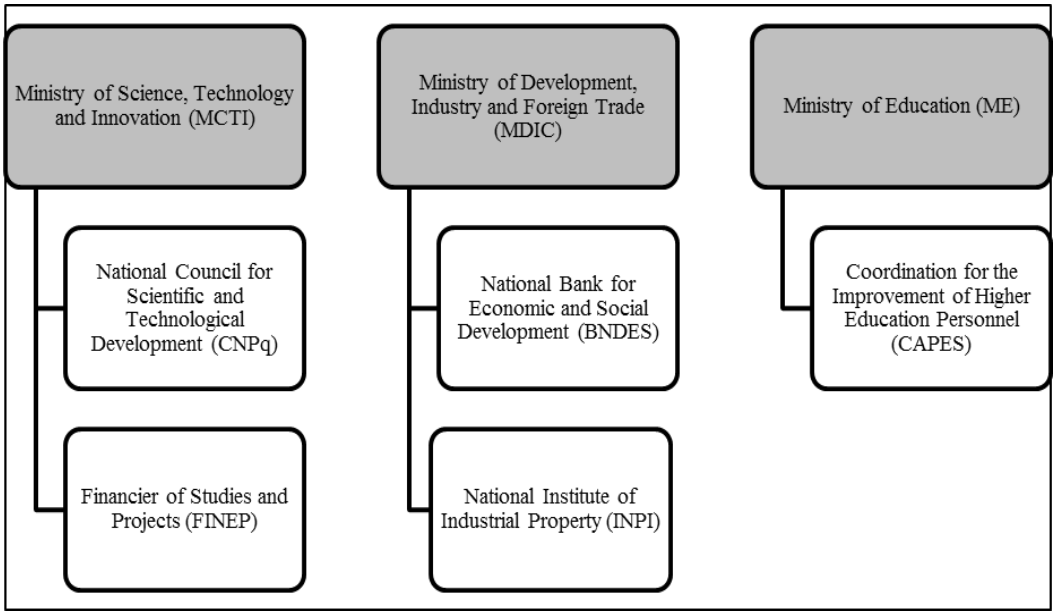
Literature suggests that universities are one of the major actors in innovation (see Mansfield & Lee, 1996). The university system in Brazil took off after WWII. The year of 1950 saw the creation of an institute called the Coordination for the Improvement of Higher Education Personnel (CAPES), and in 1951 the National Council for Scientific and Technological Development (CNPq) was created. In 1967, the Financier of Studies and Projects (FINEP) as an institution was created. FINEP today is the most important and influential Brazilian incentive and innovation office (IPEA 2015).

In 1979, Brazil was hit by the second oil crisis and had to face a huge debt and trade balance deficit. During the so-called 'lost decade', the priorities of the economic policy were to stabilize macroeconomic figures and stop the deterioration of the balance of payments. Thus, due to serious budgetary cuts, the country did not invest in scientific and technological infrastructure. In 1985, Brazil created the Ministry of Science and Technology (MCT), which in 2011 was renamed as the Ministry of Science, Technology and Innovation (MCTI). The creation of this ministry was an important step for Brazil's STI. Today the MCTI is responsible for important agencies such as the CNPq and FINEP, which aim to drive national competitiveness by means of incentives for innovation. The objective of MCTI is to transform the innovative and technological sector into a strategic component of Brazil's social and economic development by providing the fair distribution of benefits to all of the society (MCTI, 2015). In 1990, the STI policy was meant to absorb, adapt and propagate imported technology by direct means, through licenses and other agreements or through technology incorporated into machinery, equipment and system with the aim to increase the level of productivity and competitiveness. However, Rodríguez et al. (2008) criticized the industrial policies for not being horizontal, not meeting the demands of all sectors, without electing specific priorities. Viotti (2008) stresses the following aspects of STI policies from this period:

- Focus on elementary education (at least in the official rhetoric, because higher education and the academy continued to grow in the period and their budgets were not reduced, quite the opposite);

- Change of the intellectual property regime, through the adoption of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organization (WTO), with satisfactory results concerning the number and relevance of agreements on technology transfer;
- Speedy dissemination of productivity and quality control practices; of which the search for certifications from the International Organization for Standardization (ISO) and the Brazilian Quality and Productivity Program (PBQP) are archetypical;
- Dissemination of technology parks and incubators as a way to create clusters of innovative companies and stimulate the entrepreneurial spirit among students and professors in universities and research centers, and;
- Emergence of innovation as a goal of the overall STI policy, which has become more evident in the following years.

