Actions on Innovation Policy in Brazil – 2013/2014

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1. Introduction

The productivity of the Brazilian economy grew rely less than the economy of most countries in the world in the last few decades. This compromises the trajectory of Brazil's economic development. The last great productivity leap happened in the 1970's. From that time until now, the Brazilian economy –but also the overwhelming majority of countries on the planet – is having a very hard time achieving its objective of increasing its labor productivity, with negative impacts on companies' and the economy's competitiveness.

There are structural embarrassments in the Brazilian economy which cause this low productivity. The quality of education, the transport and communications infrastructure, the regulatory and institutional environment, and the production of knowledge, technology and innovation are the factors that are widely discussed by those who more closely analyze the problem of productivity in Brazil.

In the case of technology and innovation, it is important to highlight that the dynamism of more advanced economies is based on the relationship between knowledge and innovation generated inside companies. Sometimes these relationships are more explicit in specific research and development departments (R&D), but besides this dimension that is strictly private and internal of firms, there are also varied partnerships with science and technology (S&T) centers and institutions, in addition to an obvious and fundamental educational system to which the population has ample access.

Table 1 shows that the most innovative companies in Brazil are more productive than less innovative companies. This is obvious in any economy, but besides this, there is evidence that innovation causes an increase in investments in Brazil. Innovative companies invest 23% more than non-innovative companies because they need to transform their productive process.

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Table 1 – Companies' productivity per innovation class (2011)

Types of firms	Number of firms in the Brazilian Industry	Productivity (value added/worker)(R$ thousand)
All firms	98,420	39.03
Not innovative firms	60,612	34.93
Innovative firms	37,808	45.50
Innovative for firms	35,435	43.91
Innovative for the Brazilian market	4,420	67.30
Innovative for world market	309	96.38

Fonte: IBGE-Pintec/2011.

There is broad consensus regarding the close association between economic development, knowledge and technological innovation, and the central role of companies in introducing and spreading innovations in the productive process. However, the consensus is not so wide-ranging on the subject of how to create and spread technological innovation, especially in the historical conditions of economic development in countries with late and peripheral industrialization, such as Brazil.

There are two essential issues in this debate. The first one is related to the characteristics of established leader companies and their capacity to accumulate resources and competences in sufficient intensity and density to leverage or spread out capacities and progress throughout the entire productive system. The second issue is related to the role that public policies play in fostering innovation activities.

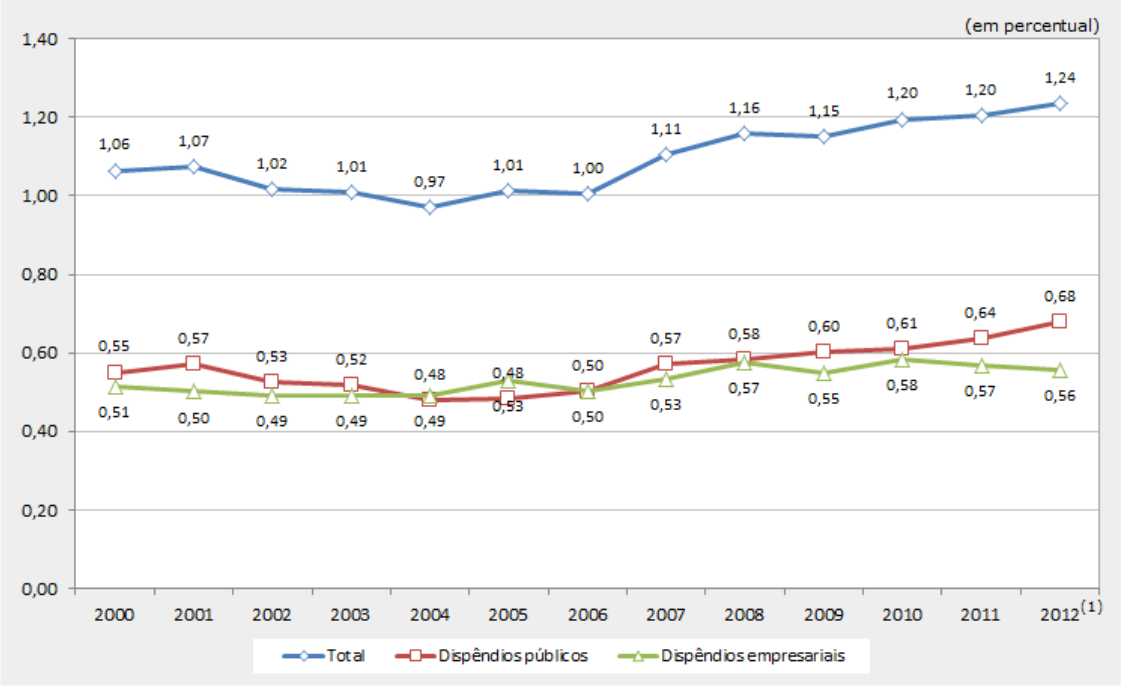
De Negri and Lemos (2011) showed that the fact that the Brazilian productive sector is so heterogeneous when it comes to companies' technological capacities and that it finds itself in an intermediate productive and technological position in the world implies that a relevant part of the technological innovation carried out by Brazilian companies takes place through the purchase of machines and equipment. Nevertheless, differently from the average characteristics of other industrialized developing economies, the Brazilian economy has a *technological nucleus of companies that innovates by creating new knowledge*.

