Capítulo 89

The Broken Helix: innovation and the political-economic crisis in Brazil

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ABSTRACT
The aim of this article is to explain how the political-economic crisis in Brazil in the second half of the 2010s affected the cooperation between government, industries and universities in promoting innovation in the country. Based on the theoretical framework of Leydesdorff & Etzkowitz (1998), the central argument points out that the budget crisis and allegations of corruption created limits to cooperation among these actors and reinforced the structural obstacles in their relationship in Brazil. The qualitative methodology applied in this research is the case study, which allows to verify whether the path between the hypothetical causes – the budgetary crisis and corruption – and the observed effect – the reduction of collaboration between government, companies/industries and universities in the promotion of innovation – behaved as planned by theoretical-conceptual discussion presented.

Keywords: Triple propeller, innovation, political crisis, economic crisis, Brazil.

1 INTRODUCTION

In contemporary society, an important tool for the growth of economies and companies and the realization of competitive advantages is innovation, a concept that refers to a set of rules and procedures that increase the acquisition, creation and use of knowledge (Luengo and Obeso, 2013). In the marketing scenario governed by hyperconnectivity and competition from organizations seeking to satisfy the wants and needs of consumers, the focus on innovation assumes strategic relevance (Prestes *et al.* , 2017). The multiplicity of exchanges and ideas between relationships such as industries, universities, governments, research centres, customers and suppliers can motivate sources of knowledge already existing to renew institutions in a dynamic way (Chesbrough, 2012).

The various forms of partnership and cooperation between multiple actors can allow institutions to deal with an increasingly competitive and dynamic global scenario (Maçaneiro and Cherobim, 2011), guarantee advantages to those involved in these arrangements and exploit resources from various sources, which makes it possible to reduce market entry costs and the development time of new products and services (Tidd and Bessant, 2016; Prestes *et al.*, 2017). In this context, innovation can be developed through the intensification of cooperation between companies, universities and governments, agents that make up a "triple helix" (Luengo and Obeso, 2013).

The aim of the article is to explain how the political-economic crisis in Brazil in the second half of the 2010s affected cooperation between government, business and universities in promoting innovation in the country. Based on theoretical perspectives on the concept of "triple helix", the central argument points out that the budget crisis and allegations of corruption involving innovation agents in the political sector hindered the execution of the government's role as instigator and financier of new companies based on new technologies and scientific research. undermining government cooperation with the private sector and universities. Industries and companies in general invested more in innovation during the crisis, but some of the most important were highly indebted or involved in corruption schemes with government entities, which limited resources to innovate. Many still do not fully recognize the importance of innovation in overcoming adverse economic contexts. In addition to the intensification of structural, motivational and procedural limitations in their relationship with companies during the crisis, universities suffered heavily from funding limitations for science and technology, which made research unviable, dismantled research groups and led to the "brain drain" of the country, damaging the collaboration of academics with government and companies in promoting innovation.

The qualitative methodology applied in this research is the case study, that allows to verify whether the path between the hypothetical causes – the budget crisis and corruption – and the observed effect – the reduction of collaboration between government, companies/industries and universities in the promotion of innovation – behaved as foreseen by the theoretical-conceptual discussion presented (Bennett, 2004). Next, the conceptual debate around the notions of innovation and triple helix will be presented. In the next section, we will discuss how innovation and the triple helix developed in Brazil until the mid-2010s. Before making the final considerations, examine the political-economic crisis of the second half of the decade of the 2010s on the components of the triple helix: government, companies / industries and universities.

2 INNOVATION AND TRIPLE PROPELLER

According to Schumpeter (1912), innovation can be conceived as a creative destruction, able to move better and new productive combinations with the abandonment of old and obsolete products and practices. However, innovation can alternatively be understood as the reconfiguration of elements into a more productive combination, which assumes broader meanings in increasingly knowledge-based societies (Etzkowitz and Dzisah, 2008). Innovation, which previously seemed limited to the incremental development of new products by companies, increasingly encompasses the creation of organizational arrangements that improve the innovative process itself. In this sense, it represents the main process of renewal that can occur in organizations (Bessant *et al*., 2005), in addition to being understood as something new and practical to be put into use (Hautamäki, 2010) or a means to develop new creative content (Benghozi and Salvador, 2013).