According to studies of the Institute of Applied Economic Research (IPEA), the emergence of innovation as a goal of the STI policy—the pro-innovation political discourse brought about improvements in terms of the STI policy in the 1990s with the creation of sector funds (see IPEA, 2015). Economic activities such as electricity, telecommunications, oil extraction, and others, would provide a stable funding source for R&D in 14 strategic sectors, apart from two special funds with the aim to promote the interaction between universities and companies, and the improvement of the research infrastructure in universities and research centers. With these sources and resources, part of the funding for R&D would not be subject to budgetary cuts any longer. Additionally, the management and decisions concerning resource allocation should be made through tripartite councils, composed of representatives of the academia, government and industry. Funding for STI through the sector funds has grown in the last years and represents one of the most important tools for the innovation policy in Brazil (Goedhuys & Veugelers, 2012). [Figure 1] highlights the governance structure of innovation in Brazil. In this research the focus is particularly on federal-level innovation incentive programs, and particular innovation industries—i.e., aero-defense, agribusiness, energy, oil, health, sustainability and telecommunications. Therefore, state and local government actors and incentive providers to other innovation industries are not included in [Figure 1].



[Figure 1] Governance Structure of Innovation in Brazil

2.2 Science Technology and Innovation Policies in Brazil

According to Viotti (2008) STI policies in Brazil evolved through three phases. The first phase, extending from approximately 1950 to 1980, is referred as 'In search of development through growth'. The second one, corresponding to the last two decades of the 20th century, is called 'In search of development through efficiency'. The last phase, which initiated around the turn of the century and is still under way, is entitled 'Development through innovation'. [Table 1] highlights the major programs to support innovation in Brazil taken place during the final phase-Development through innovation phase covering the 2004-2015 period.

[Table 1] Brazilian Programs to Support Innovation

Years	Programs	Outcomes
2004-2008	▪ Industrial, Technological and Foreign Trade Policy (PITCE)	▪ Introduce the Innovation Law 2004. ▪ Introduce the Good Law 2005.
2007-2010	▪ Action Plan for Science, Technology and Innovation (PACTI)	▪ Create Brazilian Technology System program (SIBRATEC). ▪ Increase the number and percentage of researches working in companies. ▪ Increase the ratio of innovative companies that benefit from government support.

2008-2010	▪ Production Development Policy (PDP)	▪ Decentralized federal programs into the states through the Company Research Support Program (PAPPE). ▪ This program is the evolved version of PITCE.
2011-2014	▪ Bigger Brazil Program ▪ Major IT Program	▪ Develop the Software And Services National Technology Certification Program (CERTICS). ▪ Create the national program of start-up acceleration (Start-up Brazil). ▪ Develop the Brazil Plus Information Technology Program for fostering skilled professionals. ▪ Create international hubs across the country. ▪ Attract global research centers to Brazil.
2012-2015	▪ National Strategy for Science, Technology and Innovation (ENCTI)	▪ Support the innovations in the production sector. ▪ Train and qualify human resources for innovation. ▪ Support to the sectors that concentrate more knowledge generation. ▪ Promote clean production. ▪ Use the State purchasing power to promote innovation.

Industrial, Technological and Foreign Trade Policy (PITCE) is launched in 2004. It kicked off the third period in the history of incentives and innovation in Brazil. PITCE was an attempt of industry-oriented policy based on innovation and, in this sense, was different from the traditional industrial policies of the 1960s and 1970s. It focused on the expansion of physical capacity and diverged from the focus on competitiveness of the 1990s, which, in turn, was not bound to any clear industrial policy (Arruda et al., 2006). PITCE had five main objectives: (a) To strengthen innovation in the companies and explicitly acknowledge the companies as a locus of technological innovation; (b) To increase the exports of high technology and strengthen the competition in international markets; (c) To promote industrial updating and modernization; (d) To increase the companies' production scale, and; (e) To develop some specific fields of research such as pharmaceuticals, semiconductors, software, capital goods—considered as the strategic options—and nanotechnology, biotechnology and biomass/renewable resources—considered areas to anticipate in the future (IPEA, 2015). Brazilian Federal government has also created a new governmental agency, the Brazilian Agency for Industrial Development (ABDI) as the coordinating and executive office of PITCE. Concerning technological innovation, PITCE has brought about two important legislative improvements:

- The Innovation Law (LDI), passed in 2004, aims to increase the economic efficiency and the development and diffusion of technologies, so that the level of activity and the competition in the international market have greater inducing potential. This law aims to stimulate the cooperation between universities and businesses, as well as generate technological innovations capable of increasing national competitiveness. To fulfill its goals, the law contains three principles: (a) Constituting a favorable environment to strategic partnerships between universities, technology institutes and businesses; (b) Stimulating the participation of STI institutions in the process of innovation, and; (c) Promoting innovation in companies. Importantly the law, for the first time in Brazil, allowed direct grants to R&D companies in a non-refundable way, and also enabled government purchases to be oriented by the technology criteria (Arruda et al., 2006; IPEA, 2015).

- The Good Law (LDB), passed in 2005, was introduced into Brazil's public policies. It is acknowledged as one of the most generous regulations in terms of tax incentive provision for innovation in the world (IPEA, 2015). This law allows companies to deduct twice as much the worth of expenses on R&D off a company's income tax return and the social contribution on net income. It provides a 50% discount on the manufactured products tax on purchasing R&D machinery and equipment; full depreciation and accelerated depreciation of equipment and intangible goods for R&D; full reduction of the income tax rate for shipments abroad for the registration and maintenance of trademarks and patents; 20% credit (in 2008) and 10% credit (from 2009 to 2013) of the withheld income tax for shipments under contracts of technology transfer, when they are registered at the National Institute of Industrial Property (MCTI, 2015).

Since their initiation every year companies has made more use of these incentives than the previous year. In 2008, MCTI estimates that innovation-related tax breaks were over US$ 460 million, or 18.1% of the cost of innovation projects that used the incentives of the Good Law. The direct support to innovative companies has also developed due to the growing revenues of sector funds. As a result of the Good Law, both the direct support to innovation in the form of credit and grants and indirect support in the form of tax incentives have grown through budgets for innovation, which makes Brazil one of the most generous countries when it comes to the general support to innovation in relation to GDP. The ratio between direct and indirect support is 40-60%, but indirect support is expected to grow even more since tax incentives will be more and more

used by businesses (Araujo, 2012). Concerning the incentives set by the Innovation and Good Laws, 1.1% of innovative industries have taken advantage of these benefits; among the companies with more than 500 workers 16.2% have used these incentives. Thus, it can be said that the challenge lies with taking the innovation policies to smaller businesses-i.e., SMEs.

Action Plan for Science, Technology and Innovation (PACTI) started in 2007. The action plan provided for public investments on STI equivalent to US$ 11 billion between 2007 and 2010. Three basic goals were sought for the innovation in the companies: (a) Structuring the Brazilian Technology System (SIBRATEC) by establishing a great 'network of networks' of research institutions to support technological development with approved investments equivalent to US$ 145 million; (b) Increasing the number and percentage of researchers working in companies to 33.5% in 2010 (actual number was 26.3% in 2005), and; (c) Increasing the ratio of innovative companies that benefit from government support to 24% (actual number was 18.8% in 2005). The ratio of innovative companies supported by the government rose from 18.8% in 2005 to 22.3% in 2008. Funding for purchasing machinery and equipment (14.2%) is the number one form of government support to innovative companies. The least sought items were the tools of grants (0.5%) and cooperative projects of R&D in partnership with universities or research institutes (0.8%). The absolute number of researchers working in companies dropped about 10% between 2005 and 2008. In 2008, 45,000 researchers were employed in companies in Brazil—whereas in Germany and South Korea this number reaches to 180,000, 492,000 in Japan and over a million in the USA. Another survey conducted in 2011 by the Atlantic Century II: Benchmarking US and EU Innovation and Competitiveness shows that in Brazil there are 1.5 researchers in companies for every one thousand employed people, whereas the average in OECD member countries and BRICS countries is 6.3. Finland ranks 1st with16 researchers for every thousand workers (Rodrigez et al., 2008). Among the listed countries, Brazil is ahead of other rapidly emerging countries such as South Africa, Malaysia, Mexico and India. One of the causes of the weak performance in Brazil may be the university reform carried out by the government between 2003 and 2012 with the Plan for Restructuring and Expanding Federal Universities (REUNI), which opened many public universities and made the academic career more attractive to young researchers than corporate career (Araujo, 2012).