The *technological nucleus* is composed of companies that have the capacity to accumulate new knowledge to carry out technological innovation through the leadership in terms of products and costs, with sustainable international competitiveness. This nucleus also incorporates companies that are exporting followers

and technically intensive in scale, and companies that are emerging technologically; growing, but still small. The companies in this nucleus are present in all industrial sectors and have relevant participation in most of these sectors, because they are generally big.

Private R&D investments need, nevertheless, to be increased more rapidly in this technological nucleus. National expenditures on research and development, that include public expenditures from several agencies (federal and state) and from companies (private and state), went from R$ 17.2 billion, in 2003, to R$ 54.3 billion, in 2012. As a proportion of the GDP, it meant going from 1.01% (2003) to 1.24% (2012). In the period analyzed, we also verified a small advance in the participation of the business sector in R&D investments in relation to the GDP, going from 0.49% in 2003 to 0.56% in 2012, according to the chart below.

Chart 1 – Brazil: national expenditures on research and development (R&D), compared to the gross domestic product (GDP), per sector, 2000-2012.



In the last two decades, Brazil has been implementing several policies that aim to foster ST&I activities. The diversification of these policies and their adjustment to reality are still insufficient to meet the challenges to innovate better and more rapidly. Brazil is a big country and it is not enough to only produce more of the same and in a more efficient way. It is necessary to produce new products and processes with more science.

2. The *Inova Empresa* Plan (2013): policies on the right track

The gap that separates Brazil and other, more developed nations is big. And the idea that a broad liberalization and opening of the economy would automatically produce a technological convergence between nations is, in addition to being old-fashioned, wrong. When the topic is productive development, the idea of not having policies based on science, innovation and technology is not reasonable. No country has managed to get near the technological frontier without a close cooperation between the public and private sectors.

The existence of a competitive environment is essential for innovation, since protectionism and isolation do not remove an economy and companies from their comfort zones. At the same time, the State's presence is essential, since the uncertainty and risks involved in this type of investment need to be shared and mitigated to encourage the involvement of companies. The dynamics, rhythm and time of the production of ST&I are not always predictable. For that reason, the State is a very important stakeholder. And that is how things happen all over the world. It is not by chance that more advanced countries choose scientific areas and define crucial technologies to be dominated, allocating public resources that are highly subsidized as a way to boost innovation. There is no technological development without subsidies.

The government has implemented a series of fiscal and credit incentives to encourage private investments in the economy in the last 12 years. There have been several fiscal, credit and regulatory measures, which were implemented individually or are present in the: Política Industrial, Tecnológica e de Comércio Exterior (2004), Política de Desenvolvimento Produtivo (2008), Programa de Sustentação do Investimento (2009), Plano *Brasil Maior* (2011), Plano Nacional de Ciência Tecnologia e Inovação (2012) and *Plano Inova Empresa* (2013).

Despite the significant failures and imperfections in the design of these policies, which are associated to the lack of focus and to the excess of subsidies for segments in which there are no technological risks, Brazil is on the right track regarding the measures taken to encourage technological innovation and partnerships among science and technology companies and institutions. Launched in 2013, the *Inova Empresa* Plan was the most ambitious technological innovation program ever launched in Brazil. This program raised the level of public policies when it set as a goal the

increase of productivity via technological innovation, which is essential for economic development in modern times.

