

Academic Spin-Offs and the benefits generated by startups developed Through University-Companies cooperation in Brazil

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Abstract

Startups developed through academic Spin-offs foster the development of products and processes inside and outside the innovation ecosystem that originated them and have become an important research topic with regard to Technology Transfer mechanisms and University-Company cooperation. Therefore, the objective of this article was to bring up information that could contribute to the discussion on academic spin-offs, startups and the benefits initially generated by this cooperation. The adopted methodology was the exploratory descriptive, aiming the perception in the literature used in some arguments and data that would help the understanding of this relationship. In view of this, the results

show us that there is a large number of qualified personnel within these firms and that this intellectual capital cooperates with the positive impact on a country's economic and social development.

Keywords: spin-offs; startups; transfer technology; university-companies cooperation.

1. Introduction

The use of technology created in universities represents an important basis for the economic development, therefore the cooperation of the productive sectors with the academy is a source of advantages for all involved (COSTA; PORTO; FELDHAUS, 2010; KAYSER et al, 2018). University-business cooperation is the establishment of relations between universities and companies, so cooperation activities sought promote synergy between organizations, making them more competitive in their respective fields of action. The strategic option for cooperation is interesting for companies that face some type of technological difficulty or that have difficulties to innovate in isolation. Such relations between companies and universities can occur in several ways, including through the transfer of technology (SANTANA; PORTO, 2009; KAYSER et al, 2018).

Technology transfer can be understood as the set of steps that describe the formal transfer of inventions resulting from scientific research carried out by universities and research institutes to the productive sector, it is necessary to emphasize, the importance of such a process is based on the innovation potential it provides (DIAS; PORTO, 2014; STAL et al, 2016).

In the context of university-business cooperation and in technology transfer processes, there are several mechanisms, such as, for example, technology licensing and the creation of technology-based companies, the last example mentioned is related to the so-called academic entrepreneurship that has gained highlighted due to the development of companies from the result of academic research, in this case, startups from academic spin-offs (ETZKOWITZ, 1998; COSTA, TORKOMIAN, 2008; DALMARCO et al, 2018).

In order to contribute to the debate on the topic, this article seeks through a theoretical study to address the conceptualization of technology transfer and its mechanisms, entrepreneurship, startups and academic spin-offs and to present possible contributions in the context of economic development and social for the country, in the search to meet the proposed objectives, two studies referring to academic spin-offs in Brazil were analyzed in an interval of seven years, a study developed by Costa and Torkomian (2008) "An Exploratory Study on a new type of Enterprise: the Academic Spin-offs" and the research carried out by Santos et al. (2015) "Academic Spin-Offs and their Importance in Economic Development".

2. Technology Transfer

In the context of this research, in order to understand what technology transfer really is, it is necessary to understand what innovation and university-business cooperation is about. Innovation can be defined as an

idea, practice or material good that is perceived as new and of relevant application. The innovation process is defined as the development and implementation of new ideas by people who work involved in transactions with other people within the organizational context and results in the creation of new technologies, products, processes and management models (BENEDETTI; TORKOMIAN, 2011; PINTO et al, 2019).

Innovation can be seen as a competitive advantage, since it reduces costs, through ease of manufacture or simplification of logistics; and increases differentiation, developing new products or improving existing ones (PORTER, 1985 apud MARCHIORI, 2000), in the midst of a global competition context, innovation has a decisive role for the technological and economic development of any country (GARNICA et al, 2009; MIRANDA, 2017).

Despite the fact that many developing countries seek to develop new technologies internally, most of them face difficulties due to social and cultural experiences in using, adapting and disseminating these technologies (COHEN, 2007). In these countries, the control of the technology transfer process has serious limitations and is not so well understood due to its complexity and consequent negative social impacts. On the other hand, in developed countries, the development of technologies can be perceived as a continuous process (BENEDETTI; TORKOMIAN, 2011; PINTO et al, 2019).

The Brazilian environment has historically been characterized by a lack of articulation between industrial and governmental policies on science, technology and innovation (STI). As a result, there is a gap between investments in STI and the demand for innovation in the private sector. There is a concentration of public investments in science and little investment by the private sector in technological development (CLOSS; FERREIRA, 2012).

