

Science, Technology and Innovation Bibliometric Evaluation SME's in order to improve Brazilian economic growth

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Abstract

Innovation has been pointed out as one of the main tools for the countries' economic development facing globalization. For economic growth to happen in an egalitarian way, it is necessary to strengthen, expand, consolidate and integrate a country's research and innovation capacities, that is, strengthening its National Science, Technology and Innovation System. In this system, it is primordial that there is a close relationship between research institutes, ST & I developers, and companies, especially small and medium-sized enterprises (SMEs), considered to be key players in the socio-economic development of countries. Brazil already presents initiatives that seek to strengthen relations and encourage the development of technology among these actors. This article aims to discuss the relationships between the CT & I sector and its relations with SMEs, especially in Brazil, so that together they allow the development of the economy. For this, a brief literature review was carried out, which was structured in: Relation between ST&I and the national development, where will be treated some countries experience and where brazilian historical process will be shown; The importance of SMEs for a country economic growth, where the relations between ST&I and SME will be treated and also its indicators. Despite the innovation power for the development of the countries economies is in constant discussion, it is still a need for discussion between companies and SMEs as a fundamental relation for the growth of companies and consequently for the socio-economic growth, since as SMEs are today driving forces for development. For the central

dialogue current in Brazil, the proceedings of these countries between ST & I and companies are required.

Keywords: Science Technology and Innovation, SMEs, economic growth, national policies

1. Introduction

Brazilian historical process shows a late Science, Technology and Innovation (S,T&I) development. With notably rural landmarks, the country only achieved the promises of modernity in the first decades of the twentieth century with the arrival of industry. In this sense, the creation of the CNPq (National Council for Scientific and Technological Development) in 1951 brought to light the importance of science, technology and innovation for the country's development.

This relationship between ST & I and national development is undeniable and is verified by the current concern of researchers and policy makers in conducting research in this area. There is consensus in academia, government and society that economic growth with equity depends on strengthening, expanding, consolidating and integrating the National System of Science, Technology and Innovation. Brazil's and other countries' historical experience show that the generation of wealth, employment, income and opportunity, together with the diversification of production and the increase of the value added in the production of goods and services, depend directly on the strengthening of research capacities and innovation in a country [INOVAÇÃO, 2015].

In this context, small and medium-sized enterprises (SMEs) gain a fundamental prominence because they are the basis of the economy, while they are overwhelming majority in Brazil, generating jobs, which in turn generate income, and consequently greater consumption and production. The great numbers related to the development brought by SMEs have been announced by the Brazilian Service to Support Micro and Small Enterprises (SEBRAE), which indicates that these companies in 2013 were responsible for 52% of formal jobs in the country and 27% of gross domestic product (GDP) (VITTIELO, 2017), proving that, away from market, SMEs are growing, and their importance for the growth and strengthening of the country's economy becomes undeniable.

Development, as mentioned before, is linked to the growth of innovative initiatives, shows that investment in S & T is essential for small and medium-sized enterprises, so that they can survive in an increasingly competitive market, including in small states. However, Brazilian reality shows that difficulties have been encountered by SMEs. Contrary to oligopolies, which invest heavily in innovations that result in profound changes in current technology, SMEs seek to incorporate innovations that are characterized by relatively small changes in processes and/or products to improve their quality or work productivity (RATTNER, 1984).

In order to better glimpse this production of Science, Technology and Innovation, and thus the growth of SMEs in Brazil, the so-called indicators are used, which are, within a more general panorama, a correlation between two variables. More specifically, indicators can be identified as a composite analysis of the variables involved in the innovation process, looking for the actors involved, the types of relationships that were built and the impacts caused (BENELI, et al, 2014). More than simple quantitative indications, the indicators tells how much a country or a region is developing, how much investment is being applied in

each area, and how much still needs to be invested to reach a certain level.

The importance of the analysis of how SMEs are affected or benefited by ST&I policies, and how relevant indicators could help Brazilian SMEs to grow, justifies this paper. To reach that, an exploratory research based on data, secondary indicators and documentary research on ST&I policies, on how ST&I can help countries' economies grow, initiatives to stimulate innovation, made available by the federal, state and municipal institutions operating in Brazil. This paper is structured in three main topics: Relation between ST&I and the national development, where will be treated some countries' experience and where Brazilian historical process will be shown; The importance of SMEs for a country's economic growth, where the relations between ST&I and SME will be treated and also its indicators.