The diagnostic that the technological nucleus of the Brazilian economy moves very slowly, however not in an insignificant way, with regard to its efforts to search for technological innovations, was fundamental for the design of the *Inova Empresa* Plan. According to data from Pintec/IBGE, the number of professionals, master and PhD in charge in R&D in companies went from 2,953 in 2000 to 5,632 in 2011. In nominal values, companies' investments in R&D significantly increased from R$ 3.7 billion in 2000 to R$ 14.7 billion in 2011. Investments in R&D as a proportion of the revenue (R&D intensity) increased from 0.62% in 2008 to 0.71% in 2011. Even though these activities present greater technological risks, in 2011, only 2.1% of all companies managed to get governmental financing for their innovation and R&D projects.

The *Inova Empresa* Plan set its focus on technological challenges, on thematic lines defined in strategic areas of national interest or with demand potential. Areas with a higher possibility of technological development such as health, energy, defense, aerospace, oil and gas, agriculture, and information technology and communication were selected. The integration of instruments (credit, subventions, variable and non-refundable income) and development institutions was also crucial for designing the program. The program boosted the creation of partnership consortiums between companies and STIs, aiming at innovation plans and not at specific projects. The program's entire implementation process was based on competition so that the best proposals could be selected.

In March of 2013, the *Inova Empresa* Plan made R$ 32.9 billion available in subsidized credit, subventions, variable income and non-refundable resources to be used up until December of 2014. 2,715 companies and 223 STIs applied for the program. Table 2 shows the Portfolio of Projects that were qualified by FINEP and BNDES.

Table 2 - Results from the *Inova Empresa* Program

EM R$ bilhões

Área	Ações	Carteira Total			Contratado			A contratar		
		Total	BNDES*	Finep**	**Total**	BNDES*	Finep**	**Total**	BNDES*	Finep**
Energia	PAISS	**3,92**	2,22	1,70	**3,92**	2,22	1,70	**-**	-	-
	Inova Energia	**3,82**	3,47	0,35	**0,24**	0,02	0,22	**3,59**	3,45	0,14
	Demais Ações	**5,16**	2,58	2,58	**3,84**	1,87	1,97	**1,32**	0,71	0,61
Petróleo e Gás	Inova Petro (1o edital)	**0,25**	0,06	0,19	**0,13**	0,06	0,07	**0,12**	-	0,12
	Inova Petro (2o edital)	**-**	-	-	**-**	-	-	**-**	-	-
	Demais Ações	**2,49**	0,59	1,90	**1,71**	0,59	1,12	**0,78**	-	0,78
Complexo da Saúde	Inova Saúde - Fármacos	**1,27**	-	1,27	**0,79**	-	0,79	**0,48**	-	0,48
	Inova Saúde - Equipamentos	**0,41**	0,21	0,20	**0,06**	-	0,06	**0,34**	0,21	0,13
	Demais Ações	**3,98**	2,36	1,62	**3,36**	1,94	1,43	**0,62**	0,43	0,19
Complexo Aeroespacial e Defesa	Inova Aerodefesa	**2,07**	1,53	0,54	**-**	-	-	**2,07**	1,53	0,54
	Demais Ações	**0,84**	0,10	0,74	**0,82**	0,10	0,72	**0,02**	-	0,02
TICs	Inova Telecom	**0,88**	0,76	0,12	**0,12**	-	0,12	**0,76**	0,76	-
	Demais Ações	**5,46**	3,49	1,97	**3,17**	2,51	0,66	**2,29**	0,98	1,31
Sustentabilidade Socioambiental	Inova Sustentabilidade	**1,35**	1,32	0,03	**0,02**	-	0,02	**1,33**	1,32	0,01
	Demais Ações	**2,91**	0,45	2,46	**1,57**	0,36	1,21	**1,34**	0,09	1,25
Cadeia Agropecuária	Inova Agro	**1,18**	0,87	0,31	**0,11**	-	0,11	**1,06**	0,87	0,19
	PAISS Agrícola	**0,40**	0,40	-	**-**	-	-	**0,40**	0,40	-
	Demais Ações	**1,62**	0,16	1,46	**1,02**	0,09	0,93	**0,60**	0,07	0,53
Ações Transversais	Inovação e Engenharia	**10,55**	6,86	3,69	**7,16**	4,54	2,62	**3,39**	2,33	1,06
	Descentralização para MPEs	**0,78**	0,21	0,57	**0,57**	0,21	0,36	**0,21**	-	0,21
	Infraestrutura para Inovação	**1,13**	0,64	0,50	**0,63**	0,47	0,16	**0,51**	0,17	0,34
Total		**50,46**	**28,27**	**22,19**	**29,26**	**14,98**	**14,28**	**21,21**	**13,30**	**7,91**

Obs: Data base das informações: 30/09/14 (BNDES) e 11/09/14 (Finep).

