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Hoffmann, Micheline Gaia; Sell, Denilson; Lemos, Dannyela da Cunha

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Análise de convergência entre as agendas federais e estaduais de fomento à C, T&I: um estudo com foco nas prioridades do setor de TIC no Estado de Santa Catarina – Brasil

Micheline Gaia Hoffmann michelinegaia@gmail.com
Universidade do Estado de Santa Catarina – UDESC/ESAG, Brasil
Denilson Sell denilsonsell@gmail.com
Universidade do Estado de Santa Catarina – UDESC/ESAG / Universidade Federal de Santa Catarina – UFSC/EGC, Brasil
Dannyela da Cunha Lemos lemosda@gmail.com
Universidade do Estado de Santa Catarina – UDESC/ESAG, Brasil

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Abstract: This article aims to analyze the convergence between the evolution of federal investments in science, technology and innovation (STI) in Brazil as of 2002 and the agenda of the industry of the state of Santa Catarina for the ICT sector until 2022. Data were taken from the National Fund for Scientific and Technological Development (FNDCT) and the Industrial Development Plan of Santa Catarina (PDIC), specifically in the ICT sector. Combined practices of information technology and knowledge engineering were employed for the analysis. The study showed a mismatch between the federal and state agendas. Only a portion of the demands of the state were contemplated in the projects financed during the period of this study. There is therefore, a need to mature the institutional structure through mechanisms that allow different spheres to connect. The results show that approximately half of the resources are allocated directly to companies and half to higher education institutions, organizations of ICT and foundations. On one hand, these results suggest a balance between research that emphasizes the scientific and technological relevance and alignment with the principles of the systemic model of innovation. On the other hand, it reiterates the relevance of studies dedicated to investigating the process of university-company interactions in Brazil. Implications of findings on national STI policies are included in this study.

Keywords: Science, Technology and Innovation, Science and Technology Policies, Innovation Policies.

Resumo: Este trabalho objetiva analisar a convergência entre a evolução dos investimentos federais em C,T&I no Brasil a partir de 2002 e a agenda da indústria de Santa Catarina para o setor de TIC até 2022. Como objeto de estudo, foram tomados os dados do Fundo Nacional de Desenvolvimento Científico e Tecnológico (FNDCT) e do Plano de Desenvolvimento Industrial Catarinense (PDIC), especificamente no setor de TIC´s. A abordagem empregada na análise combinou práticas da informetria e da engenharia do conhecimento. O estudo evidenciou um descompasso entre as agendas federal e estadual. Apenas uma parcela das demandas do estado foram contempladas nos projetos financiados no período. Nota-se, assim, a necessidade de amadurecimento da estrutura institucional por meio de mecanismos que permitam a articulação entre as esferas. Também ficou evidenciado que aproximadamente metade dos recursos são

destinados diretamente para empresas e metade a instituições de ensino superior, ICT´s e fundações. Esses resultados, por um lado, sugerem um equilíbrio entre pesquisas que primam pela relevância científica e tecnológica e alinhamento com princípios do modelo sistêmico de inovação. Por outro, reitera a relevância de estudos dedicados a investigar o processo de interação universidade-empresa no Brasil. Implicações dos achados sobre as políticas nacionais de C,T&I compõem também o trabalho.

Palavras-chave: Ciência, Tecnologia e Inovação, Políticas de Ciência e Tecnologia, Políticas de Inovação.

Introduction

The dilemmas and challenges associated with the consolidation and dissemination of the capacity to innovate are widely recognized in the literature (Christensen, 2000; Freeman, 1995; Suzigan & Furtado, 2006). They are also reflected in the business practices and public policies of countries that have achieved effective results in this field, like Switzerland, United Kingdom, Sweden, Netherlands, and United States (Cornell University et al., 2015; Freeman, 1995).

Brazil, along with countries such as Mexico, Argentina, South Africa, India and China, has an immature innovation system, which has research and education institutions established, but whose companies still find limitations in carrying out innovative activities (Salerno, 2017; Suzigan & Albuquerque, 2011). Given this framework, the need to define programs and policies to support such a challenge is imperative.