Innovation can be understood in several ways, but with the same foundation. For Thompson (1965: 2), innovation is "the generation, acceptance and implementation of new ideas, processes, products or

services. Innovation, then, implies the ability to change or adapt." Innovation can be defined as the effective introduction and application of unprecedented processes and products in an organization or society, intended to benefit the competent unit of its adoption and its stakeholders, as well as individuals and society in general (West and Anderson, 1996). The innovation process is perceived as a real necessity for reforms in modern times, since innovation is no longer considered an option for companies, but as an imperative for their survival (Denning, 2014). For innovation to be successful, it is necessary to have different sources of information with heterogeneous external knowledge flows (Ahuja and Katila, 2004).

The Triple Helix identifies universities, companies/industries and governments as protagonists of a local, regional, national and multinational innovation system, with the aim of developing a successful innovation strategy aimed at socioeconomic development. The model proposed by Loet Leydesdorff and Henry Etzkowitz provides a basis for innovation policies in three areas: industry/business, university and government. There are at least three main phases of the development of the Triple Propeller model. In the first, all three spheres are institutionally defined, and interaction across boundaries is mediated by organizations such as industrial liaison, technology transfer and government contract offices. In the second, propellers are defined as different communication systems, consisting of the operation of markets, technological innovations and control at interfaces. The interfaces between these different functions operate in a distributed mode that produces potentially new forms of communication, as in the cases of technology transfer or patent law. In the third, the institutional spheres of the university, industry/business, and government, in addition to performing their traditional runs, assume each other's roles, with universities creating an industrial gloom or playing an almost governmental role as regional or local organizers of innovations (Leydesdorff and Etzkowitz, 1998).

In the Triple Helix model, industry remains a protagonist in the field of production, and the government is the source of contractual relationships that guarantee stable interactions and exchanges, in addition to gradually assuming the role of instigator and financier of new companies based on new technologies. Governments can act as collectors and benefactors, supporting innovation directly and also indirectly, financing research centers (Luengo and Obeso, 2013). While public-private partnerships are recognized as important drivers of this development since the eighteenth century, the university is gradually recognized by the Triple Helix model not only as a center of higher education and research, but as a source of "entrepreneurship", generator of technology and source of critical research, education and preservation and renewal of cultural heritage. The regular influx of students continually brings new ideas, in contrast to the research and development units of companies and government laboratories, which tend to grease themselves without the flow of human capital (Etzkowitz and Zhou, 2017). Companies and governments become more dependent on universities as they want rapid responses to challenges encompassing research, development and engineering activities and demand their transformation into tangible solutions in the form of goods and services (Plonski, 1995).

The transformations in the interactions between the three actors occur with the rise of an era in which advanced knowledge is increasingly translated into practical uses due to its polyvalent theoretical and practical nature. The instituted innovation regime assumes a proactive stance in placing knowledge into practice and expanding the inputs that will create academic knowledge, which moderates conflicts typical of bilateral relations between government and industry (Polanyi, 1944) with the introduction of mediation possibilities, coalition building and indirect linkage. In cases of conflict, the government can act, not as a controller, and ensure that the Triple Helix runs well, including the dual propellers government-university, university-industry and industry-government, as well as the three individual propellers (Etzkowitz and Zhou, 2017). The Triple Helix adds Georg Simmel's analysis of the potential of the triad of the individual level of personal and family relationships to the institutional and organizational levels of university, industry/business and government interaction, creating "consensus spaces" that bring together the relevant protagonists to design and implement innovation projects (Ritzer, 2007).

This interaction can motivate the creation of "hybrid organizations", which, at the local and regional level, depend on a dynamic motivated by local and regional innovation organizers – individuals or institutions – and fed by an active civil society, in which initiatives are encouraged by various social agents. The Triple Helix also becomes a platform for "institutional training", with the creation of new training to promote innovation, such as incubators, accelerators, technology parks and venture capital companies. The promotion of startups can lead to innovative development in a certain region, with the support of municipal governments, universities and sectoral business associations (Etzkowitz and Zhou, 2017). Incubators, as physical spaces intended to host and support micro and small enterprises, aim to develop and commercialize academic research results and can attract various stakeholders, such as entrepreneurs, financial agents and government through their development agencies. Cooperation projects between universities, government and companies are usually initiated by informal exchange of information, consultancies and training programs. With the perception of common interests and the establishment of relationships of trust, progress is made towards stages such as the exchange of researchers and the dissemination and transfer of technologies through the development of joint projects and research between local, national and international actors (Ipiranga *et al*., 2010; Jesus, 2017).