* Trata-se de valor total do projeto. Desse valor, uma média de 34% corresponde a contrapartida

**Trata-se de valor total do projeto desses na média 32% correspondem a contrapartida das empresas/ICTs

Inova Empresa was responsible not only for fostering better quality and more ambitious projects, but also for rethinking the role of the public sector in fostering innovation. In Brazil, public institutions need to be enhanced so that they can assess innovation projects with rigor and efficiency. Particularly, FINEP was encouraged to rethink its internal processes, providing more agility, rigor and quality in its analyses.

The FINEP-30days process became the single entrance door for projects in the company, created more efficiency, reduced costs, increased the demand and made the follow-up and evaluation of projects feasible. Through this process, FINEP calculates the company's and projects' innovation ratings based on international parameters. In addition to this, FINEP separated the project evaluation areas horizontally, giving more rigor to the analysis, because separate teams with clear and distinct attributions analyze the company and the project, and submit their technical reports to a collegiate committee of superintendents. It also separated it vertically, because the company's collegiate board of directors, final recourse of deliberations, only analyzes projects that have been approved by the committee of superintendents. And all of this is done in 30 days, a complete novelty for Brazil, which is still very incipient in efficiency and quality when it comes to the public sector, especially with regard to ST&I.

3. Knowledge platforms: increase the level and impacts of ST&I in Brazil

It is essential for the development of the Brazilian society that our ST&I be based on the search for greater impacts, both on scientific knowledge as well as on the social and economic dimensions, so that their results are appropriate for our entire society. The analysis of the Brazilian ST&I potentials, the level of maturity achieved, and the quality of the human resources accumulated indicate that it is possible to significantly increase the standard and impacts of our production of knowledge within one generation.

In the last 15 years, the National System of Science, Technology and Innovation, despite being so new, has gained stature and has become stronger rapidly. Nevertheless, it still has difficulties in gaining scale, resourcefulness and also in educating talents in the amount required by the country's development needs. Despite the advances in the decentralization and deconcentrating of the production of knowledge, for which the support of foundations that foster research and that installed themselves in practically all the Brazilian states was essential, as well as the growth of the promotion agencies in the units of the Federation, the existence of several modern instruments, and the national strengthening of the research infrastructure, the scale and quality of ST&I are still insufficient to meet the country's demands and needs.

In spite of its growth, if the standard of investments in ST&I carried out in the last few decades is maintained, Brazil will hardly be able to follow up the world's rhythm of expansion of its scientific and technological frontier. Data from the OECD and from Eurostat show that, in the middle of the 2000's, the rate of business investments as a proportion of the GDP grew in China and in the United States 23% and 12%, respectively, while in Brazil, this growth was around 9%. Even though the Brazilian rate is close to some European countries, it is important to highlight that the scale and quality of the investments in business R&D in these countries are significantly higher than in Brazil.

Between 2000 and 2012, expenditures on R&D in Brazil had a real growth of 73%. To follow up the efforts made by China, for example, the real growth should have been, at least, the double of what was achieved. This growth was higher in terms of the federal government's expenditures (100%) and lower in the business sector (61%) and in state governments (56%). In relative terms, considering the expenditures on R&D in relation to the GDP, a real growth of 17% was observed in the period, going from 1.06% of the GDP (in 2000) to 1.23% (in 2013). For a country as big as Brazil, it would be necessary

for the R&D investments to reach a level of 2% as a proportion of the GDP at the end of this decade. It is important to emphasize that each 0.1% of the GDP in Brazil represents additional investments of R$ 5 billion.

International examples show that this situation can change in a significant way if the State and the private sector adopt measures of strong impact. The trajectories of South Korea and China, for example, register important inflection points in their R&D investment efforts, since the 2000's, whose results allowed them to reverse, even if only partially, their historical trend of staying far from the global scientific frontier.

The national growth of scientific production in the last decade was extremely significant. In absolute numbers, between 2000 and 2012, the number of articles written by Brazilian researchers and published in internationally indexed journals quadrupled (going from 13,022 to 53,083 articles). In 2000, Brazil was the 17th country in terms of global scientific production and answered for 1.2% of the articles published in international journals. In 2006, the country went to the 15th position, with 1.9% of the global production; and, in 2012, it went to the 13th position, answering for about 2.5% of all global scientific production.