The focus of public intervention in the dynamics of innovation is therefore to promote institutional instruments that allow qualitative transformations in the production structure, which would be achieved through systemic actions that alter the competitive environments in which business strategies are formed. In this perspective, state action is distinguished because it requires differentiated measures, depending on the existing structure and possibilities of change. It is the heterogeneous and differentiated dynamics of the companies and of the productive structure associated with the innovation process that constitutes the key element that gives content to the notion of intervention policies.

Therefore, in addition to the national dimension, the need for intervention with a focus on the regional dimension is reinforced. Howells (2005) argues that regional innovation policies are important both for the regions and for national policy, since they create the link between innovation, growth and economic performance and account for disparities between innovative activities in the different regions. According to Doloreux and Parto (2005), companies' innovative activities are largely based on local resources, such as labor force, supply and subcontracting systems, learning processes, traditions for cooperation between entrepreneurs, support agencies, and presence of customers and users. These resources should be considered in regional policies. In this context, Science, Technology and Innovation national policies have shifted from top-down approaches towards policies that favor more place-based approaches (Okamuro et al., 2019).

International literature presents initiatives which seek to transcend typically top-down policies in order to give space to bottom-up movements. They aim to provide the necessary conditions to define priorities aligned to the aspects that are relevant to local and regional development. The smart specialization strategy, which gives the north to two important funds of the European Union (the Multi-annual Research and Innovation Framework Program and the European Structural and Investment Funds) is referenced by Corpakis (2020) as an example of practice that involves national and regional authorities, as well as other stakeholders, such as universities and industries, with the objective of aligning investment priorities with local and regional competences and necessities. Guimón (2019) presents Similar examples applied specifically at Sweden, Germany and United States. Along the same lines, OECD (2014) references the Leading Industry Program as a good practice of South Korea and OECD (2017) highlights the interrelation between national and regional levels in Finland.

However, the interaction between different levels of governments in terms of innovation support still needs to be better understood. Okamuro et al. (2019) point out a gap in the existing literature about how local R&D and innovation programs interact with different governance levels and to what extent the national governance system matches the specific local needs.

In terms of both national and regional policies, the guidance for the allocation of resources occurs through the prioritization of sectors, areas of knowledge and strategic options. STI and industrial policies in Brazil, have historically been managed this way, as it has been in many developing countries. Nevertheless, as Jin and Mc Kelvey (2019) have pointed out, the research on strategic priorities in developing countries is not extensive.

In Brazil, much of the promotion of scientific research is carried out with public funds. In the period 2000 to 2015, national research and development (R&D) expenditure in relation to the Gross Domestic Product (GDP) increased from 1.05% to 1.28%, and in 2015 50% of investments come from the public sector and 50% from the private sector (MCTIC, 2017). This trend is not repeated in the leading countries in the world, where private sector investment is significantly higher. Of the total resources invested in R&D in companies, 94.24% come from the private sector (OECD, 2016). This reality elevates the responsibility of the brazilian government in the careful planning of the transfer of funds to universities, laboratories, researchers and companies, making it a political, economic and social issue.

Government choices in the process of formulating public policies are driven by ideologies, interests and needs of both formal and informal actors (Silva & Bassi, 2012). Therefore, the agenda-setting stage in the formulation of federal public policies is determinant in the sense of contemplating regional needs and specificities.In the case of STI public policies, the principles currently prevailing in Brazil transcend the linear model by Vannevar Bush (Stokes, 2005), who proposed a government-

academia pact based on the premise of the supreme relevance of scientific research for innovation and its necessary dissociation of practical aims. Alternative arguments have been presented by Freeman (1995), Kline and Rosenberg (2015) and Nelson (2006), and include the business sector as key actor along with other actors that make up national and regional innovation systems.

In this context and considering the related literature gaps (Okamuro et al., 2019; Jin & McKelvey, 2019), this paper is based on the assumption that the qualification of the investments in the field of STI goes through an alignment between the federal and state agendas. It also assumes that the agenda setting is consolidated by articulating information that reflects the needs of the different actors at different governance levels.