In this context, the knowledge generated in Brazilian universities is a rich source of information and training for the development of new technologies, since the transfer of technology between universities and the productive sector appears as an alternative and complementary path for the reaching a higher technological level for Brazilian companies (GARNICA; TORKOMIAN, 2009; MIRANDA, 2017).

It should be noted that university-company cooperation is the establishment of relations between the university and the company, so that the activities envisaged promote synergy between organizations, making them more competitive in their respective fields of action, hence the strategic option cooperation is made interesting for companies that face some type of technological difficulty or that have difficulties to innovate in isolation. Such cooperation between companies and universities can occur in several ways, including through the transfer of technology (SANTANA; PORTO, 2009; KAYSER et al, 2018).

Technology transfer can be understood as a process carried out between two entities in which a certain knowledge is acquired, developed and used in order to improve a methodology, a process, a product or an element of that product (LUCATO et al, 2015) . In this context, it is worth mentioning the triple helix model (ETZKOWITZ; LEYDESDORFF, 2000 apud CLOSS; FERREIRA, 2012), being one of the most

referenced in relation to the different agents of the innovation process and, consequently, of the technology transfer processes.

This model characterizes the interrelationships of three major entities: the university, the government and companies, with the aim of exploring ways to create an environment favorable to innovation (CLOSS; FERREIRA, 2012), as shown in Figure 1.

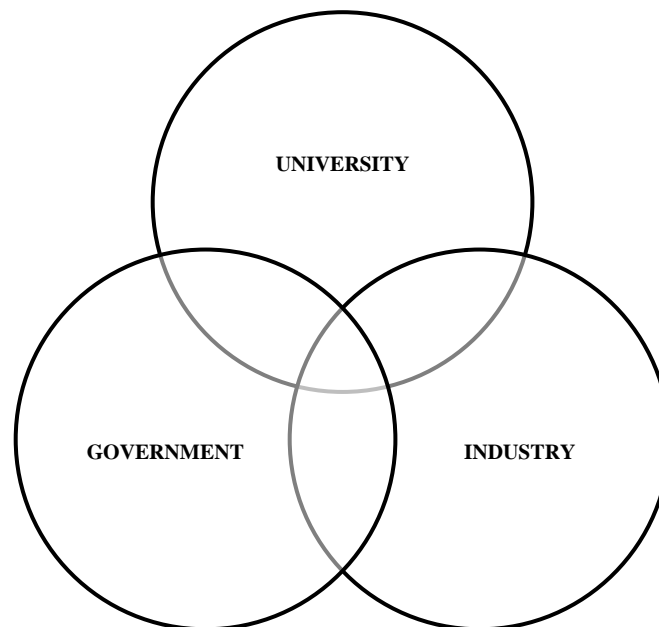


Figure 1. Triple Helix.

Source: Adapted from ETZKOWITZ; LEYDESDORFF (2000) *apud* MIRANDA; SANTOS; RUSSO (2017)

Based on the concepts brought by the triple helix model, universities and companies have a kind of mutual dependence, since companies have a need for innovative products within their commercial environment while universities have the ability to develop such products through of the research (MIRANDA; SANTOS; RUSSO, 2017)

3. Technology Transfer Mechanisms

Based The main means for the transfer of technology have been licensing and the creation of derivative companies through a mechanism known as spin-off. Based on their studies and with a greater focus on communication channels, Rogers, Takegami and Yin (2000) present in a more detailed way what are the mechanisms of Technology Transfer, in this case, publications, meetings / conferences, research projects and cooperative developments, licensing and spin-offs (GARNICA, 2009; MIRANDA, 2017).

Table 1. Technology Transfer Mechanisms

Technology Transfer Mechanism	Definition
Publications	Publications of scientific articles in academic journals.
Meetings / Conferences	Academic events where technical information is exchanged.
Research projects and development cooperatives	Agreements between Research Institutes and private companies focused on research, sharing prediction intellectual property rights, equipment and capable people.
Licensing	Permission of use of Intellectual Property Rights
Spin-offs	Transfer of technological innovation in a process of generating new companies from existing organizations.

