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TECHNOLOGY-BASED ENTREPRENEURSHIP IN SOUTH BRAZIL

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ABSTRACT:

This paper analyzes the current scenario of technology-based incubators (TBIs) in South Brazil from a socioeconomic and intellectual perspective, through correlations with higher education institutes with stricto sensu graduate programs, intellectual property rights, investments in science and technology, Gross Domestic Product (GDP) and Human Development Index (HDI). The study focused on the Brazilian South region, since it presents some of the best social indicators in the country. Based on correlation analysis, it was possible to investigate an outstanding scenario in developed nations, the technology-based entrepreneurship. The results show that: (1) the presence of TBIs is strongly related to the existence of higher education institutes with stricto sensu graduate programs; (2) the existence of TBIs is highly associated with high levels of intellectual production; (3) the States that receive more investment in science and technology are positively correlated with TBIs; (4) the existence of TBIs presents a negligible correlation with the GDP; (5) the existence of TBIs shows a weak correlation with the HDI. Thus, this study allowed the investigation of the South Brazilian scenario related to the implementation and operation of TBIs.

Keywords: Technology-based incubators; socioeconomic indicators; intellectual property; investments in science and technology.

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1. INTRODUCTION

In today's globalized market, the interest in new business creation is more intense than at any other time in the last 30 years (MAS-VERDÚ; RIBEIRO-SORIANO; ROIG-TIERNO, 2015). It can be justified, at least, because organizations increasingly seek a differential to produce and sell their products and services, aiming for greater profit (MARCUZZO; DOS SANTOS; SILUK, 2017).

Technology-based companies (TBFs) are examples of this intensification of new business. These ventures are aimed at partnerships with educational and research institutions and support organizations, such as technology-based incubators (TBIs), to minimize the various risks to which they are susceptible. The incubators of companies aim, in turn, to facilitate the creation and dissemination of new enterprises (STAL; ANDREASSI; FUJINO, 2016).

In order to be effective in terms of investing in these initiatives, there needs to be a clear initial definition of the objectives for the diversification of public support funds, which recognize the diverse economic conditions of the regions in which they are implemented (MUNARI; TOSCHI, 2015). In addition, governments must recognize the fact that companies, especially smaller and younger ones, need research, development and innovation (RD&I) subsidies to develop itself (CZARNITZKI; DELANOTE, 2015).

Thus, universities and research centers have been the links that allow the development of technologies similar to those of large companies, promoting experiences and knowledge of technical, organizational and market solutions (LÖÖF; NAVABI, 2014). Taking it into account, a central theme in the analysis of emerging economies has been the importance of cultivating skills in science, technology and innovation (PONOMARIOV; TOIVANEN, 2014), since this policy plays an important role in the prosperity of a nation in the global market (SALAMI; SOLTANZADEH, 2012).

In this sense, the objective of this article is to analyze the incubators of technology-based firms in the Southern region of Brazil under a socioeconomic and intellectual bias. This is done through the realization of correlations between TBIs and the following indicators: higher education institutions with *stricto sensu* graduate programs, amount of intellectual property rights granted, investment in science and technology, Gross Domestic Product (GDP) and Human Development Index (HDI). The study focuses on the Southern region of Brazil, which covers the States of Rio Grande do Sul, Santa Catarina and Paraná, as it presents the best social indicators in Brazil, such as the lower rates of infant mortality and illiteracy, the best indicators of health, the second highest per capita income and high Human Development Indexes. In addition, the Southern region is responsible for 16.6% of the national Gross Domestic Product (BRASIL, 2015a). Thus, the South region presents favorable conditions for the analysis of impacting factors in the implantation of institutions that aggregate knowledge, intellectual capital and technological innovation.

In this article, section two introduces a review regarding technology-based incubators, higher education institutions with *stricto sensu* graduate programs, intellectual property, investment in science and technology and socioeconomic indicators, as well as the hypotheses development. Section three details the research methodology, describing each of the steps used to achieve the objective of the work. Section four presents the results and discussions, while section five discusses the final considerations, highlighting the implications of the study.

2. Theoretical background and hypotheses development

This article reviews five important aspects for local, regional and national growth in the research and development of new technologies: technology-based entrepreneurship, higher education institutions, intellectual property, science and technology development, and socioeconomic indicators. Within these themes there are the hypotheses developed for the correlations analysis.

2.1 Technology-based entrepreneurship

Technology-based entrepreneurship receives great academic attention for being at the center of economic development led by innovation (SMITH et al., 2013; STOKAN; THOMPSON; MAHU, 2015). In this perspective, incubation initiatives should be at the core of technology and innovation policies to promote entrepreneurship, support the development of new TBIs, strengthen links between academia and industry, and stimulate innovation activities (SCHWARTZ, 2013).