Production Development Policy (PDP) substituted for PITCE in 2008, and amplified the extent of its predecessor by including more sectors among the priorities for policies and support. However, the core of the program has not changed. Innovation was defined as one of the elementary pillars for economic growth. The objectives of innovation policies were, by 2010: (a)

To increase R&D to 0.65% of the GDP, and; (b) To double the number of patents of Brazilian companies in Brazil, and triple them abroad. Due mainly to the recent global financial crisis (GFC) the goals of the PDP were unfortunately not reached. An important progress of the PITCE/PDP was to demand that Brazilian states have their State Laws of Innovation as a way to promote the partnerships between FINEP and the Research Support Foundation of each state under the Company Research Support Program (PAPPE), which is a grant initiative. Assigning Brazilian states new task of formulating local policies of STI was an important factor for decentralizing the technological development in Brazil (IPEA, 2015).

Bigger Brazil Plan (PBM) was commenced in 2011 with a set of initiatives to support and protect the productive sector, especially the industry. Its reach was broader than that of its predecessors. This plan is produced by the Ministry of Development, Industry and Foreign Trade (MDIC) and presents two sets of actions. The first one may be considered a development of former plans and lists ten goals for 2014. These goals are concerned about added investment, investments on R&D, industrial added value in Brazil, qualifying the workforce in the industry, and efficient use of energy. The second set of actions combines tools of support to competitiveness, such as increasing funding of the National Bank for Economic and Social Development (BNDES), reducing federal indirect taxes, such as the manufactured products tax, and tax substitution for specific segments, as a defense measure. This part of the plan is more similar to an initiative of support for the competitiveness of Brazil's productive sector rather than a structured plan, with goals, priorities and tools defined from the moment it was launched (IPEA, 2015). The plan is challenging, for it intends to: (a) Support inclusive economic growth in an adverse economic context; (b) Exit the international crisis in a better position than it was when it started. This would result in a structural change of the status of the country in the world economy. For these challenges to be reached, the plan focuses on innovation and the intensification of production in Brazil's industrial park, in order to achieve gain based on productivity. It adopts important measures of relieving taxes on investments and exports facing the appreciation of the exchange rate. Other measures aim to offer more credit and improve the regulatory framework of innovation, to strengthen the commercial defense and expand tax incentives, as well as simplify funding to add national value and competitiveness to productive chains (IPEA, 2015).

Major IT (TIM), launched in 2011, is a plan conducted by the MCTI. It is within the Bigger Brazil Plan, conducted by the MDIC. The plan focuses on the technology sector and devises the Software and Services National Technology Certification (CERTICS). It also creates the national program of start-up acceleration, named Start-up Brazil. This program subsidized accelerators all over the country, in order to promote innovation and

entrepreneurship, making Brazil a global player in the information and communication technology (ICT) sector and also placing the country as an innovation hub in Latin America. Another ambition of the program is the formation of skilled professionals to meet the technological demand. For this reason, a program called Brazil Plus Information Technology (BMTI) was created within the TIM plan, aiming to reduce the lack of labor in the sector. In order to leverage competitiveness of national companies, the program created international hubs to offer a global workforce, promote the relationship with new markets, and give access to local and international intelligence. The hub helped integrate initiatives and created spaces in international target markets, as described below (MCTI, 2015):

- In Asia (particularly China, Japan, India, Korea, Singapore, and Indonesia) concerning business knowledge, innovation market and partners, service centers and start-ups;
- In North America (the USA and Canada) with a focus on the market and new partners for innovation, niches such as the web, mobile, business-to-consumer (B2C) and finances; takeovers and internationalization of companies and start-ups;
- In Latin America (particularly Mexico, Colombia, Argentina, Chile, and Peru) for the distribution of software and platforms, takeovers and internationalization, and service partnerships;
- In Europe (particularly Eastern Europe, Spain, Portugal, Germany, and England) on partnerships, service centers and innovation focusing on market and partners, and;
- In Africa new business knowledge, internationalization and focusing on market and partners.