Thus, this study analyzes the convergence between the evolution of federal investments in STI in Brazil as of 2002 and the industry agenda of the state of Santa Catarina for the ICT sector for the time horizon of 2022. The objects of the study are the key technologies defined as priorities by the Santa Catarina Industrial Development Plan (PDIC) for the ICT sector and the evolution of federal investments in STI in the context of the National Fund for Scientific and Technological Development (FNDCT).

The studies that discuss the coordination between national and regional innovation policies in Brazil are mainly oriented to discuss the resource allocation as a means of reducing the regional inequalities (Andrade & Macedo, 2012; Cavalcante & Fagundes, 2007; Cavalcante, 2011; Danda, Queiroz & Hoffmann, 2016; Leal et al., 2018; Silva et al., 2019; Vieira, 2016) without entering the specifics of agendas integration. Some studies discuss the need of decentralization of Science, Technology and Innovation public policies, highlighting mainly the role of the Research Support Foundations on this process (Botelho & Almeida, 2012, Danda, Queiroz, & Hoffmann, 2016; Leal et al., 2018). Others are dedicated to analyzing specific regional systems of innovation (Roese, 2000; Pereira et al., 2015). However, few are focused on discussing their articulation to national systems. Minuzzi (2019) and Santana et al. (2020) bring some contribution among those lines. The first one, investigates the alignment of the research projects developed at UFSM during the period of 2012-2015 to the prioritized programs of ENCTI 2012-2015. The results show that more than half of the research projects developed at UFSM where in areas not aligned to the proposals presented by ENCTI 2012-2015 as priority programs to future growth sector, not being, therefore, aligned to their main objectives. Santana et al. (2020) have developed an analysis of public funding for innovation on Northeast Region by sectorial distribution, aiming at understanding if there are synergies between the sectors prioritized by the Industrial and Science, Technology and Innovation policies, and the sectors effectively contemplated by financial resources and fiscal incentives of the region. They concluded that the more traditional sectors of the locality, such as the food market, were the most affected by the tax exemption, whereas the credit and subvention have a higher impact on supporting the innovation

in sectors new to the locality and connected to strategic areas of the Science, Technology and Innovation policies.

Consolidation and Evolution of STI Policies in Brazil and their Development in the State of Santa Catarina

Analyzing the Brazilian historical context, it has been possible to observe the emergence of several institutions of a technical and scientific nature since the nineteenth century. They mark the birth of science and the emergence of technological research in the country. However, it was during the military regime that most of the STI system started to be implemented (Lima, 2009, Suzigan & Albuquerque, 2011).

It was in the 1970s that Brazil witnessed the establishment of one of the most significant STI systems among developing countries (Hirata, 2006). However, the strengthening of technology in the industrial sector did not accompany the advance of basic research, which shows the weaknesses and asymmetries of these policies. It was only in the late 1990s that the need to resolve the disarticulation between the STI policy and industrial policy was highlighted. It was also during this period that efforts were made to provide more stability in public spending on STI. The Sectoral Funds[1] have emerged as an important milestone in this regard. The operation model adopted by these funds aimed to represent an advance in the integrated action between the academic environment, the industrial sector and the government.

In 2004, the Federal Government announced the Industrial, Technological and Foreign Trade Policy (PITCE) (Casa Civil, 2003). Thus, there was an explicit concern to reinforce the National Innovation System in order to broaden the link between companies, public and private research centers and institutions to support technological dissemination, and strengthen the integrated action of different actors.

Also in 2004, Law 10,973 (Brasil, 2015) established measures to encourage STI research in production in order to train personnel and achieve technological autonomy and industrial development of the country. In this sense, the law facilitated the creation of mechanisms to promote cooperative environments of innovation.

The Action Plan on Science, Technology and Innovation (PACTI) for the period 2007-2010 (MCT, 2007), the Policy on Production Development (PDP) in 2008 and the Industrial Policy on Innovation and Foreign Trade for the period 2011-2014 (ABDI, 2011), reinforced the guidelines for strengthening integration mechanisms. It is worth mentioning the National Strategy on STI (ENCTI), launched in 2011 for the period 2012-2015, which, within a perspective of the continuity of previous policies, proposed to strengthen the articulation of STI with the other state policies, as well as to integrate their respective actors (MCTI, 2012). More recently ENCTI 2016-2019 intends to continue and improve the previous proposal.