Patent requests at INPI went from 20,639 in 2000 to 33,395 in 2012 presenting a growth of 62% in the period. If we only consider the number of requests for patents presented by residents in the country, we observe that this growth was even smaller (21% in the period). These results are much lower than the growth of the country's scientific production (308%), in the period in question; and the number of patent deposits made by residents was even lower than the real growth of the GDP: 48%.

The National Program of Knowledge Platforms (PNPC), launched by Decree No. 8,269 of 07/25/2014, tries to make a leap in quality in the Brazilian ST&I feasible in, at least, three great domains in which Brazil could become a relevant protagonist in the world, given its accumulation of competences and scientific and technological maturity: energy, agriculture and health. Besides these, the program also stipulates a systemic and bold approach of the Amazon and its biodiversity, essential for leveraging Brazil as an environmental power. Immerse in these domains, robotics, microelectronics, neuro-engineering, biotechnology, organic electronics, photonics, artificial intelligence, advanced materials, digital manufacturing, computer networks and systems, cryptography, big data, satellites and others will find all the space necessary to develop, with special attention to the fields of the future on which Brazil already has a lot of knowledge and global relevance, such as aeronautics.

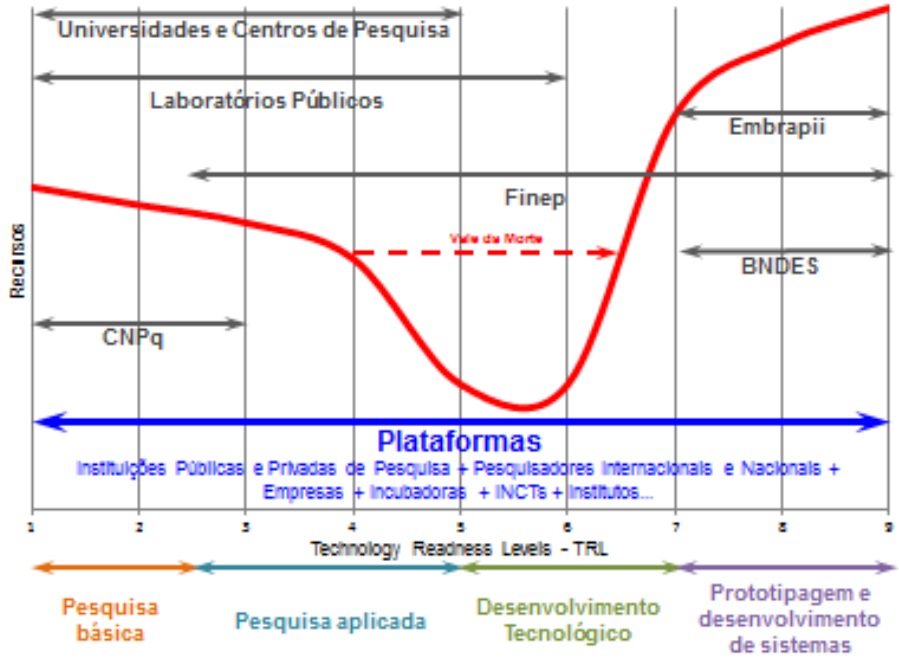
Around these fields of research, it is possible to build platforms for a structural change in our science, capable of encouraging and being encouraged by an innovative economy and environment that we need so much.

As international examples of platforms that inspired the model proposed, we have: the Digital Manufacturing and Design Innovation Institute (Chicago, USA), the Next Generation Power Electronics Manufacturing Innovation Institute (in North Carolina, USA), the Austrian Institute of Science and Technology (Austria), the Advanced Manufacturing Research Center (Boeing/University of Sheffield, in England), the Graphene Research Centre (BASF/National University of Singapore), the Cambridge Science Park, the Sky Clean, the MIT Energy Initiative, among others.

The institutional arrangement of knowledge platforms must be composed of: a) a team with leaders who are well-known for their scientific and technological capacity; b) a managing institution, that will be responsible for managing all the resources and running the platform; c) by companies aimed at developing; and d) by institutions associated to the platform – companies and/or STIs – via contracts or partnerships established for the scientific and technological production of the platform, but not necessarily located in the same region.

The program is likely to reduce our scientific, technological and innovation infrastructure deficit, based on a range of developments that are going to go from basic research, through applied research, until it reaches new technological processes and innovative solutions for the economy and for society. If we use the evaluation methodology of technology maturity levels (Technology Readiness Levels, TRL) – which goes from 1 to 10, being that the closer it is to 10 the more the technology will be available to the market –, the platforms will have as their main focus levels 4 to 7. Consistent studies show that one of the main weaknesses of the national innovation systems is located exactly in this interval, when the focus is technology, with emphasis on the so called “Valley of Death”, in which ideas, processes and products lose energy and present discontinuities in their development.

