Triple Helix Relations and Patent Deposition in Innovation Projects at a Large Brazilian University

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Abstract

Innovation nowadays is one of the most important factors for any company's long-term success, economic development, or technological and scientific advances. In Brazil, the investments in Research and Development are mostly public, counting on government support in incentives and specific legislation to foment innovation. Among the many factors that influence innovative projects' development are the triple helix relations, which are established among universities, industry, and government. The entrepreneurial university is the main institution of this model as it represents the largest source of knowledge needed to stimulate technological advancement and entrepreneurship. In this scenario, this study aimed to analyze the triple helix relations into science, technology, and innovation support institutions linked to a federal university in Brazil. The project consisted of analyzing each triple-helix actor's impact in historical data of innovation projects conducted by the university center. As a result, the government sphere's strong presence was identified as the main conductor of the innovation process, followed by a university culture of research and entrepreneurship in development and industry not as active as it was expected.

Keywords

Triple Helix, Innovation Management, Entrepreneurial University

1. Introduction

Innovation nowadays is one of the most important factors for any company's long-term success or the country's economic development. In Brazil, the investments in Research and Development are mostly public, counting on government support in incentives and specific legislation to foment innovation.

Among the many factors that influence innovative projects' development are the triple helix relations (Etzkowitz and Leydesdorff, 2000), which are established among university, industry, and government. This interaction model's main objective is to enable the three spheres to be overlapped, supporting each other to reduce barriers and accomplish trilateral relations in favor of innovation. The entrepreneurial university is the main institution of this model (Etzkowitz, 2003) as it represents the largest source of knowledge needed to stimulate technological advancement and entrepreneurship.

Another framework to help understand innovation nowadays is open innovation (West et al., 2014). Open innovation is a form of triple helix relation that runs between companies and universities or government agencies and universities. Operationally, these relations can be implemented through technology transfer efforts, based on patents, or bilateral contracts for technology development (Dahlander and Gann, 2010).

Our classic literature and researched articles do not correlate technology development contracts to patent deposits and technology transfer based on them. What are the relations of technology development contracts, patent deposition,

and technology transfer in a large university of an emergent country? What is the reasoning of agents in these relations? Are these relations fomenting innovation and entrepreneurship?

The reported project consisted of analyzing the historical data of innovation projects conducted by a large Brazilian university. The purpose was to determine the impact of each triple helix's sphere in the institution's portfolio. All projects from 2006 to 2018 were analyzed in terms of partnerships for the project, results in terms of patents, and business the partners do after patent deposition. Interviews were taken to explain quantitative data. This article is an initial report of the issues collected in this research.

The article is structured in five sections. After this introduction, we have a literature review followed by our research methodology. The fourth section presents our results, and the final section our conclusions and comments for future researches.

2. Literature review

According to Schumpeter (1984), innovation is an ongoing process of novelty creation, which changes the old balances and results in creative destruction. Innovation allows monopoly profits until new competitors got the same competitive profile and increase market concurrence.

For Drucker (1998) the innovation is an effort to create changes for for-profit purposes. According to this author, these changes occur because of: (1) unexpected events, (2) incongruences and non-conformances, (3) process cornerstones, and (4) industry or market trends. External issues as demography changes, consumers' expectations, and new technologies can also gather innovation.

According to Davila et al. (2007), innovation allows companies to redefine their sectors founding new business models, which changes competition. Technology and market approach needs to be in line with the new business models for changing a sector. Technology strategy means introducing the product or process innovation, or even new technology enablers, while marketing strategy means new value propositions for supply-chain and segmented clients (Wheelwright and Clark, 1992).

Christensen (1997) developed the concept of disruptive innovation, which complements and show the mechanisms of the former Schumpeter's concept of creative destruction. According to the author, the innovation dilemma occurs when big companies fail to develop this kind of innovation and break down in their respective markets.

Despite the importance of private investment in disruptive innovation, Davila et al. (2007) find that incremental innovation represents more than 80% of company investment in new products and processes and guarantees a lot of few differentials that companies have to their competitors. Tidd et al. (2008) point that when summing up all incomes of incremental innovation, maybe these result is better than radical ones. Wheelwright and Clark (1992) point to the importance of different projects in an organizations' portfolio. Burin Neto et al. (2013) discuss how knowledge-intensive companies must balance and manage their portfolios in constant product evolution.