2. The relation between Science, Technology and Innovations area and national development

Not today that innovation has been pointed out as a main tool to guarantee economic development in a globalized world. Galindo and Méndez (2014) point out that innovation is part of human history, through its capacity to change human behavior and ways and methods of work. Schumpeter (1997), a precursor in this recognition of innovation, said that innovation was important not only to companies but also to nations. According to him the innovation can have five fronts of application: product, processes, marketing, input and organizational. In 2014, Cornell University launched the Annual Report on the Global Innovation Index, where it considered innovation as an important factor for the development of developed or developing countries, as well as providing economic growth and well-being (Cornell University, 2014). In this way innovation improves taxes, helps economic growth, thus increasing the creation of employment and consequently improves the quality of life of the population (Franco and Oliveira, 2016).

Innovation process is interactive and gradual, based on communication and knowledge exchange. In order to better understand national policies and the dynamics of countries in relation to technological change, this structure is used by international organizations such as the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), the Organization for Economic Cooperation and Development (OECD) and the Inter-American Development Bank (IDB) (Padilla-Pérez and Galdin, 2014).

For economic growth to happen in an egalitarian way, it is necessary to strengthen, expand, consolidate and integrate a country's research and innovation capacities, that is, strengthening its National Science, Technology and Innovation System (SNCTI). Following the 2008 crisis, the innovation-based growth recovery strategy is applied in countries such as the United States and China, as opposed to late industrialization countries that based their strategies on decisive changes in education, science and technology. (MCTI, 2017). According to Lundvall et al. (2009), national innovation systems encompass relationships between organizations, institutions and socio-economic structures, also individually, and dictate the direction and speed of the innovation process, as well as the capacity for technological development.

But what is the role of governments in the innovation process? According to Padilla-Pérez and Galdin (2014), governments have two main activities that make them central to this process: generating and

disseminating knowledge through public research centers, universities and companies; create and modify institutions with laws and public policies that support STI activities, including funding and promote interaction between government, universities and society and disseminate technological knowledge. Public funding can be provided through tax incentives or special incentives for innovation and development. In addition, other financial instruments such as public loan guarantees, soft loans, public venture capital funds and support for the marketing of innovation (Padilla-Pérez and Galdin, 2014).

Achieving economic competitiveness can be very difficult to understand in practice by policy makers, for different understandings of their definition. Some consider that the creation of jobs, improvement in quality of life among others, is the ability to ensure good economic results. While others believe that economic activities are favored by low inflation, skilled labor among other characteristics (Krammer, 2017).

3. Historical process of Science, Technology and Innovation in Brazil

Since the second half of the twentieth century, a radical revolution has been underway, driven by two great advances in knowledge: the expansion of the capacity of communication systems and the technological processing of information. Countries whose population does not have an educational level for such a revolution will suffer from the growing backwardness and political-economic dependence of more developed nations. (Academia Brasileira de Ciências, 2001).

In 1951, during the post-war period, the National Research Council was born in Brazil, renamed in 1974 to the Council for Scientific and Technological Development (CNPq), with the purpose of enabling the country at that time to become the domain of atomic energy, a topic of strategic importance (Brazil, 2015). Later, in the Brazilian redemocratization period, in 1985, the Ministry of Science and Technology (MST) was created, and soon the Science and Technology Conference was held. It sought to involve the scientific community in political decisions at all levels. However, political-economic turmoil and changes in MST management have impeded discussions more effectively. In 2001, the second conference took place as a focus on internationalization and economic competitiveness as the world was globalized and technologies changed faster (Academia Brasileira de Ciências, 2001). In 2005, a third conference took place, representing a milestone in the country's Science, Technology and Innovation, redesigning C, T & I policies and proposing an agenda of concrete actions for its operationalization (Centro de Gestão de Estudos Estratégicos, 2006).

In 2008, the Federal Network of Vocational, Scientific and Technological Education was introduced, through Law No. 11,892, of December 29, 2008, formed a set of federal institutions, linked to the Ministry of Education, focused on professional and technological education in level and above. Since then, the Network has been presenting satisfactory results as the growth of applied research and technological innovation, perceived by the increase of deposits in the National Institute of Industrial Property (INPI) (Prado et al, 2017).

The fourth Science and Technology Conference took place in 2010, bringing the construction of a ST&I State Policy, based on sustainable development, from an economic, environmental and social point of view (Davidovich, 2011). In 2016, the now called, Ministry of Science, Technology, Innovations and Communications, launched the National Strategy for Science, Technology and Innovation (Encti) for the

period of 2016-2022. This document aims to strategically guide the implementation of public policies in the area of ST&I and strengthening of the National System of Science and Technology so that national production has greater added value and so that knowledge is incorporated in all economic activities (MCTIC, 2016).