It cannot be said that the triple helix proposes a universal and unique model of innovation, since the development of interactions between the three actors depends on the political, economic and cultural particularities of each community in which it is inserted and is a continuous process for the creation of an innovation ecosystem (Kamlot and Jesus, Representatives of the university, industries/companies and the government are summoned to discuss local and regional problems and potentialities, in order to generate a dynamic of innovation and entrepreneurship in which science becomes a productive force that creates social benefits. It is important to highlight that in all spaces present the same level of interaction between these actors, so that in is possible affirm that there is a self-organized dynamic, replicable equally to any local and regional reality. However, if such interaction occurs, declining regions can enhance their research and

development capabilities and provide an alternative growth engine for industries, or enhance the ability to develop them. This usually involves the attempt to attract companies to the region to improve the level of existing firms (Etzkowitz and Zhou, 2017).

3 INNOVATION AND TRIPLE HELIX IN BRAZIL

The entry of private initiative and universities into the processes of promoting socio-economic development in Brazil and Latin America are relatively recent processes compared to Europe or the United States. Previously, such processes were only promoted in Latin American countries by the State, but the government has not been able to cope with all the initiatives and needs demanded by society with excellence in the federal, state or municipal spheres. The entry of the private initiative had as its initial purpose the division of operational risks, the financing of projects that depended only on the State, the exchange of knowledge and the training of the actors for the replication of the model. The university enriched the efforts of government and private initiative as a promoter of research and models of sustainable development (Abdalla et al., 2013). However, in Latin America, the development of most universities was based on the import of technology. These institutions devote themselves to the preponderant role of human resources training. In the Brazilian case, with the end of the import substitution policy in the 1980s and the government's creation of Science and Technology Policies, Brazilians shifted more attention to scientific and technological development for innovation. This attitude became more charged in 1990 with the liberalization of markets, when the various sectors of the economy perceived the influence of knowledge and capacities of different productive activities and scientific areas and the need to develop the approach with universities and research institutes (Ipiranga et al., 2010).

State intervention in Brazil in the face of crises of capitalism was typically carried out in the 1960s and 1970s with mechanisms such as fiscal and customs incentives, subsidies for science and technology, and basic necessities such as education, health, and transportation. Public funding overburdened the State, which assumed the role of auditor (Santos, 1997). The exhaustion of the financing capacity of this model from the middle of the 1980s promoted an increase in pressure from all social sectors. The individual efforts of the State were not efficient in supplying all the services demanded by society, and the entry of private initiative in the financing of infrastructures, including research and provision of services, came to be understood as a way of ensuring development and proviecables. The new managerial model of the State was inspired by the organizational transformations that occurred in the private sector, which have changed the bureaucratic-pyramidal form of administration and made management more flexible. In Brazil, government institutions at the federal, state and municipal levels gradually abandoned the structure based on central norms to adopt another based on the responsibility of managers – who were evaluated by the results actually produced – and the participation of other anchors in new services to society or support for existing projects of greater complexity (Miranda, 2004). It is up to the government to promote a political,

economic and institutional environment that encourages companies to invest in science, technology, research and development (Fonseca, 2001).

To optimize the results of government actions in the globalized globalcontext, the alignment of government actions with entities such as industries, companies and non-governmental organizations was fundamental for the constitution of strategic alliances to ensure desired results, in addition to internal efforts to reconfigure governments (Abdalla et al., 2013). Public-private partnerships in Brazil – co-ventures between the State and companies – were further formalized in 2004, by a law that establishes a form of provision of infrastructure and public services in which the private partner is responsible for the elaboration of the project, financing, construction and operation of assets that are subsequently transferred to the State, especially in sectors lacking public investments (Peci and Sobral, 2007). These partnerships can lead to changes in relation to the guarantees and the possible joint and several liability of the private partners of the financial collaborations that are required, in addition to intervening in the very construction of the financing that will be demanded from the capital market and institutional investors (Pasin and Borges, 2003).