These policies, translated in the form of the most diverse actions in the field of STI, created an institutional arrangement that, according to

Bagattolli and Dagnino (2014) brought a significant increase of resources destined to innovative business activities. Salerno (2017), however, says there is a lack of long-term policies that are linked to development. Pacheco, Bonacelli and Foss (2017) criticize the absence of articulated policies to deal with the demands. The authors defend the need to implement mechanisms to stimulate the demand for innovation. In this scenario, despite all the advances, Brazilian industry is still far from using more technological content, with embedded knowledge, incorporating new and emerging technologies capable of revolutionizing its means of production and products (Salerno, 2017).

In Santa Catarina, although research and higher education institutions have been in place since the 1960s, it was in the 1990s that an institutional structure in the field and the allocation of specific resources for STI research were consolidated. According to Cario et al. (2011), institutions in Santa Catarina in the field of teaching and research were the result of actions in the municipal, state and federal spheres, as well as in the private sector.

In 2008, Law 14,328 (known as the Catarinense Innovation Law) was approved, establishing measures to encourage STI research in the production environment. With this law, there was the establishment of the State STI System of Santa Catarina (Fapesc, 2010).

Another important program worth mentioning is the Inova@SC program, that aims "to transform Santa Catarina in a state reference for the country in the policies of technological innovation allied to sustainability" (Fapesc, 2011, p.11). The program is part of a larger plan, called SC@2022 – Maximum State of Innovation.

As a subsidy to the programs and projects that make up the SC@2022, the Federation of Industries of the State of Santa Catarina (FIESC) coordinated several actors of the state to build the Santa Catarina Industrial Development Plan (PDIC). Under the plan, reports were prepared summarizing the priorities and actions related to industry for the development of the state, based on a process of collective construction involving representatives of industry, academia, government and the third sector. From this collective effort, it was possible to identify sixteen sectors that bear the future for the economy of Santa Catarina, with a time horizon of 2022. For each of them, key technologies were defined, which deserve a careful look at the process of forming the STI agenda.

The Evolution of Innovation Models and the Formation of the Development Agenda for STI

Innovation is a systemic phenomenon and its results come from the continuous interaction between different actors and organizations (Fagerberg, 2007), and that is why the connections between them are important (Asheim & Gertler, 2007).

This idea is the result of a process that prioritized, over time, models of innovation based on assumptions that guided the logic of public intervention in fostering innovation. According to Viotti (2003) such models implicitly or explicitly influenced STI policies. Thus, the linear model of innovation, the chain link model and also the systemic model,

are identified among other possible classifications (Caraça et al., 2009; Stokes, 2005; Viotti, 2003).

The linear model was consolidated after World War II, associated with Vannevar Busch's report "Science: the Endless Frontier", with the view that basic research is the starting point for innovation, leading to applied research, subsequent development and, finally, to production and operation (Stokes, 2005). Busch advocated an expansion of funding for basic research at US universities as a critical factor for economic growth (Mowery & Sampat, 2007).

This approach justifies research resources granted by the state, regardless of their applicability, conditioning the STI policies to the increasingly provide resources for researchers or research institutions. Thus, institutions such as research centers would be responsible for the production and supply of technologies or innovations and the companies responsible for the demand (Viotti, 2003).

Despite all criticisms of the model, Leyden and Menter (2018) argue that the Bush report was a catalyst for the development of a modern technology and innovation policy, from which a network of research institutions and laboratories was created, mainly shifting the mindset of policymakers by incorporating innovation as a fundamental responsibility of governments.

In this context, Kline and Rosenberg (1986) affirm that innovation is based on science, and the demand for innovation force science creation. Furthermore, they argue that the linear model does not consider the feedback received during the different stages of the innovation process, as well as the possibility of learning through accumulated experience. The authors propose the chain link model, which is based on the concept that innovation results from the interaction between market opportunities and the company's knowledge base (Viotti, 2003).