Souza et al. (2017) says that for decades, universities have been moving towards entrepreneurship as a way of achieving technical-scientific and financial autonomy, as well as responding to society's demand that understands the role of universities in the country's economic development. In this way, it is already possible to perceive a greater approximation and interaction of the University-Government-industry axes.

4. SMEs importance for a country's economic growth

Industrial Revolution changed its form of production into series production. In this way, small and medium-sized companies, especially "home-makers", controlled Europe and America in the late 19th century.

The development of SMEs facilitates human and capital resources mobilization for economic development in general and the rural sector in particular. They have been identified as a vehicle for generating jobs and providing opportunities for outsourcing, training, development and entrepreneurship (MICAH, 2017). Cravo (2010) argues that entrepreneurship and the formation of small businesses can reduce the differences between specific parts of technological knowledge and innovation. Thus, showing how small and medium-sized enterprises affect growth, could help in the theory of economic growth.

SMEs are vehicles for jobs' generation and opportunity offer for human development and empowerment, since it facilitates the movement of capital and human resources for the development of the economy. (MICAH, 2017). Faced with different characteristics and socio-economic realities and how they were conducted, each country or region has its definition of what SMEs are.

In recent years, a number of political and economic initiatives around the world have been held to encourage and strengthen SMEs. Taiwo (2012) notes that such initiatives are being implemented in SMEs in poor and developing countries as they have a considerable impact on the best use of local raw materials and rural development, development of entrepreneurship, connection with large companies and consequent generation of jobs, a more balanced dispersion of investments among other socio-economic impacts.

In developed countries, SMEs have high growth potential and show considerable results using available technologies and thus increasing their productivity (Christopoulos and Tsionas, 2014). This shows how technological innovations, especially in telecommunications, have enabled low-cost and highly skilled competition in Eastern Europe and Asia, resulting in an entrepreneurial economy (Audretsch and Thurik, 2001).

Companies argue that productivity growth, efficiency and innovation bring tangible benefits to the economy and therefore, it is necessary the greater incentive and government support for entrepreneurship. To encourage SMEs in developing countries, the World Bank group of Executive Boards of the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA), along with other funding agencies, have a policy of targeted assistance to SMEs, based on three arguments (BECK et al, 2005):

a. The increase of entrepreneurship and competition, thus improving efficiency, innovation and productivity;

- b. Encourage government financial support so that SMEs, overcome financial market barriers and institutional failures, and thus boost economic growth and development;
- c. Subsidize SMEs allowing them to absorb labor, thus generating more jobs.

By 2017, the World Bank Group has committed more than \$ 61 billion in loans, grants, capital investments and guarantees to its members and private companies. IBRD has received ongoing customer demand for its services and has made commitments totaling \$ 22.6 billion. And the International Development Association (IDA), a fund for the poorest, has earmarked \$ 19.5 billion to support the neediest countries facing the most difficult challenges. In addition, the Reimbursable Advisory Services revenue in fiscal year 2017 was about \$ 40 million, with the program expanding beyond the traditional areas of education, governance, economic diversification and small and medium-sized enterprises. For example, Algeria, the Arab Republic of Egypt, Jordan, Morocco and Tunisia can assess their infrastructure, analyzing the legal, regulatory and financial environment to increase private sector participation in infrastructure (Banco Mundial, 2017).

4.1 SMEs in Brazil

In order to better adapt to globalization and economy stabilization, many companies sought to increase their productivity and reduce costs, causing unemployment (Dornelas, 2005). As a result of this opportunity, new businesses and market solutions were explored by increasingly younger entrepreneurs who better understand and dominate the dynamism of the technology market (ROSSI and Theisen, 2017). Since 2014, Brazil has faced an economic recession that has affected, among other sectors, small and medium-sized enterprises due to the difficulty in obtaining credit and its smaller structures.

According to data from the Yearbook of Work in Small Businesses - 2015, carried out jointly by SEBRAE and the Department of Statistics and Socioeconomic Studies (DIEESE), micro and small enterprises are extremely relevant to the country's economic structure as well as to the generation of jobs, with MEPS representing 6.8 million establishments responsible for 17.2 million private non-agricultural formal jobs (DIEESE, 2017).