In Brazil, the State remained strong in the field of innovation through the National Bank for Economic and Social Development (BNDES) and the National Council for Scientific and Technological Development (CNPq), contributing, for example, to the consolidation of a strong and diversified industry, especially in the strategic sector of capital goods. With the shift from an industrial society to one based on knowledge (Drucker, 1993), the model of public-private partnerships proved insufficient in meeting the demands for development by proposing joint activities between public power and private initiative in favor of society. The entrance of the university – compatible with the Triple Helix model – allowed the generation of projects aimed at increasing knowledge and innovation. It is up to the university to create sources of new knowledge and technologies, establish relationships with companies and governments and create new areas of action. Carried out research in academic laboratories in general has lower costs than studies made by private companies, in addition to the great cultural emphasis of university extension to bring benefits to society and the great concentration of specialized and trained human resources for the accurate reading of the external environment and the implementation of flexible management models adapted to the reality of the surrounding region of the university (Abdalla et al., 2013). Thus, the university began to seek to know with intensity the reality of the business world, so that the benefits acquired with the resulting knowledge could intervene in favor of the improvement of education and vocational training and the technological development of companies (Gomes and Pereira, 2003).

However, in Brazil, there are limitations to cooperation between the three actors of the Triple Helix. The government should promote economic and social development through new organizational structures, develop policy plans with clear government goals aimed at innovation and knowledge, and engage in dialogue between the various policy spheres. Still, there are clashes related to excessive bureaucratization and lack of flexibility for the implementation of projects in society, which makes explicit the need for

professional and participatory public management. The private initiative should develop innovative products and services, promote interaction with the technology transfer centers of the scientific community and lead the processes of change, but has little capacity for investment in innovation and technology development, revealing the lack of academic and technological bases for conducting research. The university suffers from dependence on development bodies to conduct research and has a myopic vision of professional training and training of manpower, maintaining weak links with society and private initiative. In addition, the increase in awareness of the need to transfer to society the results of research funded with public resources has not yet been accompanied by concrete actions that enable the transfer of technology, which presupposes the absorption of knowledge generated in the university by other actors. This scenario is aggravated by the dispersion of institutional channels of communication between the university and the company, which accentuates the decoupling between the supply and demand of technology and the waste of knowledge and technologies that could be of social interest (Abdalla et al., 2013).

Despite the addition of some universities relatively advanced theoretically and technologically, and the government improves the mechanisms of financing and support for development, science, technology and innovation, the same does not happen with a large part of the companies, which did not modernize technologically and only few make the people participating in the organizational processes acquire rancid for work, in general through continuing education at the university. However, it is possible to say that a transition of science and technology policy from a top-down approach to a model with contributions from various sectors of society – including academia, industry and federal, state and municipal governments – was gaining strength in Brazil since the beginning of the 2000s, with the creation and strengthening of institutions in universities for the management of contracts with companies. business incubators, technology parks and technology transfers (Etzkowitz and Mello, 2004). Many of these institutions – especially incubators – are highly concentrated in the Southeast and South Regions of the country, according to the National Association of Entities Promoting Advanced Technology Entrepreneurship (Anprotec) (Vedovello *et al*., 2001).

Although the difficulties are known, the Brazilian economic environment was favorable throughout the 2000s and early 2010s for interactions between universities, industries/companies and governments to strengthen. The economic situation was strengthened with the greater international notoriety of Brazil – which was selected in that period to host large-scale events in the sports, cultural and scientific areas – and the superficial effects on economic activity in the face of the economic-financial crisis initiated in 2008 in the United States by the action of the "capitalism managed" of the Brazilian government. in which the Central Bank of the country intervened and adopted regulatory measures in order to prevent the crisis from transshipping the entire country. In addition, the discovery of extensive oil fields in the pre-salt layer of the Brazilian coast added value to national development and stability (Jesus and Kamlot, 2017; Zardo and Mello, 2012).

In relation to the development of interactions between government, industry/business and university in such a favorable economic context, in the 2000s, some Brazilian programs involving government institutions, private initiative and universities were developed, such as SOFTEX (Society for the Promotion of Excellence in Brazilian Software), PBQP (Brazilian Quality and Productivity Program) and PADCT (Program to Support Scientific and Technological Development with) the qualification goal for global competitiveness. Some government-supported universities intensified cooperation with companies, such as the Federal University of Viçosa (UFV) and companies such as Nestlé and Monsanto for the development of seeds and agricultural defenses. The Escola Superior de Agricultura Luiz de Queiroz (ESALQ) maintained research related to pulp and paper with private initiative. The Federal University of Santa Catarina (UFSC) helped the mechanical and electrical industries of the state through joint work, promoting the development of the region. Steel companies Cosipa and Copersucar conducted joint research with the Institute of Technological Research of the State of São Paulo (IPT). In the medical area, the Heart Institute (INCOR), of the University of São Paulo (USP), has developed several commodities for clinicians, reviewing them for industry (Mendonça *et al*., 2008).