Therefore, on one side, disruptive Technologies can change the way companies do things in a specific market. Still, for the other side, the risks and costs involved in investing in these technologies can be impeditive (Davila et al. 2007). This uncertain result of more innovative endeavors justify the government's fundamental role in innovation (Mazzucato, 2014).

According to Bessant and Tidd (2009), innovation does not occur only base on a wish or idea but is a result of a complex process involving risks. It can be systematically managed. Despite the current thought as if innovation resulted from a genial and individual idea, or even an attribution for scientists and engineers, it needs more and diverse knowledge for good results. This complex and collaborative way is illustrated in Figure 1, showing how incremental, iterative, and fuzzy is working on innovation.

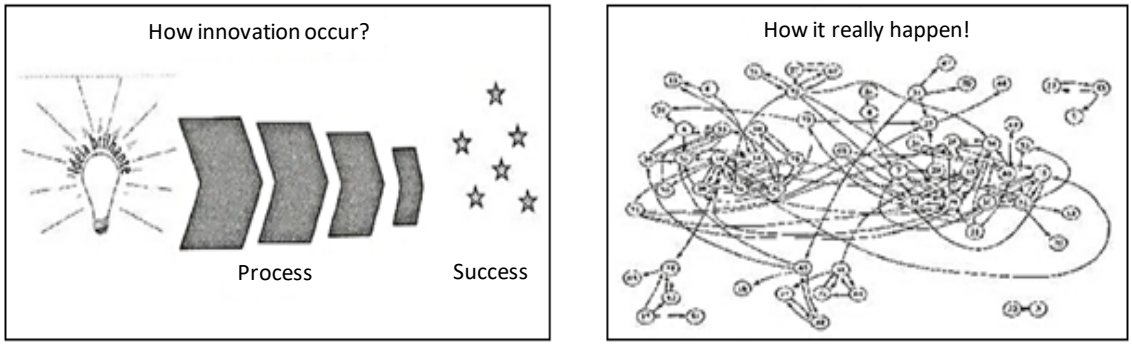

Figure 1 – Literature of processes for better innovation versus an actual process. Source: Bessant and Tidd (2009, p. 106).

In Brazil, a lot of research in business innovation suggests using processual models as references for new product development (Rozenfeld et al., 2006; Barbalho and Rozenfeld, 2013; Silveira et al., 2018). Despite being well used for teaching specific technical disciplines, these models are not well aligned to divergent thinking (Brown, 2019) and innovative competencies of innovation leaders (Dyer et al., 2011). They also correspond to an in-house way of developing innovation and not open innovative approaches (Chesbrough, 2003).

The actual generation of new business models involves different spheres of society and not exclusively the innovative companies. University, industry, and Government are key actors to perform the needed different roles in every innovation strategy (Etzkowitz et al., 2005). According to Bessant and Tidd (2009, p. 105), "the innovation is not a sole act, but a game with multiple actors".

An important concept over relations of actors for innovative endeavors is the already mentioned "open innovation", a practice which compared to closed innovation, is an open paradigm where a company works in collaboration with others and with academia and public partners for developing new technologies (Chesbrough, 2003; Huizingh, 2011).

According to Tidd, Bessant, and Pavitt (2008), companies explore external sources of innovation because of: (1) reduced technological cost for market entrance, (2) decrease on project risks, (3) reach scale economies, (4) decrease the time-to-market, and (5) promote sharing on learning issues.

In this context, Etzkowitz (2009) argument that through partnerships or in competition for startups alignment, the role of universities for regional development, social or economically, can be as higher as its capacity to influence industry and government. According to the author, university-industry relations comes from:

- Interests in basic research and funding by government agencies;
- Industrial projects requesting academic support;
- Joint formulation of research programs with goals and applications for multiple funding sources.