The complex and heterogeneous classification of Brazilian companies may explain the difficulty in studying them and proposing more appropriate new theories and conclusions (Leone and Leone, 2012). In Brazil, the most commonly definition used to classify a small company is in Complementary Law 123/2016, also known as the General Law of Micro and Small Enterprises (MPE), which was updated with complementary Law 147 / 2014, which classifies a small company according to its billing, which must be between \$ 360,000 and \$ 3.6 million annually. The Brazilian Institute of Geography and Statistics (IBGE), classifies the size of the company according to the number of employees. Thus a small company comprises between 20 to 99 employees, while the medium company, 100 to 499. The medium company is not mentioned in the General Law, however, different financing agencies in the country present their own classifications, such as the Bank of the Northeast (BNB) and National Bank for Economic and Social Development (BNDES) that use revenues over R\$ 16 millions up to R\$ 90 millions.

5. Relations between SMEs and S, T & I

The concept of the association between science and technology (S & T) and economic development is not new. According to Vonortas (2002) in Latin America, the foundations of S & T in Brazil and Mexico, were at the beginning of the decade of 50, followed by the other countries of the region. However, the results do not follow the international standards to be applied by Asia, for example. As research and development (R & D) expenses, international change and marketing expenses tend to be driven to universities and universities. Therefore, for SMEs, a new form should be opened.

As discussed earlier, with globalization, advancing of technology plays a key role in increasing competitiveness and improving social and economic factors. From this, new approaches to the scope and objectives of S & T policies have opened up new opportunities and challenges for companies, universities and governments. The government acts as a catalyst and facilitator, subsidizing the development of technologies and companies, collective actions and learning processes (Vonortas, 2002. Vila, Pérez, & Coll-Serrano, 2014).

According to Bahia and Sampaio (2015) the transformation of industry through innovation is the central theme for the development of Brazilian production. For this, the state seeks to engage companies in this change of position regarding new technologies, creating policies to encourage innovation.

The participation of foreign companies during the Brazilian industrialization process, especially during the 1980s and 1990s, where the import substitution model blocked Brazil's technological development and capacity, facilitated the transfer of technology and accelerated the industrialization process (Pacheco, 2003; Gonçalves, 2007). For national companies, the case for technology came from the importation of machines and equipment (Pacheco, 2003).

Bahia and Sampaio (2015) comment that there is a confrontation regarding the symmetry of the innovation system in Brazil between good academic indicators and low levels of private sector R & D activity. There is a great effort in the qualification of people and the strengthening of academic research, however, companies have not been able to strengthen themselves with regard to technologies (Pacheco, 2003). On the other hand, Gonçalves (2007) states that Brazilian industries are more concerned with licensing and purchasing R & D, know-how, patents, trademarks, consulting services and signing technology transfer contracts.

In 2004, the Law of Innovation was sanctioned, Law n° 10,973, aiming at greater interaction between universities, research centers and companies. In 2016, the Regulatory Framework for Innovation emerges, Law n°. 13,243, with the objective of debureaucratizing these relations and thus the law gain greater autonomy. In this way, a more competitive and cooperative environment is expected with the ICTs and the empowerment of small entrepreneurs and startups.

Within this context, the institutionalization of entrepreneurial university concepts and mechanisms for this to take place is necessary, so that, a strategic vision that benefits university-business interaction can be drawn and allows the better development of innovation processes (Souza et al, 2017)

6. ST&I indicators for SMEs

Paranhos and Palma (2010), showed that although the Science and Technology (S & T) indicators showed that Brazilian research had improved in number and quantity, yet it was difficult to transform scientific knowledge into wealth and development. In more developed countries, the relationship between scientific knowledge and technological development is much more aligned due to government initiatives and policies that promote such advances.

A widely used indicator to measure innovation is the number of deposited patents, however, it may not be effective for countries with a poorly developed innovation system. These, use this indicator for a knowledge analysis and thus guide how to manage ST&I policies of a country or region (Costa et al, 2018).

Thus, the Legal Framework mentioned in item 5 of this paper, have come to supply the need to better use the knowledge to generate innovation, advancing in the processes of technology transfer, pointed out by the authors.

The discussion about the influence of SMEs in the country economy is of solar importance to understand, also, the production of science, technology and innovation. With a significant participation in the economy, small businesses (here also include micro-enterprises) gain space and visibility in the national business scenario, corresponding, according to SEBRAE, to more than a quarter of the Brazilian GDP in 2011. (SEBRAE, 2014).