Source: Adapted from Garnica (2009) *apud* Miranda (2017)

Historically, universities and other research institutions have fulfilled their basic function of transferring knowledge through publications, extension programs or even courses and training (CLOSS; FERREIRA, 2012). However, in addition to the traditional objectives linked to teaching and research, transferring knowledge to industry arises as a new mission for the university (MUSCIO, 2010).

In this context, mechanisms of technology transfer appear that go beyond scientific conferences and publications, such as technology licensing, R&D projects and spin-offs. In the scope of university-business cooperation, academic spin-offs can be understood as companies derived from an academic institution, in a more exemplified way, if in the midst of research a profitable invention or idea arises, creative teachers and students can develop a company to commercialize his creation, that is, a startup from the spin-off transfer mechanism (CONSTANTE, 2011 *apud* MIRANDA, 2017).

4. Technology Transfer Mechanisms

The history of Entrepreneurship in the world has no definite date. Studies show that between the years 1271 and 1295, a merchant named Marco Polo tried to develop a trade route to the East and, in an entrepreneurial initiative, signed a contract with a capitalist who started to sell his products. His travels and actions characterized the person who practices entrepreneurship, that is, an entrepreneurial person who takes physical and emotional risks, in order to achieve his goals. Marco Polo became known as one of the first entrepreneurs in world history. According to Matos Brito et al. (2013).

In the medieval period, an entrepreneur was one who managed large projects without taking serious risks. In the 17th century, the first relations between entrepreneurship and assumed risks emerged. It was during this period that the entrepreneur began to establish contractual agreements with the government in order to perform services or provide products. In the 1990s, entrepreneurship became the focus of public policies and studies in institutions of secondary and higher education. This was due to the intense technological advancement, which forced people of the time to prepare to innovate, continuing or

becoming competitive in the market. All of this, even today, is observed through government incentives for new investments, integration of the discipline in school curricula and reducing the bureaucracy of financing for the implementation of new businesses. (Rede E-tec Brasil, 2013)

According to the trajectory of the history of Entrepreneurship, in view of the need to innovate, the idea of entrepreneurship has become indispensable, which can be applied in the most diverse areas, including in the academic sphere, for example, with the expression entrepreneurial university (ETZKOWITZ, 1998; PAVITT, 1998; COLYVAS et al, 2002; SHANE, 2004). In the midst of this context, so-called startups also appear.

The concept of startup has evolved a lot over time. First, these nascent companies were seen as a small company in its initial stage (GITAHY, 2010). Over time, the concept of startups has evolved and what is understood is that these organizations are companies that are born in extremely uncertain environments. They are small civil, commercial organizations or a specific enterprise capable of generating wealth with an accelerating promotion. Steve Blank (2014) a scholar in the field says that “A startup is a temporary organization, designed to search for a repeatable and scalable business model”.

The history of startups, innovative environments and entrepreneurship began in Silicon Valley - the cradle of this paradigm shift. Steve Blank (2014) says that Silicon Valley started its development from the 2nd world war, continuing in the cold war. The American government has invested millions in a secret Harvard laboratory, in addition to encouraging ownership and reducing capital gains taxes, expanding the availability of credit. Hence the promotion of entrepreneurship and its startups, which are temporary companies / organizations and in search of a receptive and scalable business model, started.

According to FONSECA (2016), “The rise of startups reached its peak in mid-2010, where dozens of start-up centers around the world started to be called ecosystems due to the high concentration of elements favorable to the emergence of these companies.” Given this statement, it is understood that Startups must have an innovative product or service to transport progressive innovations.

Currently, there are several types of startups, however, this article focuses on a specific type, startups from spin-offs in the university-company axis or also called academic spin-offs. According to Shane (2004), academic spin-off can be conceptualized as a company created to explore an invention resulting from research work produced in an academic institution, in parallel Bigliardi, Galati and Verbano (2013) conceptualize academic spin-offs as a specific type of startup company founded by an academic inventor with the aim of exploring technological knowledge that originated within a university environment with a focus on developing products or services.

According to Sánchez and Pérez (2000), there are three basic types of academic spin-offs, as shown in Figure 2.