Finally, the program, with the aim to attract global research centers, brings international development companies to Brazil. Its intention is to include the country in the global chains of R&D and its goal is to connect advanced research to generate products that can compete not only in Brazil, but also in the international market. Brazil aims to mobilize its productive force to innovate, compete and grow. The big mighty market, the government purchasing power created by inclusive policies, the extensive energy resources to be explored, the young workforce and business creativity are institutional advantages. These are formidable natural and social resources to develop the vision of 'Bigger Brazil' (MCTI, 2015).

National Strategy of Science, Technology and Innovation (ENCTI) initiated in 2012, has been active until 2015. Federal government associated the production development plan, the Bigger Brazil Plan, with the scientific and technological development plan so called ENCTI. According to the MCTI, responsible for the ENCTI, the main guidelines for the strategy are: (a) To provide support to innovations in the production sector as a way to reduce the technological gap in comparison with developed countries; (b) To train and qualify human resources for innovation; (c) To support the sectors that concentrate more knowledge; (d) To promote clean production, and; (e) To use the state purchasing power to promote innovation. ENCTI also listed the priority programs, in the area of ICTs; Pharmaceuticals and healthcare industrial complex; Oil and gas; Defense industrial complex; Aero-spatial; nuclear; Frontiers to innovation (biotechnology and nanotechnology and new materials); Green economy incentive (energy, biodiversity, weather changes and oceans and coastal zones) and STI for social development (programs to popularize STI and improve scientific teaching, productive inclusion and social technology, assistive technologies, those directed to the social inclusion of disabled people, and technologies for sustainable cities) (IPEA, 2015). For the execution, ENCTI provides US$ 23 billion to be shared amongst the MCTI, Ministry of Education and Culture (MEC), Ministry of Development, Industry and Foreign Trade (MDIC) and Ministry of Defense (MD). It also supplies US$ 7 billion to Federal public companies (such as BNDES, Petrobras, and Eletrobra) and state research support foundations (IPEA, 2015).

National Program of Support to Company Incubators and Technology Parks (PNI) is another incentive system. MCTI works together with the National Association of Entities Promoting Innovative Enterprises (ANPROTEC) that represents technology parks and incubators, as well as with Brazil's Micro and Small Businesses Support Service (SEBRAE). SEBRAE has been very active to provide incentive for Brazilian incubators. Learning from the past experiences PNI follow a more mature management model to provide better support to their incubated companies. Furthermore under this program FINEP has also been providing generous support to technology parks so as to boost their competitiveness through better structures, training workers and enabling them to access good international practices (IPEA, 2015).

2.3 Innovation Incentive Systems in Brazil

Support of innovation in Brazil takes place in a number of ways. Support to company innovation may be given directly, through loans or grant or through indirect support, in the form of tax incentives. Direct support to companies is provided to priority sectors elected by the

government. These instruments are sometimes combined, as in the case of projects funded through special conditions that require the participation of universities as a partner. Through this combination, Brazil seeks to integrate universities and businesses for innovation. This is in line with Huggins & Strakova's (2012) view on university-business relations, which demonstrates an awareness of the need for regional research performers to improve knowledge commercialization and to create knowledge that is applicable to the needs of the economy. Apart from enjoying the benefit of becoming more competitive by means of innovation, companies also get tax reduction when they hire staff with PhD degrees. As for the STI infrastructure, the government has given support to it by means of technology park and incubator development, and provision of equipment. Financial measures to support innovation are possible through tax incentives. This reduces the cost of R&D through proportional discounts on tax, tax credits, accelerated depreciation and other measures or through direct subsidies that destined to reduce the difference between the social and public marginal return of innovation projects (IPEA, 2015). [Table 2] presents a summary of the funding offices with their respective incentive systems currently active.

It is also worthwhile to mention previously successful incentive programs that helped Brazil to form new systems. For example, FINEP's Zero Interest Program (PJZ) offered credit for innovation at zero interest rates, demanded no actual guarantees and set the payback to 100 installments. This program is dedicated to micro firms and SMEs operating in strategic sectors of the PDP. Similarly the First Innovative Business Program (PRIME) supported innovative companies up to two years old through direct subsidies for 12 months (FINEP, 2015).