In the 2010s, the Brazilian companies that filed the most invention patents predominantly operated in seven segments: domestic appliance manufacturing; extractive industries; manufacture of computer equipment, electronic and optical products; manufacture of machines and equipment; manufacture of vehicle parts and accessories; manufacture of cellulose, paper and paper products; and the manufacture of organic chemical products. In that period, 15% of Brazilian companies that innovated sought cooperation with other organizations, while, in those seven segments, the percentage rises to 17%, suggesting that these segments seek more cooperation with other organizations, including universities. When only cooperation with universities is considered, 27% of national companies trust relevance to this association, while in the seven segments, the percentage increases to 32%. In these segments, three present over average results: "Extractive industries", with 62%; "Manufacture of computer equipment, electronic and optical products", with 48%; and "Organic chemical manufacturing", with 34%. Of the total number of national companies, 36% made innovations, a percentage that increases to 42% when analyzing only the seven segments of the companies that innovated the most in Brazil. When the average number of abandoned projects was verified in relation to the total number of companies, 3% abandoned or did not complete an innovation project, a result that is maintained for the seven segments. Taking into account that percentage-wise the number of companies in these segments is higher than the average and the percentage of abandonment is equal, it can be inferred that companies in these 7 segments abandoned fewer projects. Thus, the greater the search for knowledge from universities, the greater the degree of success in innovations and the lower the rate of abandonment of projects (Prestes *et al*., 2017).

4 THE POLITICAL-ECONOMIC CRISIS AND THE EFFECTS ON THE TRIPLE HELIX IN BRAZIL

The main developed and some emerging economies carried out development and innovation projects after the economic-financial crisis of 2008, dismissing policies to stimulate the sector, although many of them – such as the United States and the United States – have less interventionist traditions. However, Brazil remains with an aging manufacturing stock, makes little progress in terms of innovation and invests less than a fifth of the average of large economies in research and development, which tends to harm the competitiveness of companies within the framework of trade agreements (Casarin, 2018). The result is clear in Table 1, based on research by the National Confederation of Industry (CNI) of Brazil:

Table 1 – Investment in science, technology and innovation in 2017 (in US$)

Country	Investment in science, technology and innovation (in US$)
United States	533,000 million
China	279,000 million
Japan	202,000 million
Brazil	20,000 million

Source: CNI, 2018.

CNI research (2018) separated four categories of digitization, into more basic (G1 and G2) and more advanced (G3 and G4) levels. About 75% of the Brazilian companies mapped are in the G1 and G2 categories and only 1.6% at the G4 level. The least development occurs in most cases in small and medium-sized enterprises. In addition, the CNI also points out that Brazil presents difficulties in developing and training the workforce and solving problems in infrastructure, which hinder the flow of production (Casarin, 2018).

The weak performance of innovation in Brazil is deeply related to the worsening of the political-economic crisis in the country in the second half of the 2010s, which affected the State, industries/companies and universities and their cooperation. It is fitting to check the specific impacts on each component of the Triple Helix and how the crisis impaired its interaction with the other components.

The Government

Brazilian science is going through a difficult time, largely due to the marked cut in resources that occurred in recent years and accentuated in 2018. Brazil ranked 13th in world scientific production due to continued public investments by the federal government towards the first half of the 2010s, as well as by state research support foundations. However, with reduced funds, it is difficult to make such production have a significant impact on public management and the productive system, since the Brazilian innovation index is extremely low. While some developed countries allocate up to 5% of GDP for innovation, the 2018 budget for innovation in technology, science and innovation is the lowest of the decade. Throughout the crisis, stimulating innovation was not a priority of the federal government (Soares, 2018).