Espectro de atuação das Plataformas do Conhecimento



Fonte: elaboração própria a partir de dados do Office of Science and Technology Policy, U.S. National Security and International Affairs, 2011

4. A sense of urgency for 2015-2018

There is still a lot to be done and it is not only a matter of amount of resources. The National System of Science, Technology and Innovation has been doing the same thing, in the same way for several decades. With the current instruments available, it will not be possible to increase investments in ST&I in Brazil. To get closer to the most advanced countries, public investments in ST&I need to increase approximately 10% a year to jump from the current R$ 28 billion to reach R$ 60 billion in 10 years. The system needs to become more diversified, more complex and more agile.

To do this, it is possible to join universities and research institutions with our companies – around state-of-the-art ST&I centers, boosted by the great intelligence of engineers, physicists, chemists, biologists and hundreds of other researchers (Brazilian and foreign) – to start new arrangements capable of delivering products and processes of high social impact to the Brazilian society. Vaccines, medication, advanced materials, seeds that are resistant to climate changes, and laser systems for agriculture are examples that may save lives and enhance our economy.

In spite of the robust indicators of the *Inova Empresa* Plan, it probably only impacted less than 1/3 of the companies that already have continuous R&D. Most of the resources are still available for companies as subsidized credit. The non-refundable resources for companies and universities, risk participation in the capital and governmental purchases in the sectors of health, oil and gas, and defense will have to become more relevant in the plan's new edition.

The implementation of knowledge platforms will take two or three years to begin, this is partially justified because the institutions in Brazil will need to learn how to work with orders according to what is stipulated in Article 20 of the 2004 Innovation Law. We must emphasize that a knowledge platform is either a company, a consortium or a non-profit private entity that gathers public and private agents, who work together to achieve concrete results to solve a specific technical problem or to obtain an innovative product or process of high technological risk, with predefined goals and deadlines.

However, the bases of this program are in perfect tune with the most modern things being done around the world today. The program is based on technological orders made by the Presidency of the Republic, a long term perspective, budget predictability, focus on great technological, economic and social opportunities, public-private partnerships, (companies, STIs, government, laboratories) with focus on product delivery, process and solution of specific technical problems, public announcements for the selection of proposals with a special procurement regime, and international partnerships for selecting, developing and evaluating results.

Brazil also follows the international trends to increase expenditures on ST&I in sectorial ministries. Except for MEC's expenditures, the MCTI is not alone anymore in the support of the ST&I system, it answers for 50% of all expenditures on S&T. In addition to this, there is a set of legal obligations linked to the regulatory agencies and funds (Aneel, Anatel, ANP, Funttel and others), besides Senai, Petrobras, BNDES that have also created means with the capacity to finance the ST&I system in Brazil. This trend needs to be expanded.

Inova Empresa and platforms are not enough. It is crucial to think about a new model for the ST&I system in Brazil, with other scales, logic and decision making processes for allocating the investment. In 2015, the greatest priority for leveraging the ST&I system in Brazil is regulating the Social Fund. Even though the Social Fund also has the objective of developing science and technology (Article 47 of Law No. 12,351), its application in this area has not been regulated yet. So far, only about 50% of the resources collected from the Social Fund have been invested in health and education,

according to what is stipulated in Law No. 12,858/2013, in order to fulfill the goal stipulated of 10% of the GDP established in Paragraph VI of the *caput* of Article 214 and in Article 196 of the Federal Constitution, for education and for priority applications in the area of health care.

It would be necessary for at least an amount of 20% of the resources from the Social Fund – that are still not being used – to be invested in science, technology and innovation. In order for this to happen, it is fundamental to regulate the Social Fund's Financial Management Committee (CGFFS), through a decree, that is responsible for determining how the resources are going to be used, or through a specific piece of legislation according to what is done in the areas of health or education. Opening the Fund so that ministries and agencies can have direct access to its resources is essential for the expansion of the ST&I system in Brazil.

It is also decisive to make the Presidency of the Republic get closer to the strategic decisions regarding science and technology. In order for this to happen, it is necessary to reorganize and guide some institutions, organizations and councils in a way to create a fast decision-making structure, which is capable of meeting the existing needs with the urgency that Brazil requires.