Dahlander e Gann (2010) states that companies can use formal or informal methods of protection when incorporating innovation in their business models, as patents, copyrights, or market insertion and recognition. Formal approaches are not always the most appropriate way of protection (Huizingh, 2011) because these decisions are made in the early stages of projects. Some businesses are carried out over open access codes, a non-protected technology way of doing things.

Knowledge capitalization is converting knowledge into capital employing intellectual property copyrights (Etzkowitz, 2009). According to Jungmann and Bonetti (2010), good management of the intellectual property can allow Brazilian companies to increase competitiveness. Barbalho et al. (2019) present an overview of Brazilian experience in a National Post-Graduation Program of Technology Transfer and Innovation, which triggers more research to patent, and patent to business endeavors.

For Bessant and Tidd (2009), the most secure way of knowledge protection is the industrial secret. Once the product is launched, it will probably be copied or suffer from illegal utilization. Intellectual property rights are applied to innovations because of the protection it provides for inventors and the purpose of market novelty entry.

Jungmann and Bonetti (2010) state that intellectual property management range from technology identification, intellectual property deposition, licensing and contracting, and market introduction of intellectual property-based products.

Research conducted by Amadei and Torkomian (2009) analyzing São Paulo State's public universities revealed that internal policies in more entrepreneurial universities drive the valorization of intellectual property, impacting directly on the number of patent deposits. This study also demonstrates that the main partners for research are public agencies and not private companies.

The triple helix concept was built in a study conducted by Etzkowitz and Leydesdorff (2000). The authors analyzed MIT's (Massachusetts Institute of Technology) role in the recovery of the American economy during the '30s throughout the collaboration of government, academic and industrial leaders in the New England area of United States (Almeida et al., 2012; Etzkowitz and Carvalho de Mello, 2004).

Traditionally, universities represent the domain of knowledge and new technologies. Industries are the locus of economic development, and the government is a moderator of inputs and outputs of the other spheres (Etzkowitz et al., 2005). These are fundamental activities of each actor, but Leydesdorff and Etzkowitz (1998) state that university, industry, and government's primary functions must be open to influence the secondary actors for instigating innovative ways of conduct its activities.

In the triple helix model, the industry creates value, the university provides intellectual capital, and the government supports innovation through policies and incentives for research and development (Almeida et al., 2012). However, this joint interaction model in which regions of overlapping spheres (Figure 2) appears is considered the final phase of the study conducted by Etzkowitz and Leydesdorff (2000), explaining the strategies for advancing innovation.

According to Etzkowitz et al. (2005), Brazil has been presenting a transition from a top-down innovation system focused on purely governmental initiatives to a triple-helix model with a centralized role in the university. These transformations result from the evolution of three stages of the three-propeller models, shown in figure 2:

- The Triple Helix 1, a statist version with the other spheres subordinated to the government;
- The Triple Helix 2, a version without state intervention (laissez-faire), with little interaction between the spheres and without the performance of bilateral activities, and;
- The Triple Helix 3, a version with overlapping spheres and emergence of trilateral networks and hybrid organizations, such as incubators and technology transfer centers. These organizations drive innovation by exploiting the potential of integration between spheres.