The contingency of resources for Science and Technology in 2017, which spread to 2018, produced a reduction in funds for the Ministry of Science, Technology, Innovation and Communications (MCTIC) was only R$ 4.1 billion for 2018, much lower than the approved for 2017 and about a third of what was eight years ago. These clippings directly and deeply affect funding agencies, such as CNPq, and support for research and infrastructure projects for researchers and teaching and research institutions. This reduction was extended to other areas of government and spread to state bodies linked to research. Constitutional Amendment 95 froze public spending for 20 years, which increases the risks that research laboratories will be closed, researchers will leave the country, and students will abandon scientific and technological careers (Moreira, 2018). The fiscal adjustment reached sectors that contribute to innovation, which compromises Brazil's entry into the most advanced sectors in terms of innovation (Casarin, 2018). The budget losses were even greater in June 2018, because, with the pressure made by the truckers' strike for the reduction of the price of diesel, the federal government made new clippings in the budget. The MCTIC suffered a clipping of more than 21.75 million reais (Betim, 2018).

The corruption spread by the political apparatus became more evident with Operation Car Wash, a set of investigations underway by Brazil's Federal Police, which began in March 2014 and investigates crimes of active and passive corruption, fraudulent management, money laundering, criminal organization, obstruction of justice, fraudulent exchange operation and receipt of undue advantage. (Truffi, 2017). Politicians and managers linked to state companies of mixed economy – such as Petrobras – and public companies that invest in innovation – such as the Brazilian Agricultural Research Corporation (Embrapa), a public research institution linked to the Ministry of Agriculture, Livestock and Supply – were involved in corruption systems that erupted Operation Car Wash, which compromised the allocation of funds for innovation and the application of policies for their inventiveness. It is worth remembering that the return that investments in science, technology and innovation have already provided to the country by these companies is significant. Research at universities and at Embrapa promoted productivity increases in agriculture and reductions in costs, making Brazil one of the world leaders in agricultural production. The interaction between Petrobras and laboratories of Brazilian universities made deepwater oil exploration viable, for example (Moreira, 2018).

Law 13,243, known as the new legal framework for science, technology and innovation, was sanctioned in 2016 and regulated by decree of February 2018. This law simplifies cooperation agreements between public and private institutions and the import of inputs for research, old demands of the scientific community, and seeks to generate an adequate environment for innovation, in the context of an industrial barracks that improves results and saves resources with the use of sensors and artificial intelligence. However, in addition to the reduced commitment of industries to minimize the differences that separate them from countries such as Germany and China, attention to areas such as science and technology – fundamental to innovation – is minimized by the State, which translates into insufficient investment for the sector (Batista and Almeida, 2018). Bureaucratic difficulties, such as the persistence of delays in the

granting of patents by the National Institute of Industrial Property (INPI), can be added to this picture. Those who yearn to patent a product can take more than 10 years to wait, which is too expensive for companies (Soares 2018), but it is still an unusual situation in the Brazilian reality.

Industries / Companies

The companies received incentives not only from the federal executive branch, but also from the legislature to invest in innovation. For example, in May 2018, the Senate approved a provisional measure that would require technology and information technology companies to invest in research, development and innovation in return for tax exemptions (Senado Notícias, 2018). After these incentives, the country's private sector investment in research and development increased from R$37.4 billion to R$38.1 billion between 2014 and 2015 in the face of the crisis. Total national spending on research and development in 2015 was R$76.5 billion, adding public and private investments. This represents a drop of 3.5% compared to the amount recorded in 2014. Investments in research and development in relation to GDP showed stability, which is justified by the increase in the participation of companies, which are investing more to face the crisis with more innovation. According to the MCTIC (2017), national research and development disempockets funded by private companies increased from 0.57% in 2014 to 0.61% in 2015, but are still at lower levels than developed economies and China, as shown in Table 2.

Table 2 – National research and development expenditures financed by private companies in relation to GDP (2015)

Country	National research and development expenditure financed by private companies (relative to GDP)
United Kingdom	0,82
China	1,54
Japan	2,72
Brazil	0,61

Source: MCTIC, 2017.

The participation of contractors behind the actions of Operation Car Wash and the indebtedness of Petrobras and other companies that act as some of the greatest incentives for research and innovation engrave the picture, which showed a growing disarticulation of industries and service providers, which negatively impacted technological and economic development, economic stability and existing businesses. as well as the level of employment, slightly recovered from 2017 to 2018. The generalized crisis that hit employment reflects the greater economic instability and the greater risk associated with existing businesses, in addition to disfavoring the generation of new ventures and discouraging the creation of jobs (Rodrigues, 2018).

In addition, according to the CNI (2018), 42% of Brazilian industries were unaware of the importance of digital technologies for competitiveness, in a research conducted with 2,225 companies in 2016. Another CNI research, in 2017, carried out with 759 companies, pointed out that only 1.7% of the

entities consulted used the most advanced and available technologies in the perspective of the fourth Industrial Revolution (Batista and Almeida, 2018).