Business incubators are seen as organizations that constitute or create a favorable environment to incubating and developing new businesses (BERGEK; NORRMAN, 2008). In this sense, they must offer various technical support services designed to expand new and emerging companies under independent financial and operating conditions (MASUTHA; ROGERSON, 2015). The presence of these companies is extremely important for a region and needs to be supported to contribute to the development of new technologies and products, job creation and benefits for communities (BERGEK; NORRMAN, 2008; DELIGIANNI; VOUDOURIS; LIOUKAS, 2015).

The TBFs work with intensive application of scientific and technical knowledge to produce goods and services to create advantages over existing products in the market (UBEDA et al., 2013). Colovic e Lamotte (2015) complement that a great amount of knowledge is produced by incubated firms, however, this knowledge does not always overflow to other potential entrepreneurs, since it is used for commercial purposes, primarily. All effective transitions from the laboratory to the market are important for the country's economic growth (WOUTERS; KIRCHBERGER, 2015).

About the international performance, one characteristic of the TBFs of countries with emerging economies is the fact that their technological and market strategies are, in most cases, based on imitation. That leads to difficulties for such firms to create their markets, as they run into more structured and larger external competitors which provide the same or similar product in foreign markets (CAHEN; LAHIRI; BORINI, 2016).

In the case of Brazilian TBFs, the opportunities are mainly in markets where the national demand is too small to justify the internalization of the foreign competitors' operation. There is also the case when there are markets in the developed countries that do not present enough interest for the performance of more structured companies, being niches also potential of success for Brazilian TBFs (RIBEIRO; OLIVEIRA JR.; BORINI, 2012).

2.2 Higher education institutes

Universities are an extreme important source of scientific knowledge and are strongly linked to public research institutes, providing knowledge and resources to innovative businesses such as TBFs (LÖFSTEN, 2016). Such educational institutions serve as a marker for the design and implementation of appropriate science and technology policies by providing context information for collaboration with industry (FREITAS; MARQUES; SILVA, 2013).

In addition, the scientific excellence is a critical factor for the discovery of technological opportunities for industry (D'ESTE et al., 2012), having higher levels of activity in graduate programs. Thus, institutions that offer graduate courses, especially in the *stricto sensu* modality, are directly related to research and development and can provide new technologies for companies and improvements to society.

In Brazil, according to the Sistema de informações Georreferenciadas (2015), there are 3,302 higher education institutions with *stricto sensu* graduate programs, that is, those that only include master's and doctoral degrees. Of these, 708 are located in the States of the Southern region, accounting for approximately 21.5% of Brazilian institutions with this profile.

The university presence is also important as regards the qualification of the workforce, the effect generated by its research to increase productivity, solve local problems, increase the general level of knowledge and culture in the region and its contribution as a locus of innovation (ROLIM; SERRA, 2015). This information induces the belief that there is a positive relation between the existence of TBIs and the presence of higher education institutions with *stricto sensu* graduate courses in the municipalities belonging to the States of the South region of Brazil. Thus, the following hypotheses are created:

Hypothesis 1a: The existence of TBIs is positively related to the existence of higher education institutions with *stricto sensu* graduate programs.

Hypothesis 1b: The cities with the greatest number of higher education institutions with *stricto sensu* graduate programs have TBIs.

2.3 Intellectual property

The term Intellectual Property (IP) comprises a set of legally recognized rights when ideas or inventions are protected (OH; MATSUOKA, 2016). These instruments emerge through the dynamic interaction between excellence research, business activity and public support strategies, making it possible to obtain relevant resources for companies. Thus, excellence in research provides extremely important technological advances, contributing to the creation of new markets and new job opportunities (D'ESTE, 2012).

In Brazil, according to the National Institute of Intellectual Property (BRAZIL, 2015b), in the period between 2000 and 2012, an amount of 505,206 intellectual property rights was granted, including patents of invention, utility models, certificates of addition, trademarks, drawings industrial, technology certificates and computer programs. Intellectual property rights are recognized for inducing the dissemination of new technologies, stimulating the diffusion of knowledge and raising the competitive strategy of companies (BRÜGGEMANN et al., 2016; KAY; YOUTIE; SHAPIRA, 2014).