[Table 2] Active Brazilian Innovation Incentive Systems

Providers	Programs/Systems	Receivers	Total Amount
▪ Financier of Studies and Projects (FINEP)	▪ Inovacred	▪ Credit with a focus on micro and small and medium-sized firms. This support is granted in a decentralized way, through financing 16 agents that operate in their own states or regions, assuming the risks of the operations.	▪ US$ 512 million
	▪ Tecnova	▪ Grants; focus on micro and small and medium-sized firms, with support from state partners.	▪ US$ 76 million
	▪ FINEP 30 dias Inovação (FINEP innovation 30 days)		▪ US$ 6 billion
	▪ Inovacred Express	▪ Credit, focus on medium and big companies.	
	▪ Subvenção Econômica (Financial grants)	▪ Credit, micro and small business.	
		▪ Grants for micro, small, medium and big companies.	
▪ National Council for Scientific and Technological Development (CNPq)	▪ Recursos Humanos em Á reas Estratégicas RHAE—Pesquisador na empresa (Human Resources in Strategic Areas (RHAE—Researcher in the company)	▪ Focus on micro, small and medium-sized technology companies.	▪ US$ 95 million
▪ National Bank for Economic and Social Development (BNDES)	▪ Prosoft	▪ Focus on medium-sized software company.	▪ US$ 17 million
	▪ MPME Inovadora (Innovative SMEs)	▪ Focus on micro and small and medium-sized innovative companies. This support is granted in a decentralized way, through financing agents that operate in their own states or regions, assuming the risks of the operations.	▪ US$ 240 million
▪ Financier of Studies and Projects (FINEP) & National Bank for Economic and Social Development (BNDES)	▪ INOVA	▪ Focus on priority areas of aero-defense, agribusiness, energy, oil, health, sustainability and telecommunications for the whole line of small and medium-sized innovative companies.	▪ US$ 8 billion

3. Results and Discussion

As stated by Scotchmer (2006), a vitally important question facing modern economies today is how to promote innovation. This is also the main topic of the research reported in this paper. The investigation on the innovation incentive systems in the context of Brazil that seeks a knowledge-based economic development produces a number of findings and insights. These are invaluable for addressing the research question.

The first finding is that the design and formulation of innovation policies in Brazil seems to lack a thorough investigation to provide a reliable background for the government intervention. Many support programs are launched with no or not much previous investigations about the demand and needs of the productive or academic sector (see IPEA, 2015). For that reason, some goals of the industrial policy resemble more of a wish-list rather than a set of structured goals strictly related to the necessary measures to achieve them. This puts the investment and success of public policies under a high-risk. The integration between the government and trade associations that represent companies and universities is highly important in this process so that public policies and incentive programs are successful in delivering their goals. Brazil's innovation policy is a supply-side kind of policy, and the gap between supply and demand of innovation policies is growing (see IPEA, 2015). The budgets for innovation-oriented public policies are also growing. However the innovative effort of the private sector has not followed through (see IPEA, 2015). This is to say, the lack of studying the context well added to the increase of innovation budgets and resulting in a programmatic activism of policy makers. Innovation support programs are systematically launched as part of creating an innovation ecosystem. However, they contain no regards to the real need, demand, objectives and interactions with the other existing programs. On that point, Botelho (2011) argues that in Brazil there are many policy measures erratically seeking for innovators, with much juxtaposition and with much room for departmental competition.

The second finding is that even though Brazil has large number of innovative companies, not all are ready to claim available resources or incentives because of the excessive bureaucracy. Only when a company becomes familiar with the way and learns how the system works, it makes use of these incentives effectively. Bureaucratic difficulties have made way for the rising of professionals specialized in the preparation of incentive applications (ABES, 2015). Nevertheless, these professionals charge high fees, which make the incentive systems much less attractive especially for start-ups and micro firms and SMEs. Additionally, even if Brazil has a few different forms of innovation support, including STI infrastructure, tax incentives and direct financial

support, and the innovation incentive lines are broadly disseminated, many companies still are not aware of these incentive systems (see ABES, 2015).