The distribution of SMEs in the main sectors of the economy is a relevant indicator of where their growth is best envisaged. In the Northeast region, between 2009 and 2011, 11.3% of MPEs are in industry and 88.7% in services, while medium-sized companies had 33.3% in industry and 66.7% in activity according to SEBRAE data. (SEBRAE, 2015).

This paper shows an exploratory research based on data, secondary indicators and documentary research on initiatives that stimulate innovation. For this item, it was held a brief bibliometry using the Web Of Science platform as a source of bibliometric data to perform the compilation of information and their respective comparison. The WoS research was done by inserting the key words: 'science technology and innovation indicators' OR 'innovation indicators' OR 'Science Technology Innovation' OR 'SME' OR 'small and medium enterprises' OR 'small business'. A total of 384 files were found, and were arranged in spreadsheets, for their better visualization and systematization. Graphs were then drawn up to demonstrate the results.

With the bibliometric evaluation, it was possible to verify the scientific production on C, T & I indicators in small and medium enterprises worldwide. With this bibliometric evaluation, it was possible to verify the scientific production on C, T & I indicators in small and medium enterprises worldwide.

In data analysis collected from the Web of Science, it was noticed that most of the authors work in network and that the country with the highest production is China, with 60 publications, corresponding to 15.6% of the total of publications as shown in Figure 1.

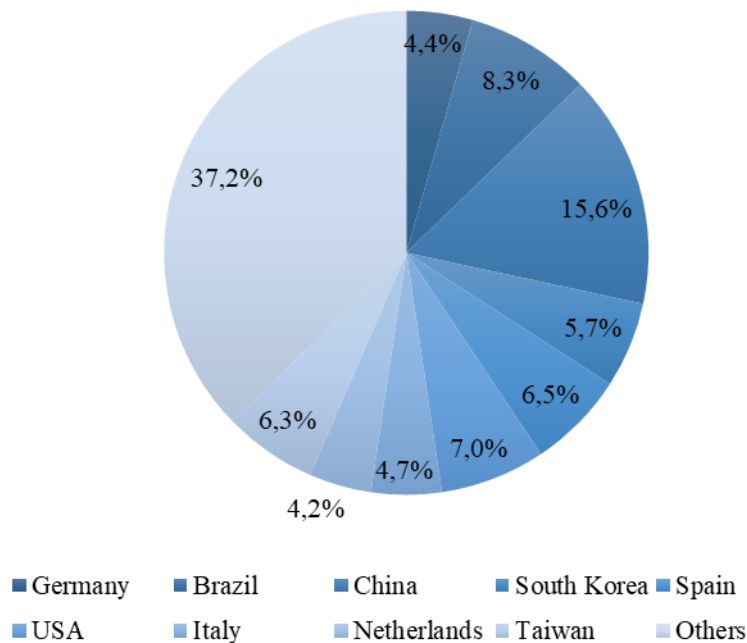


Figure 1 - Percentage of publications by country

Brazil has reached the second position, with 32 publications, as it can be possible seen in Figure 2, which coincides with the entrepreneurial tendency of these two countries, which occupy the first two positions within BRIC's (CHEREZ, et al, 2014).

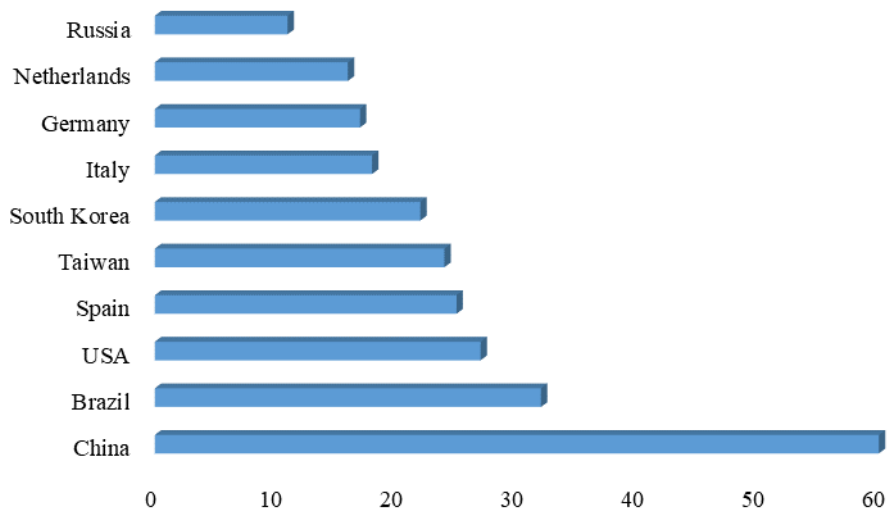


Figure 2 – Ranking of 10 countries with the higher number of production at the theme.