In the Southern region of Brazil, the focus of this study, there is 21.82% of the concessions, distributed among its three States as follows: 7.65% in Rio Grande do Sul, 6.22% in Santa Catarina, and 7.95% in Paraná. To compare this level of activity, the national average of intellec-

tual property rights granted in the same time period is 1,439, while the average presented by the South region is 2,828. This indicates that the States of the South region had activity level in IP approximately 97% higher than the other Brazilian States (BRASIL, 2015b).

It is important to note that IP is heavily protected by universities, which are increasingly committed to promoting new initiatives for regional and national economic development (HUANG; CHENG, 2015). Therefore, it is inferred that there is a positive relation between the existence of TBIs and the production of IP in the municipalities of the Southern region of Brazil. Thus, the following hypotheses are stipulated:

Hypothesis 2a: The existence of TBIs is positively related to high levels of intellectual production.

Hypothesis 2b: The cities with the best intellectual property indices have TBIs.

2.4 Technology and science development

Governments play a central role in innovation systems through two main activities. First, they generate and disseminate new knowledge through public research centers, universities and companies. Second, they create and modify institutions (such as laws, regulations and policies) that support scientific activities, including funding (PADILLA-PÉREZ; GAUDIN, 2014). In this context, technology emerges as an important asset in companies, supporting their growth and the retention of competitive advantages, always tied to socioeconomic development (WANG; WANG; WU, 2015).

Nevertheless, according to Lasrado et al. (2016), actually incubators have such a significant effect on employment growth that it is statistically higher than that produced by the industrial sector. And federal, state, and local funding agencies around the world are very excited about this market that primarily operates through business incubators, science parks or technology centers (SCHWARTZ, 2013).

In Brazil, the Ministry of Science, Technology and Innovation (MCTI), with the incorporation of two of the most important development agencies in Brazil - the Financing of Studies and Projects (FINEP) and the National Council for Scientific and Technological Development (CNPq) - began to coordinate the work of implementing the programs and actions that consolidate the National Policy on Science, Technology and Innovation (PONOMARIOV; TOIVANEN, 2014). In addition, the government has encouraged cooperation between companies and research institutions through the Brazilian Enterprise for Research and Industrial Innovation (EMBRAPII, 2015a), which focuses on business demand using the infrastructure of research institutions. From this perspective, it is visualized that there are national mechanisms designed to foster and develop new ideas.

The average investment of the FINEP, CNPq and EMBRAPII development agencies during the period from 2000 to 2015 totals R$ 1,454,261,945.67 in Brazil, while in the South this amount is R$ 292,851,600.00 (BRASIL, 2016; EMBRAPII, 2015b). These data indicate that the Southern States receive from these development agencies investment in science and technology corresponding to 20.14% of the amount invested in the country.

According to the Institute of Applied Economic Research (IPEA), much of the research and development (R&D) investments made by countries come from universities and public research institutions (DE NEGRI; CAVALCANTE; ALVES, 2013). However, according to Freitas, Marques e Silva (2013), business research units, in the form of dedicated centers or departments, are equally essential for the development of new scientific fields.

Thus, it can be seen a positive relation between investments in science and technology

and the existence of institutions that seek to develop these new ideas that arise through research and development. Therefore, to elucidate this consideration, the authors hypothesize the following relation:

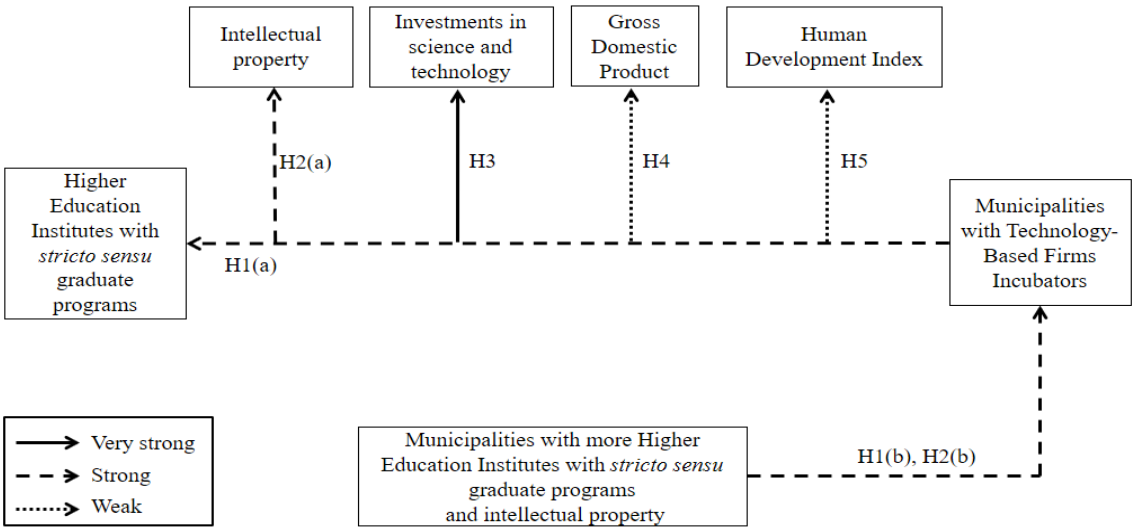
Hypothesis 3: States that receive more investments in science and technology have TBIs.