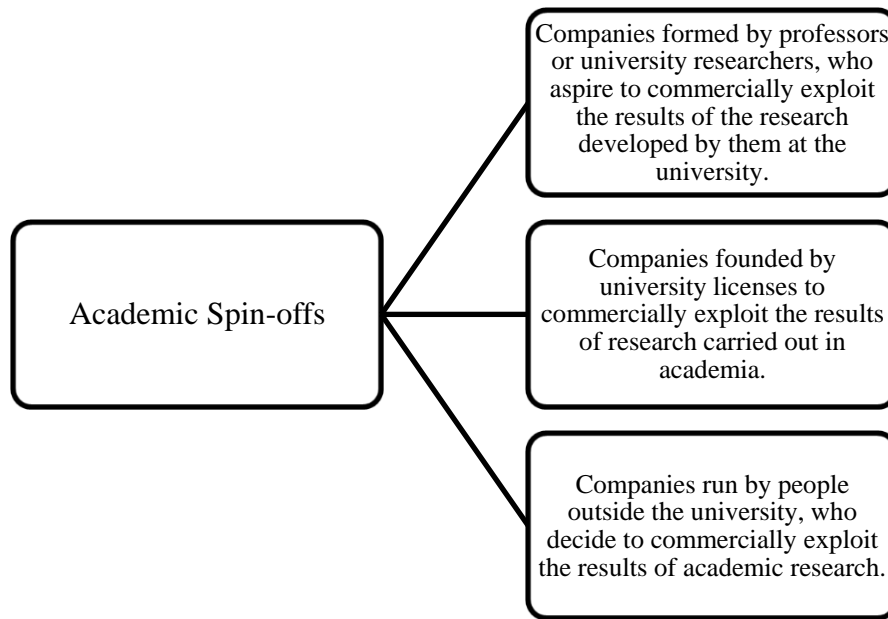


Figure 2. Types of academic spin-offs

Source: Adapted from Pedrosi Filho and De Matos Coelho(2013)

In relation to the theoretical discussions regarding the definition of academic spin-off, some authors conceptualize that a startup company developed by an individual without a link to a university, but as long as the know-how comes from an academic institution, there may also be the consideration that this is an academic spin-off (RAPPERT; WEBSTER; CHARLES, 1999 apud PEDROSI FILHO; DE MATOS COELHO, 2013).

Despite the various definitions available in the literature for academic spin-off, in general, there is a fundamental characteristic of academic spin-off, necessarily its basic product or service was developed from research carried out within the structure of universities.

5. Benefits presented by academic Spin-offs worldwide

In general, there is a consensus among theorists about the benefits achieved through academic entrepreneurship. Startups from the academic spin-off mechanism are usually technology-based companies and according to Monck et al. (1990), these types of companies represent an economic promise, since the technological sector drives the economy in a wide way, either by raising income levels or even by inducing the growth of businesses considered traditional (MONCK et al. , 1990; SANTOS et al., 2015).

Also according to Pedrosi Filho and De Matos Coelho (2013), academic spin-offs have a positive impact on the development of the local economy, since the creation of startups and economic activities related to companies are usually local, in addition to the tendency to form clusters. known clusters, such as, for

example, Technology Parks, once technology companies are established in a given region, they are prone to attract other economic actors, such as service providers or suppliers, which helps to local economy. According to research carried out in several countries, indirect economic impacts may be greater than direct impacts. Still with regard to the economic impacts generated by the spin-offs, Shane (2004) presents relevant data regarding academic entrepreneurship around the world.

USA (1980)	France (1987 - 1997)	England (1985)
<ul style="list-style-type: none"> • 72% of the Technology-based Companies created in Boston were based on technologies developed in the laboratories of the Massachusetts Institute of Technology - MIT 	<ul style="list-style-type: none"> • 40% of the technology-based companies created were academic spin-offs. 	<ul style="list-style-type: none"> • 17% of technology companies in Cambridge originated from academic spin-offs.