The company is positioned at the center of the innovation process, where research is not a precondition, but only one of the activities to be undertaken. In this sense, research activities can be motivated by problems or ideas that arise at any stage of the innovation process that is beyond the knowledge base and capabilities of the company (Kline & Rosenberg, 1986). In this way, "policies inspired by the chain link model emphasize support for strengthening the technological capabilities of companies and their relations with research institutions" (Viotti, 2003, p.60).

Deconstructing the theses that put emphasis on a specific actor in the innovation process, Freeman and Soete (2008) defend the understanding of innovation from the perspective of the systemic model, that is, companies do not innovate in isolation, but within a context of relations with other companies and institutions (Viotti, 2003). This perspective transcends the simplistic perception that R&D is the source of innovation, considering the simultaneous influence of organizational, institutional and economic factors (Lima, 2009).

Thus, it is possible to observe the importance of the national environment and the definition of governmental policies that point to

the development and consolidation of relations between the different institutions that make up the innovation system. It is the technological capabilities of national companies that build the country's competitive performance, and these capabilities can be developed through a national action (Nelson & Rosenberg, 1993; Nelson, 2006).

National innovation systems not only foster interaction but also work as repositories of various resources that companies depend on in their innovation process, such as knowledge, financial resources, and demand, which are largely regarded as supplied within the nation – hence the term "national" in innovation systems. (Edler & Fagerberg, 2017)

For Nelson (2006), a country's innovation system tends to reflect conscious decisions to develop economic strength and comparative advantages. Within this approach, it is recognized that the institutional structure differs between national economies and that there are implications in terms of which types of technologies and sectors thrive in the national context. Thus, policy design must take into account a specific view of the institutional characteristics of the national system (Lundvall & Borras, 2007).

Nelson (2006) argues that the government policy framework supporting innovation shows a diversity of programs as well as a fragmented nature, ranging from funding research in universities with a focus on the productive sector, as well as policies directed at specific sectors or to protect some areas or industrial groups.

In some countries, the government tries to shape the type of productive development for certain economic sectors. An example would be the high-tech pockets in backward economies such as Brazil and Argentina that clearly reflect the ambition of their military elites. "If public action can bring advantages to a particular national industry, such support can be justified in terms of increased economic efficiency. Otherwise, it will be considered pure subsidy or protection, and this is something that cannot be accepted" (Nelson, 2006, p.465).

When analyzing STI and industrial policies from the 2000s in Brazil, Da Silva, Ieis and Farah Jr. (2015) affirm that these policies privileged existing sectors, even though these sectors were not necessarily fundamental to the construction of a new standard regarding technology and innovation, which resulted in a system based on incremental innovation and disjointed policies subject to review according to government's interest.

Lundvall and Borras (2007) argue that government agencies need to be coordinated amongst themselves when it comes to leading and proposing innovation policies, as well as being in interaction and dialogue with the business community, unions and educational institutions – a crucial condition for the development of socially relevant programs.

In addition to the national perspective, Malerba (2007) points out that it is necessary to consider the coexistence of the different geographical dimensions, be them local, national, regional and global, as well as the sectoral specificities in the development of policies. If national policies actively promote central industrial areas for a period of time,

neglecting others, it is possible that such a strategy affects the entire national innovation system, which may eventually block some specific path (Castelacci, 2009).

In this sense, the balance between regional and national demands needs to be respected in the formulation of policies in the field of STI, including the participation of actors from these different spheres. Innovation policies designed from a regional perspective are sensitive to the specific preconditions, potentials and challenges encountered in a region, taking into account their particularities and knowledge bases (Asheim et al., 2015). By taking these issues into account, investments in STI are geared towards addressing the problems and aspirations of society in a more targeted manner, at the same time as the national strategies are observed.

Methodology

The study sought to identify reference information sources both to analyze the topics that were prioritized in research financing and to identify the priorities of the industry in the ICT sector.