2.5 Socioeconomic indexes

Countries need indicators that are efficient for measuring and assessing their development from the economic, social and environmental points of view (KUBISZEWSKI et al., 2013). Reliable criteria for analyzing the overall performance of nations, regions, and the planet as a whole are capable of providing a fundamental connection between the establishment of the economy and the formulation of rational policies (GIANNETTI et al., 2015). Thus, socioeconomic indicators are formulated to indicate the basic characteristics of the societies development, with emphasis on the traditional use of the Gross Domestic Product (GDP) and the Human Development Index (HDI).

Gross Domestic Product is the most used indicator to analyze the evolution of countries' economic activity. In addition, GDP analyzes the total market value of all final goods and services produced by a country's economy over a given period of time, including only monetary measures (FERREIRA; PEREIRA, 2015). When one analyzes the proportion of the GDP with the population of a country, so there is the GDP per capita (FRUGOLI et al., 2015).

Human Development Index has established itself over the years as an important



one can note the size of Brazil and the differences emerging from its regional characteristics, which encompass social, economic, cultural and significantly educational traits (SANT'ANNA; RIBEIRO; DUTT-ROSS, 2011).

Socioeconomic indicators are therefore of the utmost importance to evaluate the development of countries and help in the creation of companies and the generation of economic opportunities. In addition, they act as a mechanism that points out the region's most suitable for receiving investments (KLAFKE et al., 2016). Thus, it is possible to believe that there is a positive relationship between the existence of TBIs and indicators such as the Gross Domestic Product and the Human Development Index in the municipalities of the South region of Brazil. Thus, the

following hypotheses were formulated:

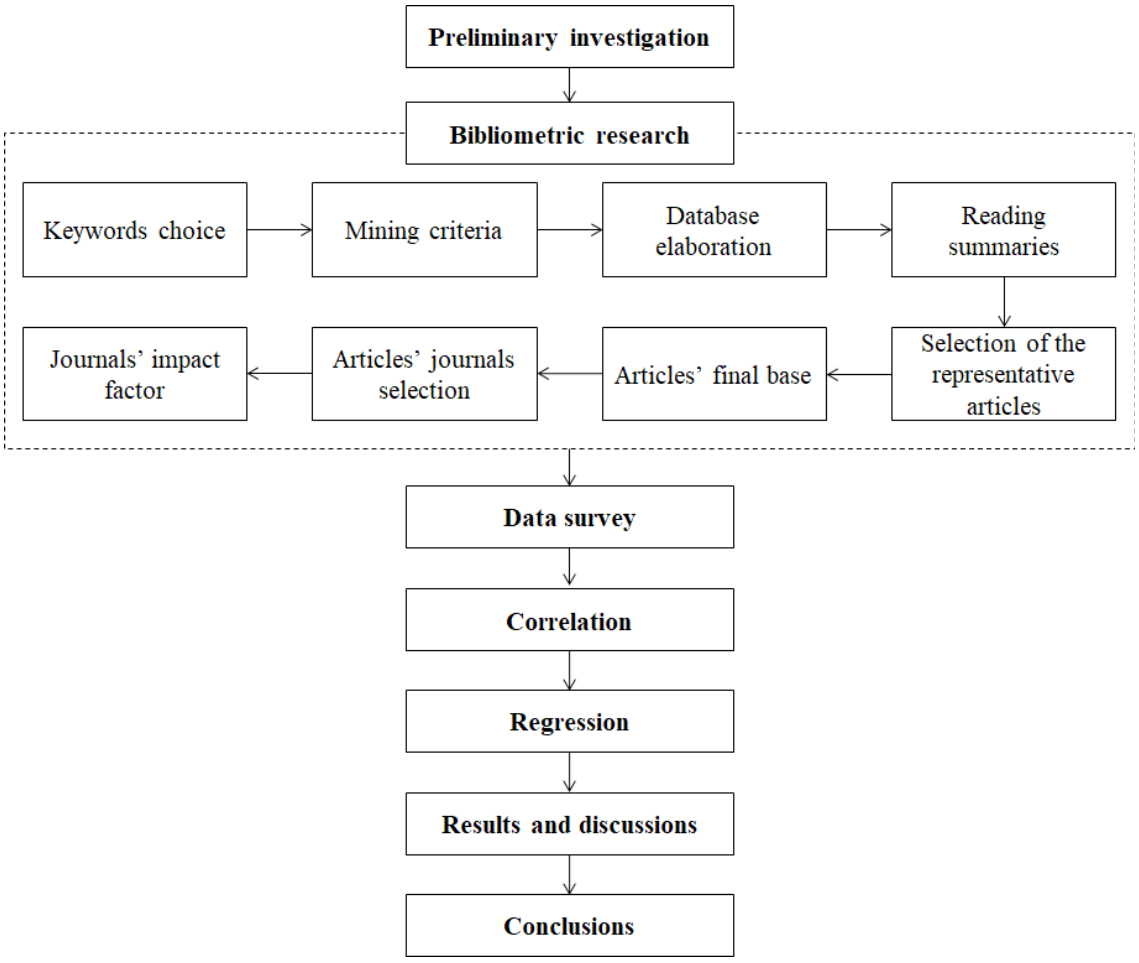
Hypothesis 4: The existence of TBIs is positively related to better levels of the Gross Domestic Product indicator.