Figure 3. Academic Entrepreneurship in USA, France and England

Source: Adapted from Shane (2004)

In the specific case of the Massachusetts Institute of Technology - MIT, it is worth mentioning the magnitude of the figures presented by the institution in relation to the impact on the local economy, according to Roberts and Eesley (2009) at the time of their research, there were 25,800 active companies developed by students of MIT, about 3.3 million people were employed in jobs related to the activities of these companies and there was an annual turnover of approximately \$ 2 trillion dollars, still according to the researchers, should the MIT academic spin-offs become a independent nation, there would be a great chance that that nation would occupy the position of the 17th largest economy in the world (PEDROSI FILHO; DE MATOS COELHO, 2013).

In the context of a knowledge-based economy, there is no doubt as to the fact that the creation of technology-based companies streamlines the local economy and reduces the dependence on traditional industries, since they favor the diversification of products and services (MONCK, 1990; LEMOS & DINIZ, 2001; SHANE, 2004; PEDROSI FILHO; DE MATOS COELHO, 2013). Based on studies carried out by Pedrosi Filho and De Matos Coelho (2013), academic spin-offs generate the most diverse benefits, however, in addition to the positive impact on the economy, the following main contributions can be pointed out:

- **Strengthening academic entrepreneurship:** academic spin-offs develop a renewal in the research culture, since they increase the involvement of researchers in the mechanisms of commercialization of technologies. The possibility for academics to develop companies and continue their research activities allows new cooperative

relationships to be developed between universities and academic startups, so the entrepreneurial culture in the academic environment allows for a greater production of innovations which benefits the economy as a whole .

- **Commercialization of new technologies still under development:** it is a common behavior in large companies the fear of investing in technologies considered risky or at a very early stage, in view of this, academic spin-offs appear as a marketing tool for technologies still under development and that due to the risk of error could become patent on university shelves.
- **Stops the brain drain process:** startups from academic spin-off processes tend to demand specialized labor, as, normally, they are technology-based companies that present jobs to academics who would otherwise follow the “brain drain” process in looking for opportunities elsewhere. The stagnation of the “brain drain” is extremely beneficial because it allows the developed innovations to remain in their original places, which brings competitive advantages to the region or even to the country.

In addition to the various benefits presented, it should be noted that in the context of startups in general, studies show that academic spin-offs are the most successful startups in relation to the others and in comparison with the transfer of technology through licensing, they generate jobs and superior financial flow (ASSOCIATION OF UNIVERSITY TECHNOLOGY MANAGERS, 1998; SHANE, 2004).

6. Academic Spin-Offs in Brazil

In the search to portray the scenario of academic spin-offs in Brazil, two in-depth studies on the reality of Brazilian academic startups were selected, the first was a study by Costa and Torkomian (2008) entitled “An Exploratory Study on a New Type of Enterprise: the Academic Spin-offs ”and the second was a study developed by Santos et al. (2015) called “Academic Spin-Offs and their importance in economic development”.

Although it was carried out in 2008, the first article mentioned so far presents the most comprehensive study of the situation of academic spin-offs in Brazil, the research reached the number of 33 spin-offs from 9 Brazilian universities distributed throughout the country, a of the points presented in the survey is the location of the companies surveyed in the country.