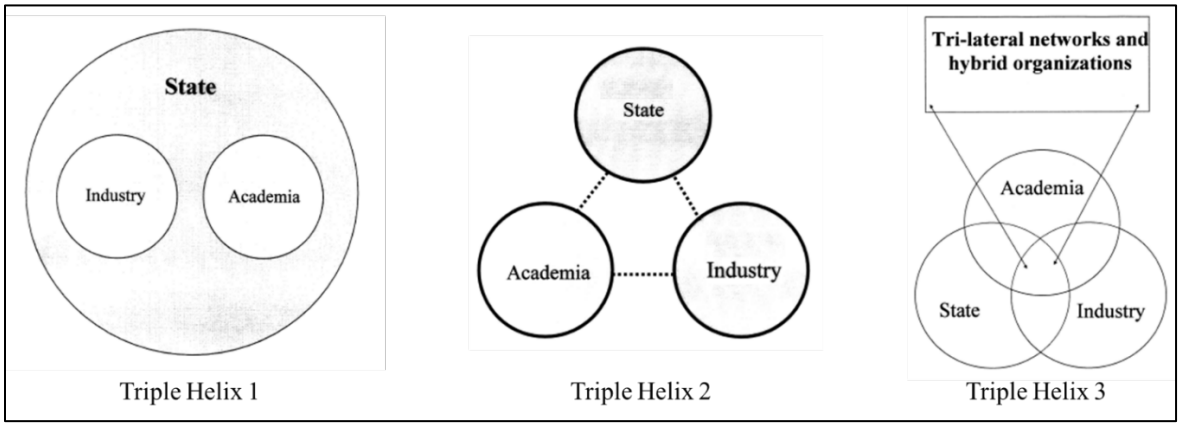

Figure 2 – Evolution of triple helix models. Source: Adapted from Etzkowitz and Leydesdorff (2000).

Thus, in the Triple Helix 1 model, the state encompasses academia and industry, completely coordinating the relationships between them, which is seen as a flawed model for bottom-up initiatives. It offers little space for them, discouraging innovation. On the other hand, the Triple Helix model 2 tries to reduce the state's role and presents the institutional spheres separately, but with strong borders that isolate them in their respective environments. Finally, the Triple Helix 3 presents the overlap of the institutional spheres, with each also exercising part of the functions of the other two, resulting in hybrid organizations emerging from this interface, helping the coexistence of the objectives of each propeller in the innovation process (Etzkowitz and Leydesdorff, 2000).

Other theories emphasize the governmental sphere's role at the center of the innovation process, such as the Sabato-Triangle theory (Etzkowitz and Carvalho de Mello, 2004), or firms and industries as the main agent of innovation (Etzkowitz et al., 2005). The triple helix explores these entities' relationships with the centralized focus on the entrepreneurial university (Etzkowitz and Leydesdorff, 2000), which is now considered the largest source of new business and technology with potential for economic and social development. Thus, Etzkowitz (2009) states that the university's primary role is to be the institution designed to promote necessary lateral relations between the governmental and industrial spheres, acting through its educational function. The concept that emerges from this new function is "the entrepreneurial university", which is focused on reconciling the academic knowledge generated with the return in the form of applications and new business to society.

According to Etzkowitz (2009), explicitly entrepreneurial university identifies areas of research and teaching excellence that must be explored, attracting support and significant external funds. It is also responsible for exploring society's problems and needs to provide a basis for further studies and projects. The entrepreneurial university can draw up a strategy geared to academic objectives and transform university knowledge into a real socio-economic value (Etzkowitz, 2003).

The evolution of university missions occurred through two academic revolutions. The first academic revolution was the transition from the teaching university to the researcher. The second is the change to the entrepreneurial university. The university needed to put aside the isolated academic model as an "ivory tower" and be actively embedded in society to transfer its research to generate growth and new enterprises effectively. The university's internal logic's traditional missions give rise to new visions compatible with the present society, evolving from the first purely educational mission to the second mission of research and impelling the third mission of economic and social development (Etzkowitz, 2009). Tidd et al. (2008) affirm that the creation and sharing of intellectual property is a new essential role of universities, which has grown significantly in recent years because of its importance in generating technologies faster and faster.

Therefore, the development of the university entrepreneurial culture helps identify research with the potential of immediate or long-term applicability. This culture can arise through the search for external funding for conducting research, which can occur both from the university outwards and vice versa, from a private or public need (Etzkowitz, 2009). According to Tigre (2006), university centers are attractive to high technology companies because of their cultural, educational, and innovation-friendly environments. The manager of these university centers needs to be able to count on the support of good infrastructure with access to competitive technical services, including investment by governments and universities in the form of technology parks, incubators, and tax incentives (Barbalho et al., 2019). Also, the high flow of human capital in students and their respective potential innovators passing through the university reinforces the importance of the academic environments for innovation (Etzkowitz, 2003).

According to Etzkowitz (2009), an entrepreneurial university relies on four pillars:

- Academic leadership capable of formulating and implementing a strategic vision;
- Legal control over academic resources, including physical facilities (buildings) and intellectual property (resulting from research);
- Organizational capacity to transfer technology through patenting, licensing, and incubation, and;
- An entrepreneurial culture among administrators, faculty and students.