Hypothesis 5: The existence of TBIs is positively related to better Human Development Indexes.

3. METHODOLOGY

This section describes the variables and method used in the analysis in order to quantitatively support the study. This empirical research is classified as correlational (survey), since it summarizes results expressing relation between two variables (ROVINE; EYE, 1997), and recognizing the linearity intrinsic to such a method. Furthermore, according to Rovine and Eye (1997), the correlated components must have a well-known combinatorial structure with clarity by the researchers who use them, as explained in previous sections. Thus, for the design of this study, several steps were performed with the purpose of reaching the results, as shown in Figure 1.

Figure 1 – Research methodology



Source: Authors (2017).

3.1. Preliminary investigation

This stage consisted of a preliminary investigation on the subject, in which searches were carried out in periodical portals and on online platforms to verify current publications regarding incubators of technology-based companies associated to socioeconomic and intellectual indicators. Thus, it was possible to approximate the conceptions and guidelines thought by the researchers with what has been published by other authors in the area.

3.2. Bibliometric research

In the second stage of the research, a bibliometric review was carried out, whose purpose was to justify and to base the importance of the studied subject. The information was filtered through the choice of keywords based on the research theme. Through this, a selection and bibliometric analysis of articles was carried out contemplating the main search engines, such as the bases ScienceDirect and Web of Science, with the keywords "technology-based incubators; technology-based firms; socioeconomic indicators; correlation; incubated firms; intellectual property; post-graduation; gross domestic product; human development index; science and technology investments", as well as combinations of these terms. The period between 2011 and 2016 was the delimiter, considering the criterion of the most relevant articles and the correspondence of the terms in the title and abstract.

Subsequently, a database was developed to present the articles that resemble the research and, consequently, the abstracts were read to fulfill the objectives of the bibliometric revision, generating a final repository of 67 articles. From this, the quality of the articles published through the periodic impact factor was verified. In this way, the databases were analyzed in order to identify original and relevant approaches that approach the proposed research.

3.3. Survey of data

This stage consisted of a current survey of existing TBIs in the Southern region of Brazil. To this end, it was assumed that such incubators would be present or supported by higher education institutions. Thus, a search was made in the e-MEC register of institutions and courses of higher education to verify which higher education institutions are registered, in which cities they were, and later, the technological-based incubators linked to these institutions were identified.

For the cities of the Southern region that have the presence of TBIs, their socioeconomic indicators, such as the Gross Domestic Product and the Human Development Index, were searched on the portal of the Brazilian Institute of Geography and Statistics (IBGE). In addition, a survey was made of the capital invested in science and technology by the National Council for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico) in the electronic website of the Brazilian Enterprise for Research and Industrial Innovation (EMBRAPII) and the Aquarius Platform of the Ministry of Science, Technology and Innovation (CNPq), the Financier of Studies and Projects (FINEP) and EMBRAPII in Rio Grande do Sul, Santa Catarina and Paraná, in addition to the other Brazilian States.