FIGURE 4 - Location of Academic Spin-offs in Brazil

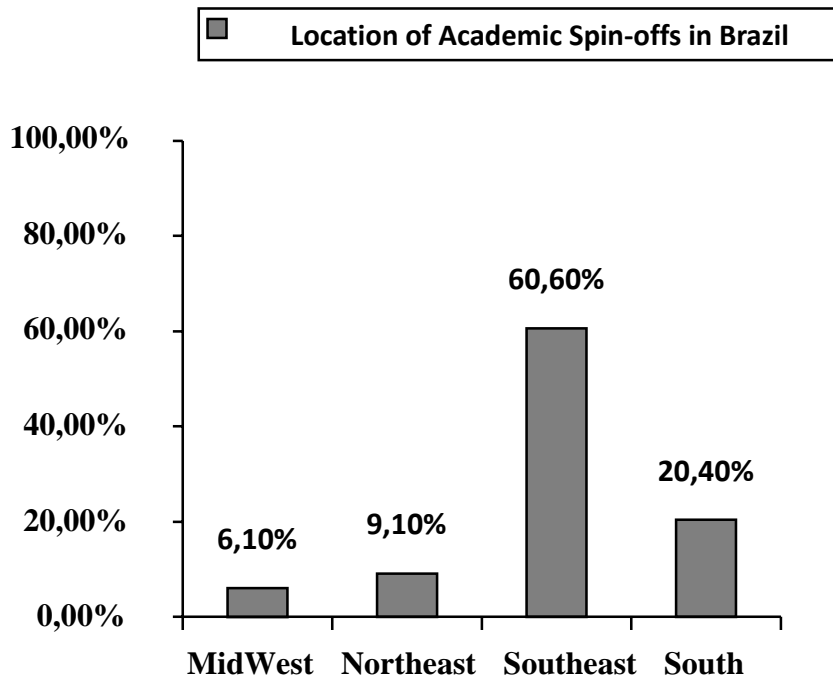


Figure 3. Location of Academic Spin-offs in Brazil

Source: Adapted from Costa and Torkomian (2008)

Although Due to typical research difficulties, the North region of the country was not covered, however, the distribution presented is relevant, the Southeast region holds the largest amount with 60.6% of national spin-offs, followed by the South region with 20 , 4%, Northeast with 9.1% and Midwest with 6.1% (COSTA; TORKOMIAN, 2008). Based on the research, USP and UNICAMP are the Brazilian universities that most presented numbers of development of spin-offs in Brazil, this probably occurs due to the culture of cademic entrepreneurship widespread in these universities, which suggests that the diffusion the entrepreneurial impulse in universities could generate a change in reality.

It is worth mentioning another important point of the research, the academic background of the members of the investigated academic spin-offs.

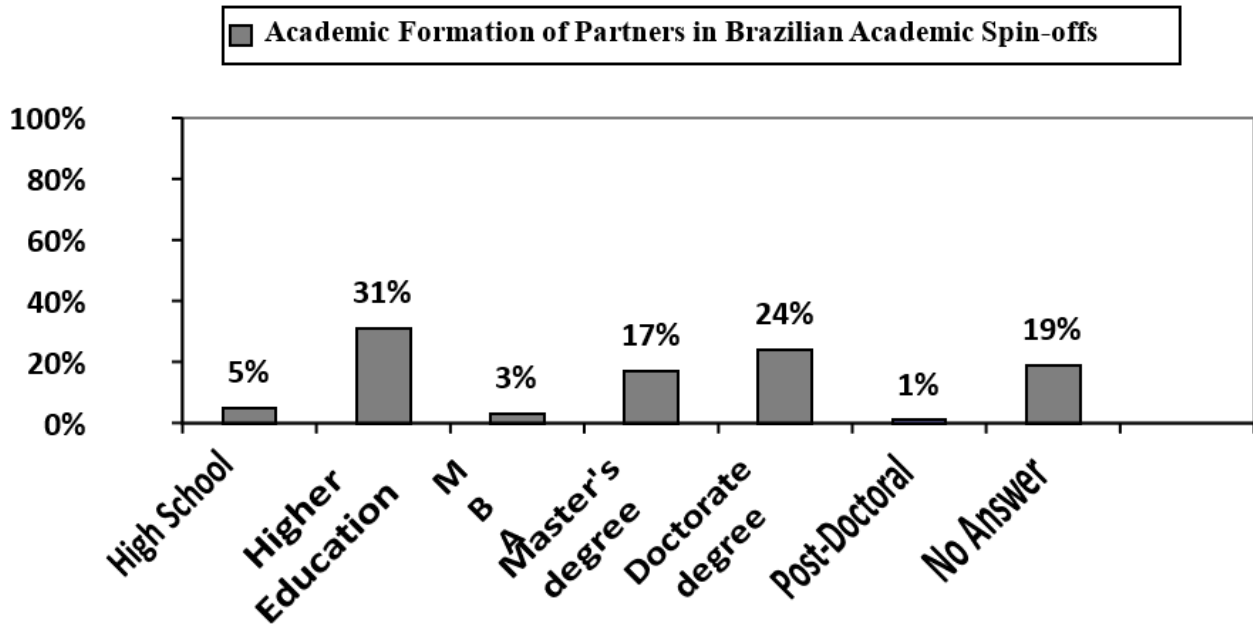


Figure 4. Academic Formation of Partners in Brazilian Academic Spin-offs
Source: Adapted from Costa and Torkomian (2008)