In Brazil, at the federal level, the sectoral funds of the Ministry Science Technology and Innovation are sources to analyze the projects financed by the Brazilian government. In order to carry out the research, the projects funded by the Sectoral Funds by FINEP - Funding Authority for Studies and Projects and CNPq - National Council for Scientific and Technological Development in economic sectors related [2] to ICT were selected from the Integrated Management System of STI - Science and Technology Institution (SIGCTI [3], acronym in Portuguese) and the Aquarius Platform [4]. The data extracted from this platform and used for the development of this research are available in Sell et al (2019).

The reports produced by PDIC were used in order to analyze the profile of the demand of the industry of Santa Catarina related to the ICT sector. Among the information gathered in such reports, the identification of priority sectors, key technologies for the sector, critical success factors, and structuring actions for the state are highlighted.

Santa Catarina is a state that stands out for its high level of development on multiple segments. This state was ranked second overall on the Index of Regional Management Challenges (IDGE), ranking first on indicators of social development. The industry of Santa Catarina is highly relevant on the national scenario, being the fifth biggest industrial complex of the country and having one of the most diversified production chains (Fiesc, 2019). Moreover, Santa Catarina is Brazil's fourth biggest center of innovation, hiring 51,8 thousand people (ACATE, 2019). It's worth also highlighting that Santa Catarina has a history of public investments on the field of science and technology, with a rate of 2.39% of its total revenues spent on expenditures of Science, Technology and Innovation, whereas in the other states this index is around 1%, on average (Vieira, 2016).

The approach applied in this study combine practices of information technology and knowledge engineering to enable the identification and analysis of the themes present in public financing and in strategic demands identified in Santa Catarina in the ICT sector.

Different disciplines may be used to analyze the events related to a system of STI. In the case of informetric studies on projects, the most frequent analyses have verified both the historical content formed by the documents produced throughout the life cycle of a project. The contents have been analyzed by criteria that include the thematic profile of the documents produced, the chronological evolution of this profile, the types of study and the methodological approaches adopted by the work teams and authors (Pacheco, et al., 2012).

In this study, the use of data on the characterization of projects funded in the ICT sector based on the statistical informetric is combined with knowledge engineering techniques in order to analyze the themes of the projects financed and the declarations of priorities in the sector of ICT of SCTI in Santa Catarina.

The knowledge engineering techniques related disciplines aim to highlight the semantic layer that can be derived from the data and informetric content in SCTI. In this research, correlation analysis and topic mapping algorithms were applied on the data collected in projects funded by FNDCT and on the priorities identified by the focus groups organized by the PDIC. Through the analysis of these maps of topics, the profile of the themes prioritized by the federal initiatives is compared to the themes identified by the SCTI actors in Santa Catarina.

In the proposed method, the ISNER® tool was used to discover the themes prioritized by the federal initiatives and to analyze the ICT priorities in Santa Catarina, according to the following steps:

1. Recognition of candidate terms: In this stage the candidate terms for relevant terms (domain entities) are identified, using a statistical approach that combines terms in a set of words (seven words in sequence in a sentence) and sorts them according to the frequency within the document. This strategy allows the identification of relevant terms, including compound terms (e.g. "Artificial Intelligence").

2. Validation: verify if the recognized entities are valid for the domain under analysis using a glossary that combines IEEE and ACM taxonomies, as well as Wikipedia terms and keywords located in productions of the Lattes curriculum in the main field of knowledge Exact Sciences. An entity is considered valid if it is in the glossary. The search is done based on the textual index created for the group of funded projects, in each period and, when successful, the entity found is added to the list and marked as valid.

For the analysis of the projects, the title information, keywords, abstract, objectives and purpose of the projects were gathered and organized according to the project contracting year and separated in triennia, with the following strata: (a) 1997 to 2006, (b) 2007 to 2011 and (c) 2012 to 2016. The abstracts of each period were then searched using the ISNER © tool.

Finally, an analysis of convergence of the themes financed in Santa Catarina to the priorities described in the PDIC was carried out. This analysis was conducted by ICT specialists, who received the stratification of the terms extracted from the projects.