In the portal of the National Institute of Intellectual Property (INPI), the amount of intellectual property rights granted in all municipalities in the South region, as well as in all Brazilian States, was surveyed for the period from 2000 to 2012. In the Sucupira Platform of the Coordination for the Improvement of Higher Education Personnel (CAPES), the search for higher edu-

cation institutions was carried out, which present *stricto sensu* graduate programs, that is, they comprise only master's and doctoral courses, in the municipalities of the South-Brazilian region, and in all the States of the country.

3.4. Correlations

From the data collected, correlations were made to test the hypotheses formulated. For this step, the Statistica software was used, in which, from the database, matrices and correlation charts were made to analyze the association between the variables, considering 95% confidence. Correlations were made relating the number of TBIs to the number of higher education institutions with *stricto sensu* graduate programs, with the IP rights index granted, with the capital invested in science and technology by the development agencies FINEP, CAPES and EMBRAPII and with the GDP and HDI indicators, and all variables correspond to the cities that have TBIs in the Southern region of Brazil. As a result, for the cities in the South region that have more institutions of higher education with *stricto sensu* graduate programs, as well as for the cities with the highest number of intellectual property rights granted, a correlation was made with the number of TBIs existing in these cities.

3.5. Correlation analysis

The correlation analysis refers to statistical inferences of the coefficient of linear association, which measures the degree of relationship between two variables. The correlation was considered positive when the phenomena varied in the same direction, while it was negative when the phenomena varied in the opposite direction. Thus, from the correlation coefficients obtained in the fourth step, the relationship between each of the variables was verified, in order to confirm or reject the formulated hypotheses. After this phase, it was possible to discuss the results obtained and to draw up the conclusions of the study, identifying the scenario of TBIs in the Southern region of Brazil.

4. RESULTS AND DISCUSSION

This section describes the statistical findings and comments on the relationships between the variables included in the analysis, contextualizing the results. For demonstrating data quantitatively, Table 1 summarizes the parameters considered for the discussion.

Table 1 – Parameters resulting from correlations

Hypothesis	Variable	Correlation degree with TBFIs	Correlation intensity
H1(a)	Higher education institutes with *stricto sensu* graduate programs	0,87344	Strong
H1(b)	Cities with more higher education institutes with *stricto sensu* graduate programs	0,8316	Strong
H2(a)	Intellectual property	0,76376	Strong
H2(b)	Cities with more intellectual property	0,73025	Strong
H3	Investments in science and technology	0,97293	Very strong
H4	Gross domestic product	0,08629	Negligible
H5	Human development index	0,39655	Weak

Source: Authors (2017).

In the first hypothesis, H1 (a), the degree of correlation found was 0.87344, indicating a strong relationship between the existence of incubators of technology-based companies and higher education institutions with *stricto sensu* graduate programs. This means that, in cities with TBIs, there is a high degree of assertiveness in the consideration that there are higher education institutions with the characteristics selected.

Since, following the statement by Fritsch and Aamoucke (2013), universities are responsible for collecting, generating and storing knowledge and making it available to the market in general, the result of the association in this correlation indicates that the incubators of base companies are making use of the resources that the university has. However, after decades of research, it seems that most postgraduate courses still have students with greater ability to publish academic articles and use sophisticated statistical techniques than the solution of work environment problems, directly linked to the activity entrepreneurship (COLOVIC; LAMOTTE, 2015). Thus, Mas-Verdú, Ribeiro-Soriano and Roig-Tierno (2015) argue that, if knowledge-based entrepreneurship is an important vehicle for promoting economic growth, an exclusive policy should be formulated and implemented with a focus on the start-ups developed by academics in universities.

In the hypothesis H1 (b), the study also showed a strong positive correlation, 0.83160, between higher level of academic activity, represented by *stricto sensu* graduate programs, and TBIs. In this way, it can be affirmed that the cities that have higher education institutions with the aforementioned characteristics are highly related to TBIs.

This result is in line with the idea of Löfsten (2016), where graduate programs in universities are an important source of scientific knowledge, and TBFs can use these resources by developing connections with higher education institutions. Nevertheless, as Colovic and Lamotte (2015) argue, little is known about the impact of a nation's technological performance on the creation of TBFs. In this sense, the study pointed to a clear relationship between the level of academic entrepreneurship and the development of technological areas, contributing to a possible paradigm shift in this scenario.

Nevertheless, Pret, Shaw and Drakopoulou Dodd (2016) and Lasrado et al. (2016) say

that university researchers have a lot to gain from studying the knowledge and skills required to benefit entrepreneurship in different economic contexts. Such dynamism can be understood as a continuous and feedback loop, since, while academic activity improves the technological entrepreneurship environment, it offers an immense field of work for that one, especially in *stricto sensu* graduate programs, according to the study elucidated.