The survey showed a high degree of training of the partners in the surveyed spin-offs as a sample, 31% of the partners had some degree, 24% had a doctorate degree, 17% had a master's degree, 3% had an MBA degree, 5% had complete high school and 1% even had a postdoctoral course (COSTA; TORKOMIAN, 2008). The data collected reinforces the academic profile of most of the members of the national academic spin-offs, presents the possibility of how this mechanism enables university-business cooperation, but also reaffirms the importance of spin-offs as an impediment to “brain drain”, since it creates demands that are able to absorb an extremely qualified workforce, such as, for example, doctors in specific areas of knowledge.

The most relevant point presented, as a great benefit of this technology transfer mechanism is the possibility of investment in technology that these startups develop.

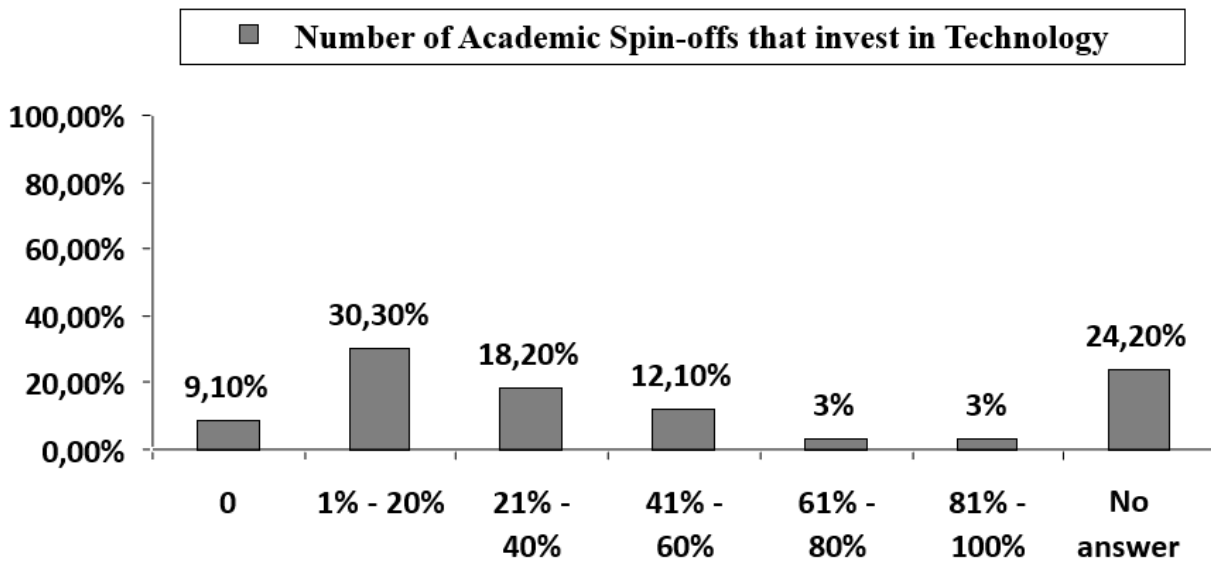


Figure 5. Number of Academic Spin-offs that invest in Technology

Source: Adapted from Costa and Torkomian (2008)

Based on the research developed by Costa and Torkomian (2008), 30.3% of the surveyed spin-offs invested from 1% to 20% of their billing in technologies, 18.2% invested from 21% to 40% of billing, 12, 1% invested 41% to 60% of revenues, 3% invested from 61% to 80%, 3% invested from 81% to 100% in technology, while in 9.1% they did not invest in technology. The data are relevant because, in general, spin-offs have a concern with the development of technologies, which contributes to the creation of innovations and allows for the increase of the capacity to compete of these companies and the country as a whole.