However, Philpott et al. (2011) contrast the idea of the movement toward the entrepreneurial university by stating in their study that the process for achieving the third mission is more complicated than it may seem. That is because the entrepreneurial mission, according to the author, cannot weaken the primary and secondary missions of teaching and research. On the contrary, it must explore the synergy between them to reach the institution's maximum potential. In addition to making the academic community aware of its importance, achieving the optimal alignment between the

university's entrepreneurial and non-entrepreneurial activities is crucial for building the entrepreneurial university. Finally, these issues need a significant cultural change in Brazilian universities, independent of public or private (Barbalho et al., 2019).

3. Methodology

According to Vieira (2009), research must have objectives aligned to already existing knowledge. Gil (2008) states that research can be defined as a formal and systematic process of developing new knowledge or technologies. According to Silva and Menezes (2001), research is classically classified in four ways: nature, basic or applied; approach for the problem; objectives; and technical procedures. This research is an applied, explorative, quantitative, and qualitative approach. The methodological procedures are described below.

The first step consisted of bibliographical research with the main concepts of innovation, triple helix, disruptive technologies. A literature analysis was done in qualified databases from CAPES/MEC (Coordination of Superior Education Improvement / Brazilian Ministry of Education). A representative number of Brazilian-based studies were selected to identify previous research in the Brazilian context.

The second step relates to consolidating the project portfolio database in the Center of Innovation of the Brazilian University studied. According to triple helix concepts, its projects were analyzed and initially consisted of various MS Excel® based datasets and a DotProject solution, all of them not integrated. The consolidation started integrating datasheets.

As the work for the consolidation of the portfolio of innovation projects was carried out, some meetings with relevant personnel were run to incorporate relevant analysis into the portfolio database. The database for project analysis was gathered directly from the project management office of the Center of Innovation, which has been implemented according to Artto et al. (2011) and Barbalho et al. (2009), focusing on specific contributions to manage innovation portfolios (Jugend et al., 2015). This implementation was carried out concurrently to the present research once the managers want the historical data on their hands to define new strategic directions for technology development efforts. All projects from 2006 to 2017 were analyzed, taking into account projects closed and in execution. Projects under a proposal phase or terminated were not included in the database for analysis.

Relevant data not available on datasheets were gathered from the DotProject solution used in the Center of Innovation. Having the database consolidated was possible to classify and to present a panoramic view of innovation projects. The way projects were classified according to:

- Classification by time: short time, up to one-year projects; medium time, among one and three years; long time, major than three years' projects.
- Identification of organization which funds the projects: private – companies, private foundations, civil associations, private institutions in general; public – federal or provincial public organizations; own resources – funding from the own university, its departments, and faculties;
- Project stakeholders: identified on the Dot Project through analysis in scope, objectives, results, and scope definition in each project. More than investors, all stakeholders were classified according to triple helix actors.
- Intellectual property: a database of projects and patents and other intellectual property assets were compared to identify which projects generate which asset. Assets were classified in patent, shared by UnB and other institutions; software register – a computer program; none intellectual property asset.
- Identification of the assets was the starting point for spin-offs endeavors.

This study's analytic phase was performed, crossing data in these classifications to understand our research question. Part of the result of this analysis is presented in this article.

4. Results

We found 286 projects, summing up to 300 Million BRL. Public funding represented 212 projects, and only 74 were private. Most of the projects lasted less than one year, and a few of them lasted more than three years. Only 23% of the projects have triple helix relations, and 53% in our sample relates to government agencies and the university. It is explained because the researched university is located in the Brazilian federal district. Only 19% of the projects, 55 of them, relate to University and private companies. Figure 3 shows data from the research sample.