In the hypothesis H2 (a), the correlation analysis between TBIs and IP levels was positive and of strong degree, with a value of 0.76376. That is, in cities with TBIs there is a higher level of IP, measured by the items considered in the theoretical reference.

Based on the assumption that developing country governments, such as in Brazil, are responsible for creating appropriate policies for their growth (SALAMI, SOLTANZADEH, 2012), and that, according to Padilla-Pérez and Gaudin (2014) , government is responsible for creating and modifying the constituent structures of an innovation system, such as universities, it must be said that many of the discussions of these results tend to be policies. However, according to Sant'anna, Ribeiro and Dutt-Ross (2011), it is important to point out that Brazil has a very varied character in relation to its regions, due to its size. Thus, with a view to a more correct judgment, it is considered that more actors have equal or greater merit and even responsibilities towards the creation, development and expansion of the inventive structures and activities considered in the study, these actors being mainly entrepreneurs of the private initiative, which often collaborate effectively for a good performance of projects coming from TBIs in universities.

In the hypothesis H2 (b), a positive and strong correlation was also found, with a value of 0.73025, between higher IP level and TBIs. In other words, cities with higher IP levels are highly related to TBIs.

Intellectual production activity is an important aspect to be considered in corporate strategies, since they are sources of creation and dissemination of knowledge (KAY; YOUTIE; SHAPIRA, 2014). The IP study covers a wide range of items, such as computer programs, patents, trademarks, technology certificates and others, from research and development. Therefore, this result ratifies the one proposed by Fritsch and Aamoucke (2013), when they say that there is a strong relationship between the presence of research and development activity and the innovative types of emerging businesses currently. However, it is important to consider, according to Love and Roper (2015), that researchers suffer from high risks of commercial uncertainty of their productions, while companies are better equipped to deal with this situation. In this context, according to the results found, Kay, Youtie and Shapira (2014) agree that companies should create a strategic plan with increased attention to the maximization of returns on investments in IP, in order to recognize investments in innovation processes, products and services as competitive positioning factors.

The H3 hypothesis resulted in a very strong positive correlation of 0.97293 between IBTs and investments in science and technology. That is, cities that have TBIs are very highly related to larger investments in science and technology.

According to Pret, Shaw and Drakopoulou Dodd (2016), it is necessary to consider the relevant contextual conditions and circumstances of a given economic system, such as geography and financial aspects, to understand the benefit that human capital derives from it. This is because, according to the authors, investments in science provide technological changes that cause changes in regulation and, finally, alter the status quo of the subjects and objects involved in the context - in this case, positively. The infrastructure available for R&D activities in higher education institutions, such as TBIs, drives the development capacity of businesses and regions (VILLANI; RASMUSSEN; GRIMALDI, 2017), reflecting the importance of public and private investments in

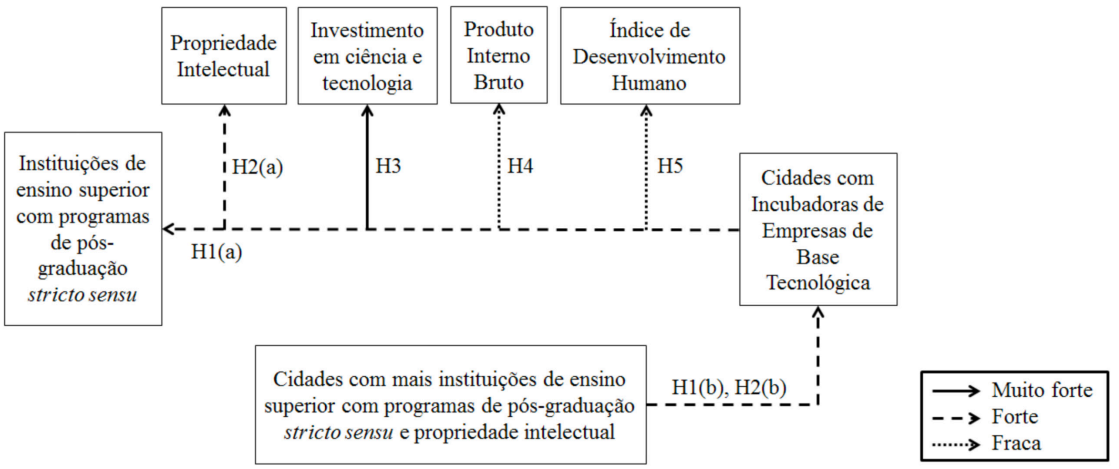
science and technology.