Following the proposed analysis, produced by Santos et al. (2015) and titled as “Academic Spin-Offs and their importance in economic development”, the second article analyzed brings more recent data and based on a research developed with 3 academic spin-offs originating from the Federal University of Minas Gerais and located in the Park Technological BH-Tec.

Regarding the objectives proposed by the research, Santos et al. (2015) present the contributions that the analyzed academic spin-offs produced and divide them into returns to society and returns to the mother university, as can be seen, later in this work.

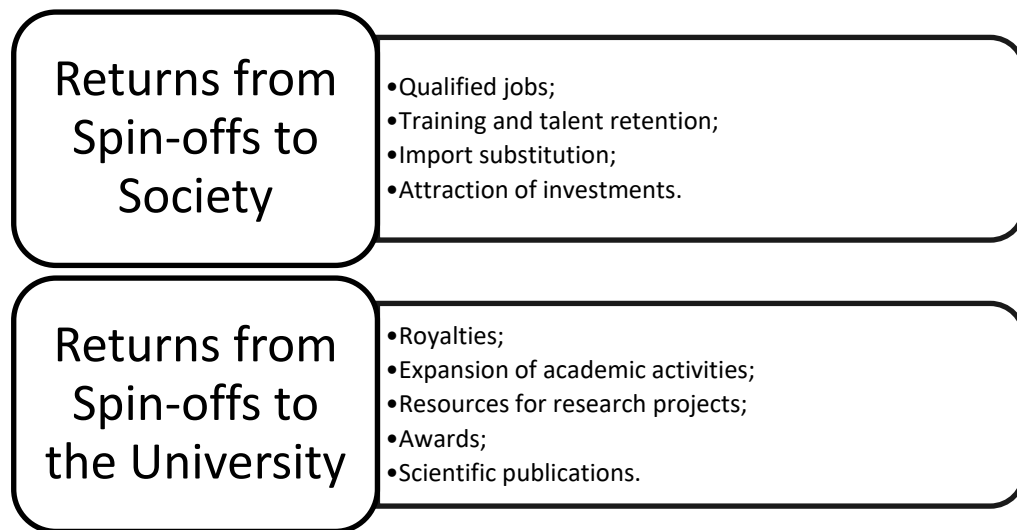


Figure 6. Returns generated by Academic Spin-offs for Society and Universities

Source: Source: Based on Santos et al. (2015)

Among the various returns that these academic startups have presented to society, the most relevant were the creation of jobs for qualified labor and the positive impact on the regional economy; academic spin-offs develop products capable of replacing imports and make it possible to attract investments to the regions where they are located. In turn, this mechanism allows returns to the university, ranging from the possibility of publishing academic papers and obtaining prizes to the payment of royalties that allow the expansion of academic activities due to greater resources at the university.

7. Conclusion

Based on what was discussed in this article, the importance of the innovation process is evident through the survey of companies that were born from University-Business cooperation in Brazil.

According to the proposed objective - which was to raise information for the contribution of the discussion on academic spin-offs, startups and the main advantages generated by the University-Company cooperation. Through the comparative study, we obtained as results the following statements: In the article dated 2008, where 33 spin-offs were raised from 9 Brazilian universities, one of the important points in the research was the location of these innovative mechanisms, the development of research and innovation in Brazil and the biggest highlight of Brazilian spin-offs is found in the Southeast and South regions of the country, followed by the Northeast and Midwest regions.

Another important point was the number of partners of these nascent companies in the Universities. Of the 100% surveyed, 31% of the partners had a degree and 24% had a doctoral degree.

A third point taken into account was the amount of investment by entrepreneurs, owners of nascent companies, in technology, where only 3% of respondents invested from 61% to 80%, 3% invested from 81% to 100% in technology, while in 9.1% did not make any investment in technologies.

In a fourth point - in the second article, we discussed the positive evidence brought by Spin-offs to Society and Universities, such as qualified jobs, talent training, actions to attract investments aimed at society and royalties, promotion for research projects and publications.

With all these benefits created by academic startups, it is necessary to draw attention to the benefits generated by cooperation on the University-Business axis. It is clear that, in the face of a multifaceted and competitive market, cooperation must come combined with the ethics of cooperation and with respect for the environment, with social equity and with the principle of otherness.

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