Thirdly, tax benefits are still frowned upon in Brazil since when it comes to innovative companies small businesses are left out, because the Law adopts the criterion that the benefit should be given to the companies that make profits. Tax incentives tend to stimulate the execution of more profitable, less risky and short-term innovation projects. Thus, projects of high social relevance to be carried out for a longer term, subject to more uncertainty and likely to have more intense spillover effects are left out (see IPEA, 2015). Similarly grants promoted by FINEP sponsors innovation in companies in the priority areas determined by the Federal government with strict ways that the funds may be spent. Whilst such approach is providing a strategic focus, at the same time it limits the incentivization of different aspects of knowledge-based economic activities, thus carries the risk of not having a balanced knowledge-based economic development.

Fourthly, resources originated from scholarships programs are quite important to foster new talent, and leverage innovative companies and their major cost concerns on hiring the talented labor force. However, values pre-set by CNPq concerning the professional and academic training of the staff members seem to be below the market expectations. This makes it very difficult for a company manager to hire these young knowledge workers (see Yigitcanlar et al., 2007). In practice companies, while willing to employ highly educated and talented workers, hesitate due to concerns on the quality of these workers and their contributions to the company (see ABES, 2015).

Next, traditionally major concerns of innovation incentive support mechanisms were incentive systems having full of red tapes and applications being stuck in the deep government bureaucracy. In recent years, in order to cut the red tapes, FINEP has set some incentive systems, such as FINEP 30 Days program in 2013. This system is considered as a new model policy for financial innovation support provision to projects across Brazil (FINEP, 2015). The new model aims mainly to cut the red tape off credit access, and this way projects submitted by companies are to be analyzed within 30 days. Although the system has not managed to cut all of the red tape, it provided a promising direction for the future efforts in dealing with the problematic issue of government bureaucracy.

Sixthly, when international best practices analyzed, the findings show us that tax incentives are broadly used by developed countries to increase the promotion of R&D and

innovation, as is the cases of Canada (since 1944), USA (since 1954), and Australia (since 1986) (Kannebley & Porto, 2012); where direct support is more commonly used in the developing country context. In this perspective, Brazil presents a degree of balanced provision in both categories of innovation support by providing a wider spectrum of options for companies with different profiles. This can be interpreted as strength of the innovation support program of the country.

Lastly, as highlighted by De Brito & De Mello (2006), Brazil's main challenge in innovation policy is to encourage the business sector to engage in productivity-enhancing innovative activities. At about 1% of GDP, R&D and innovation spending, both public and private, is comparatively low by OECD standards and is carried out predominantly by the government. Therefore, even with the broad range of programs exposed aiming to support innovation, Brazilian companies still find it difficult to have access to public funding suitable for specific their needs and to boost their innovation attempts (Cassiolato et al., 2003).

4. Conclusion

This study thoroughly investigated the major federal-level incentive systems available for the growth of Brazilian technology companies' innovation capabilities as a strategy to promote knowledge-based economic development. The analysis of the Brazilian innovation support programs displays a rather promising outlook, even though there is still much room for improvement. However, the research has several limitations. Firstly, it reports only the federal-level incentives. Beyond this level government innovation support schemes the country also have state and local government level programs—although they are not as significant in terms of the amount of financial support provided to firms. Secondly, the analysis only focuses on the innovation incentives provided to the technology companies in the mentioned priority industries. Lastly, the study fails to provide outcome measures of the investigated schemes—such as the number of patents, innovative products, economic returns, firm growth, and so on. Our prospective research will particularly focus on addressing all of these critical limitations and will also undertake comparative studies with other emerging and developed counties.

In the light of the findings and insights presented earlier in the paper, we suggest the following improvements in the governance, policy and design of the innovation incentive systems. Brazil has shown significant improvements during the last couple of decades in providing a concentrated support system for innovation. However, our review has shown that what has been

provided so far both in terms of quality and quantity is not sufficient enough to make significant changes in boosting the innovativeness of companies in Brazil. Therefore, more resources through more effective and efficient mechanisms should be channeled to increase companies' knowledge and innovation bases. Additionally, removing if not at least minimizing the red tape from the application, allocation and utilization processes of the incentives are critical. Moreover, broadening of the incentive programs to deliver the needs of companies with differing needs and priorities is a healthy approach supporting companies in their quest to become more innovative and thus competitive. A successful incentive model that Brazil could adopt is the tax incentive program that is widely used across OECD countries to support innovation. In the near past Brazil introduced a zero tax program and then abolished it. Although, at present Brazil possesses a legislation concerning fiscal incentives, it is still underused by companies. Furthermore, one of the most critical improvement areas in Brazil is to significantly enhance healthy communications between the companies and the incentive provides in order to receive the highest possible return from the incentive programs. Finally, the recent corruption allegations from Brazil related to Petorbras also bring to mind the importance of a transparent, fair and accountable governance system to deliver the incentive programs.