The annual appreciation of these indicators shows us the behavior of scientific production in the world and its changes within each period. Figure 3 shows data from 2005, a milestone that was chosen because it was the date when the law on technological innovation in Brazil was regulated until 2017, the date on which the data was collected for this research in the WoS.

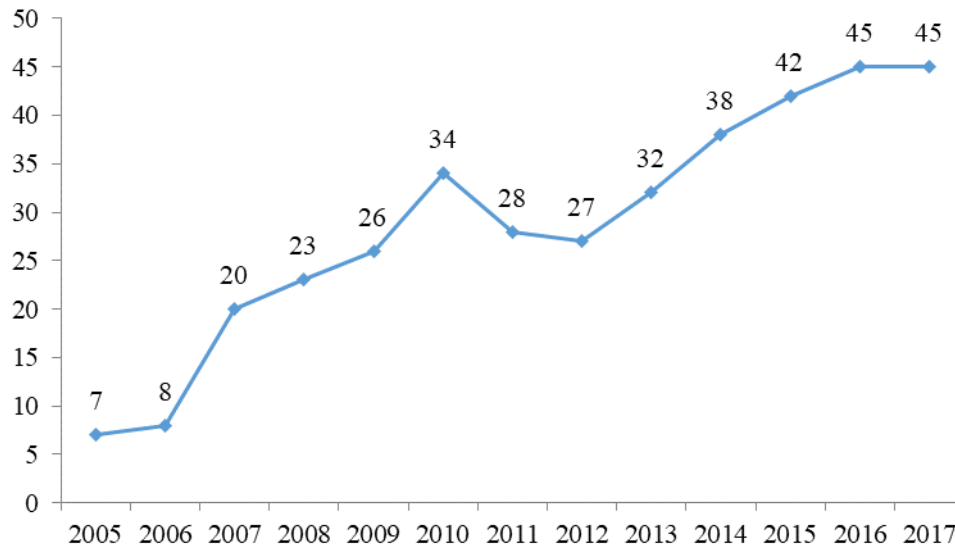


Figure 3 - Number of publications about ST&I indicator per year.

From 2006 to 2007, the number of publications on C, T & I indicators for SMEs almost tripled from a small number of 08 publications to a considerable 20 publications. Another numerical growth that stands out is the one presented between 2009 and 2010, a fact that was mainly due to the researchers' interest in dealing with economics, and consequently the influence of C & T in small businesses, to the detriment of the calamitous world crisis which haunted the world.

When analyzing the articles with the largest numbers of citations, we find that within these journals the most prominent, within the key words used in the research, is the Research Policy, with 129 references made to the article "How journal rankings can suppress interdisciplinary research: A comparison between Innovation Studies and Business & Management. In addition, the cited journal has an impact factor of 4,661, a number that shows how cited are the publications of that periodical in a period of time.

7. Conclusions

From this brief survey, it can be seen how important is the development of Science, Technology and Innovation for the socio-economic development of a country. Each region and each government has sought the best way to encourage the development of this strategic area according to its specificities. Government policies are built for innovative growth and development within educational institutions and research centers, as well as in the productive sector, giving subsidies to industries and small businesses.

As already mentioned, SMEs, in face of the global economic crisis, were fundamental for the recovery and growth of the economy, generating more jobs, increasing exports and making money circulate within the country. Thus, government policies that de-bureaucratize and facilitate the interaction of technology and innovation actors with SMEs, allowing technologies to be transferred and thus companies to grow and continue the cycle are fundamental.

Brazil, in recent years, especially after the Legal Framework for Innovation, has shown an effort to improve the interaction between the ST&I actors. However, the current Brazilian political scenario has generated

distrust and concern in the world market and between research institutions and the business sector. The freezing and cutting of resources for the education and research sector is one of the main obstacles to the development of ST&I in the country, directly affecting the generation of internal wealth. From the results shown in item 6 of this paper, an alternative for both researchers and SME production and development sectors would be the development of networked research, with countries that are advancing in studies on the benefits of relations between the two sectors and in the evaluation of ST&I indicators within the companies, which would help in the future development or even adjustments in the national policies. It is suggested as a theme for future work, the evaluation of the current indicators used in Brazil to evaluate the technological development and innovation of SMEs and perhaps, if necessary, the proposition of adjustments or new indicators more suitable with companies realities within the Brazilian economy.

8. References

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