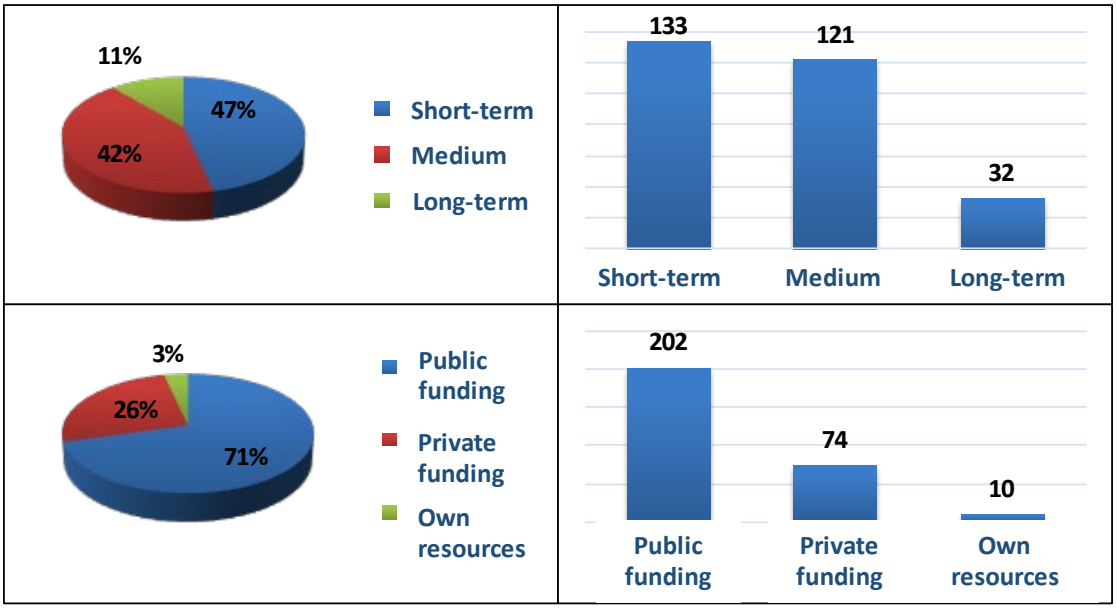

Figure 3 – Project characterization. Source: Authors.

More projects have been classified as short time, a period under one-year duration. Medium time projects are that among one and three years, and long-time are over three years. Few long time projects are identified, which suggest few disruptive technologies as results of projects.

Rather than private partnerships, we detected more government partners in the analyzed projects (Figure 4). From the researched projects, only 10 had patents as a result (Figure 5).

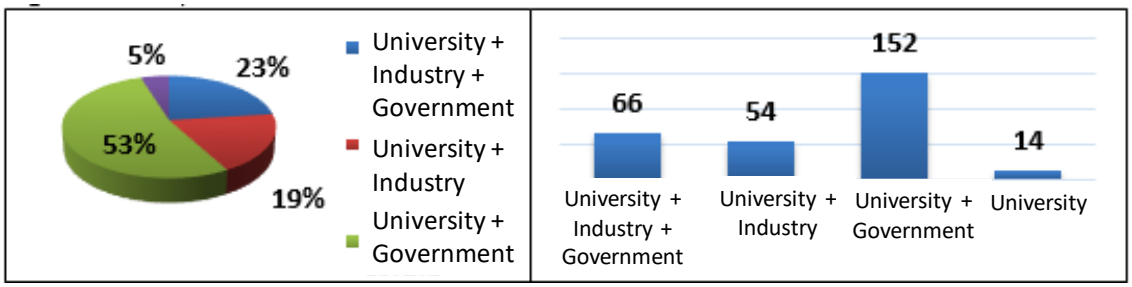

Figure 4 – Triple helix actors. Source: Authors.

None of the projects with less than one-year duration had a patented technology. But mainly medium-term projects have this result. Long term projects were large alliances between the University and some government agency, and some are yet running when the research was carried out. When analyzing the partnership in projects with patents resulting, 70% have university, industry, and government as partners, while projects without patents have only 21% of all triple helix actors. Data also show that 67% of university-industry projects were short-term ones, and only 10% of them have a patent as a result.