Lastly, we conclude the paper by highlighting the importance of innovation incentivization to form a prosperous innovation ecosystem one more time with a quote from De Blasio et al. (2014), "the external acquisition of knowledge is not always regulated by market mechanisms and agents cannot prevent observation and interaction from other agents, a phenomenon known as spillovers from knowledge in the literature; the social returns from innovation are therefore usually greater than the private ones and the resources allocated by agents to innovate are smaller than the socially optimal amount. Public subsidies therefore allow reducing the gap between private and social returns" (p. 3-4).

List of Abbreviations

ABDI	Agência Brasileira de Desenvolvimento Industrial (Brazilian Agency for Industrial Development)
ABES	Brazilian Software Companies Association
ANPROTEC	Associação Nacional de Entidades Promotoras de Empreendimentos Inovadores (National Association of Entities Promoting Innovative Enterprises)

BMIT	Brasil Mais TI (Brazil Plus Information Technology)
BNDES	Banco Nacional de Desenvolvimento Econômico e Social (National Bank for Economic and Social Development)
CAPES	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordination for the Improvement of Higher Education Personnel)
CERTICS	Certificação em Tecnologia Nacional em Software e Serviços (Software and Services National Technology Certification).
CNPq	Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for Scientific and Technological Development)
ENCTI	Estratégia Nacional de Ciência, Tecnologia e Inovação (National Strategy of Science, Technology and Innovation)
FINEP	Financiadora de Estudos e Projetos (Financier of Studies and Projects)
GDP	Gross domestic product
HDI	Human Development Index
ICT	Information and communication technology
ISO	International Organisation for Standardisation
IPEA	Instituto de Pesquisa Econômica Aplicada (Institute of Applied Economic Research)
LDB	LDB Lei do Bem (The Good Law)
LDI	Lei de Inovação (The Innovation Law)
MCT	Ministério da Ciência e Tecnologia (Ministry of Science and Technology)
MCTI	Ministério da Ciência, Tecnologia e Inovação (Ministry of Science, Technology and Innovation)
MD	Ministério da Defesa (Ministry of Defense)
MDIC	Ministério do Desenvolvimento, Indústria e Comércio Exterior (Ministry of Development, Industry and Foreign Trade)
MEC	Ministério da Educação e Cultura (Ministry of Education and Culture)
OECD	Organisation for Economic Co-operation and Development
PACTI	Plano de Ação em Ciência, Tecnologia e Inovação (Action Plan for Science, Technology and Innovation)
PAPPE	Programa de Apoio à Pesquisa em Empresas (Company Research Support Program)
PBM	Plano Brasil Maior (Bigger Brazil Plan)
PBQP	Programa Brasileiro de Qualidade e Produtividade (Brazilian Quality and Productivity Program)

PDP	Política de Desenvolvimento Produtivo (Production Development Policy)
PITCE	Política Industrial, Tecnológica e de Comércio Exterior (Industrial, Technological and Foreign Trade Policy)
PJZ	Programa Juro Zero (Zero Interest Program)
PRIME	Programa Primeira Empresa Inovadora (The First Innovative Business Program)
PNI	Programa Nacional de Apoio às Incubadoras de Empresas e aos Parques Tecnológicos (National Program of Support to Company Incubators and Technology Parks)
R&D	Research and development
REUNI	Plano de Reestruturação e Expansão das Universidades Federais (Plan for Restructuring and Expanding Federal Universities)
SEBRAE	Sistema Brasileiro de Apoio às Micros e Pequenas Empresas (Brazil's Micro and Small Businesses Support Service)
SIBRATEC	Sistema Brasileiro de Tecnologia (Brazilian Technology System)
SME	Small and medium-size enterprises
STI	Science, technology and innovation
TIM	TI Maior (Major IT)
TRIPS	Trade-Related Aspects of Intellectual Property Rights
WTO	World Trade Organisation

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