Finally, the hypotheses H4 and H5 also presented a positive correlation, but of negligible degrees (0.08629) and weak (0.39655), with the socioeconomic indicators GDP and HDI, respectively. This means that cities that have TBIs are little or very little related to better indexes of socio-economic indicators HDI and GDP.

The considerations to the HDI item and its relation with TBFs are delicate to be affirmed, to the detriment of the fragility of its own composition, as some authors suggest (PARUOLO; SATISANA; SALTELLI, 2013; SANT'ANNA; RIBEIRO; DUTT- ROSS, 2011), and express little direct relation, since this index takes into account factors that are indirectly impacted or take a long time to be impacted by the incubation activity of companies, as an improvement in the quality of life, which would explain the result. On the other hand, in the GDP indicator and its relationship with TBFs, there is a somewhat unfair comparison, since the indicator in question considers goods produced, not carrying out measurement of the research and development activity, primordial in incubators of companies, which also generate profit. Even those TBFs that emancipated from incubators and emerged into the labor market are often difficult to identify, specifically in relation to their origins and the level of contribution to such an index

Figure 2 summarizes the five hypotheses of the survey, indicating the existence of correlation and its intensities, in a legend that obeys the following scale: dotted line indicates weak or negligible correlation, dashed line means strong correlation and continuous line represents a very strong correlation.

Figure 2 – Summary of hypotheses



Source: Authors (2017).

In short, the results found in this study point to an already existing trend, but of development relevance in the Brazilian context, compared to more developed nations, such as the United States, China and some European countries. It is a need to broaden the understanding of the actors in this context about the functioning mechanisms of the university, business, government and social relations of the countries that emerge at the best levels. Equally important, it should be noted that due recognition by public authorities about how to avoid disrupting these inventive and productive relations, but rather to study them and structure options to support the economic development of these.

5. FINAL CONSIDERATIONS

The present study aimed to analyze the panorama of the incubators of technology-based companies in the South region of Brazil under a socioeconomic and intellectual bias. For this purpose, correlations between TBIs and indicators were made: higher education institutions with *stricto sensu* graduate programs, quantity of intellectual property rights granted, investment in science and technology, Gross National Product and Human Development Index, focusing on the region South of Brazil, which covers the states of Rio Grande do Sul, Santa Catarina and Paraná, since it presents the best social indicators in Brazil. Through the analysis of correlations, it was elucidated a scenario that is more and more salient in developed nations, the technology-based entrepreneurship.

The aspects of academic activity in *stricto sensu* graduate courses and level of intellectual production presented strong degrees of correlation with incubators of technology-based firms, and imply considerations related to human capital and commercial bias. The idea of commercialization is associated with the capture of additional resources, a recurrent gap in these enterprises, but for this, there are the technology transfer agencies, with the objective of providing local and national economic development. In this context, universities should facilitate the implementation and operation of knowledge and technology transfer agencies through bilateral agreements with business incubators.

While human capital impacts entrepreneurial activity, the ability to acquire it reflects the turbulence of the environment in which a particular socio-economic ecosystem is found. Considerations in this regard also complement Love and Roper (2015), regarding the assertion that some types of connections to university research centers often require a good level of expertise and absorptive capacity on the part of new and risks of uncertainty or failure in this activity. This assertion indicates that the negotiations fall on a high level of human capabilities, experiences and intuitions, indicating that they are being carried out because there is a good level of human and technological capital being developed in the region.

In relation to the very strong correlation found between investments in science and technology and TBIs, he agrees with Padilla-Pérez and Gaudin (2014) when they say that the government has ample instruments to strengthen innovation systems: public investments, support for small and medium businesses, education, training, trade policies and regional development. In addition, in recent years Brazil has emerged with a growing importance in innovation and production in international trade (GOEDHUYS and VEUGELERS, 2012). Finally, it is stated that the emerging economies, like Brazil, should be analyzed mainly on their internal capacities of development and cultivation of science, technology and innovation.

5.1 Limitations and future research

The geographical scope of this study was delimited as being the Southern region of Brazil because it is easier to access to the researchers, besides the economic and social criteria previously considered. Therefore, the conclusions of the study can not be generalized at the level of greater geographical coverage, as for other Brazilian regions or even for the whole country, since each region presents different characteristics in relation to the items analyzed. Considering that this research does not exhaust the theme, nor does it constitute an absolute end, for future studies it will be necessary the on-site investigation of the selected samples through the application of instruments such as semi-structured interviews and questionnaires. Thus, there is an opportunity to verify whether the macro context analyzed actually reflects, or is reflected, by the internal environment of the TBIs and their supported ventures.

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