Universities

Despite recognizing a scenario of containment of expenses and budgetary restrictions, the federal government indicated that it worked intensively in the dialogue of the telecommunications, research and innovation sectors at the governmental level and in the articulation with state governments and civil society for the formulation of guidelines for national science policies. Technology and innovation. The Minister of Science, Technology, Innovation and Communications Gilberto Kassab himself highlighted the role of academia in the fight for resources for Brazilian science to develop (Kassab, 2018). The MCTIC (2017) shows that about 320,000 people work with research and development in Brazil and that most work in universities, as shown in Table 3.

Table 3 – People working with research and development in Brazil

Sector	Number of people
Universities	237.585
Companies	69.746
Government	9.935
Private non-profit sector	1.816
Total	319.082

Source: MCTIC, 2017.

However, many innovation projects that depended on government support were underfunded or closed, so the government was unable to promote a political, economic and institutional environment that would stimulate universities to invest even more in science, technology and research. The gravity of the situation was evident when, in 2017, 23 Nobel Prize winners sent a letter to President Michel Temer calling for an end to budget cuts in the areas of science and technology. The group's call was associated with that of the Brazilian scientific community, which had already held demonstrations against the cuts. According to scientists, the result will be the impracticability of the continuity of scientific research in Brazil. The letter pointed out that the cuts would harm the country for many years, with the dismantling of internationally renowned research groups, and lead to a "brain drain", which would seriously compromise the future of the country (Lewer, 2017).

It is also possible to observe that the crisis intensified structural limitations in the relationship between the university and companies, such as the lack of professional project management in several universities and the lack of definition in the elaboration of clear institutional policies for the relationship with the external environment, which reduce uncertainties. It is worth highlighting also motivational barriers related to the uncertainty of companies regarding the value of cooperation and procedural, such as those linked to legal barriers to technology transfer, the complexity of contracts to be negotiated and the lack of ex-experience of universities in interdisciplinary work. Added to this picture is the need to

disseminate information on the production of research centres and the lack of complementary technical services (Porto, 2000). In the vision of most companies, universities should take a set of actions, such as the further development of scientific marketing and the strengthening of the approach with the agents of local innovation and production systems (Kamlot & Schmitt, 2015; Ipiranga *et al*., 2010), which is more difficult without resources in times of crisis such as the current one.

5 CONCLUSIONS

The Triple Helix identifies the actors and relationships, institutional arrangement, and dynamic mechanisms fundamental to innovation and entrepreneurship, so that academia, industry/business, and government interact to create innovation resources through existing or newly created hybrid organizations (Etzkowitz and Zhou, 2017).

To stimulate the development of the triple helix in Brazil, municipal, state and federal governments should create conditions for the adequate development of a financial market that stimulates and supports entrepreneurial activities, mainly those oriented towards micro, small and medium-sized enterprises, especially those with a technological and creative base. With regard to venture capital, it would be necessary to clarify with incubator managers and entrepreneurs about the nature of that capital and the creation of more robust legislation to protect companies. The supply of this capital could be encouraged by the development of an efficient capital market, stimulating greater participation of pension funds and the creation of investment companies and reducing the costs that affect this activity. In addition, the government could, through increased direct support to banks and investors, encourage the private sector to support incubated enterprises (Vedovello *et al*., 2001).

In order for science and technology to fulfill their role of bringing advances to other areas, such as economics and health, the government subsidy should be regular and continuous to research centers or companies that have the structure to do the studies, which does not happen according to Jorge Almeida Guimarães, president of the Brazilian Industrial Research and Innovation Company (Embrapii). In addition to the investment to take advantage of innovation, it was necessary, according to BNDES Planning Superintendent Mauricio Neves, that resources be allocated appropriately, with the definition of priorities in a development agenda and public policies by governments and managers (Batista and Almeida, 2018).

Investment in Science, Technology and Innovation is essential to ensure economic growth in periods of recession. However, a major challenge is improving the quality of basic education and science training in secondary education. For an educational revolution, the participation of the sectors involved – universities, scientific entities, managers and professors – and society as a whole is necessary, in addition to the significant reduction of excessive bureaucracy, which generates a large waste of time and resources and obstacles to innovation (Moreira, 2018).

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