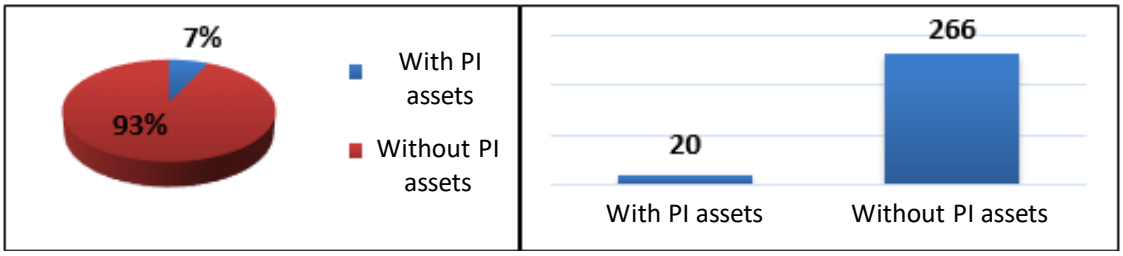

Figure 5 – Intelectual property in projects analyzed. Source: Authors (2018).

Qualitative data demonstrates that actors, academic and industrial ones, do not trust patents as a differential for their business activities. Only four of them resulted in a technology transfer to any company for commercial purposes from patent deposition.

5. Discussion

Data gathered in this research allow some discussion about Brazilian triple helix relations. First of all, a contradiction compared to previous literature: most of the projects are funded by government agencies but have short time horizons. The expected result, according to Mazucato (2014) was more long-term planning from government agencies. As the researched university is in the Brazilian federal district, it can suggest a lack of planning for research and technology. Specific research protocols must be designed for this purpose.

A second issue to discuss in the kind of partnership was more present. Suppose taking into account the three possibilities of triple helix relations (Figure 2 - Etzkowitz e Leydesdorff (2000), data suggest that the first or the second model was more present depending on the profile industry-university relations. We need more data for this categorization because, in model 1, the government drives industry-university relations, which is not real in model 2. Our data make it possible to infer that model 3 is not the current practice in the studied university.

But our data also suggest that in some studied innovation ecosystem, all the models co-exist, and taking this into account, most model 1 may represent our case studied as a typical innovation practice drive by government efforts but without a long-planned horizon.

Patent deposition data allow us to corroborate to Etzkowitz (2003) in terms of the role of triple helix relations and its results because the patents were more probably generated if the three actors act concurrently in a project for more than two-thirds of patent deposition efforts.

Finally, in terms of outcomes of innovative efforts performed on these projects, we see a small tax of entrepreneurship return, i.e., the number of patents and mainly innovative companies by resources invested. We had only 19 patents generated and only four licensed to a company. If input data were analyzed, almost a third of a billion BRL were requested to develop four business models, a really low conversion rate.

6. Conclusions

The main scientific contribution of this research is that in an emergent country like Brazil, patents are not a focus of innovative efforts. The low rate of patents in industry-university projects suggests that businesses are run away from patents, but maybe trusting industrial secrets and intimate relationships among actors. Also, the high presence of short-term projects among industry and university shows a profile that jeopardizes patent deposition possibilities. Data also suggest that triple helix's projects outlined more patents.

Qualitative data suggests that the whole context of the Brazilian market and regulatory issues contribute to academics and entrepreneurs' mutual mistrust for investing in patents. The conversion rate can be higher than the uncovered by this research once industrial and private partners, in general, can use the knowledge gathered in research projects to open new non-patent based business. An issue to investigate more in future works.

This research has a practical implication for public decision making in Brazil and emergent countries. For having more technological-based business, maybe it will be better to fund triple helix partnerships. In our sample, university-

industry relations tend to be more based on short-time cycles. They also have a lower effort to patent deposition. As a consequence, they were characterized by a low generation of technology-driven businesses. Therefore, maybe higher project cycle-times, and incentives to co-titular patent deposition, can result in more universities spin-offs.

Our article shows the kind of triple helix relation which produce more in terms of technology-driven business. So, an example of how bridging research for the society is analyzed. This paper can contribute to the themes of R&D, emerging markets, and innovation ecosystems. Its main limitation is based on only one university, one strongly leveraged by its place in the Brazilian federal district. Another limitation is the research protocol that does not gather qualitative data from third parties of these projects, but only from the university innovation center. Third parties can have information regarding technological deployments from these research projects, enriching the whole analysis.

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