Results and discussion

Public funding of STI projects by FNDCT

Based on the data provided by the Aquarius Platform and the SIGCTI, it is observed that the projects financed by FNDCT between 1997 and 2016 totaled R$ 16,030,598,282.93. This amount was used to finance the different modalities supported by FNDCT throughout Brazil. From this amount, 8.8% was applied in economic sectors directly related to ICT, totaling R$ 1,406,703,234.85 applied in all states, including the Federal District.

Figure 1 shows that out of the amount used in financing research and innovation projects in ICTs by state, 5.5% was destined to projects developed by ICTs and companies from Santa Catarina, totaling R$ 77,529,740.43 of investments destined to the state. Of this amount, 53% was invested in projects contracted directly with companies (corresponding to R$ 41,410,955.59). It should be noted that in the analyzed period, Santa Catarina received R$ 640,754,463.97 from sectoral funds in projects and actions for all economic sectors. Proportionally, the ICT sector accounted for 12.1% of the resources allocated to the state, a proportion only surpassed by São Paulo, which in the same period had 17.25% of the investments received allocated to the ICT sector.

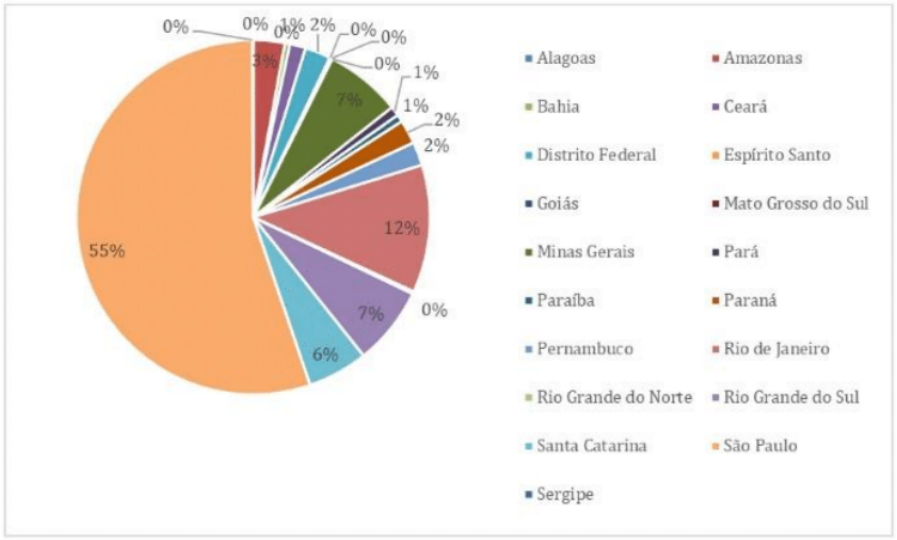

Figure 1.
Distribution of funds from the FNDCT in the Brazilian states in projects related to ICTs
Source: Research data, 2018

Based on the extraction of the terms from the funded projects' description, it is possible to see the themes prioritized in the federal public funding in STI. Figure 2 illustrates, by means of a term cloud generated by the entity extraction algorithm described in the Methodology section, the main terms identified from the titles and summaries of projects financed with ICTs in the country. The identified terms (translated into English) assist in the identification of themes prioritized in the public financing agenda in Brazil. As shown in Figure 2, between 1997 and 2006, STI projects financed by FNDCT prioritized topics such as software engineering, artificial intelligence, free software, image processing and data mining. In 2002, investment in sectors directly linked to ICTs was intensified. Based on the identification of the projects and the consultation with experts in the ICT sector, it was verified (in the period between 2003 and 2006) that the themes funded reflected the priority of developing know-how in the country in software engineering (such as quality standards, metrics and methodologies), as well as reflecting the federal government's intention to promote free software.

Between 2007 and 2011, it was observed the maintenance of the funding in projects related to software engineering and artificial intelligence, and the priority moved to projects related to microelectronics, integrated circuits and embedded systems. In the same period, there were calls for proposals launched by the FNDCT, observing recommendations from the Information Technology Area Committee (CATI), which considered the National Microelectronics Program (PNM Design) a priority (MCT, 2002).

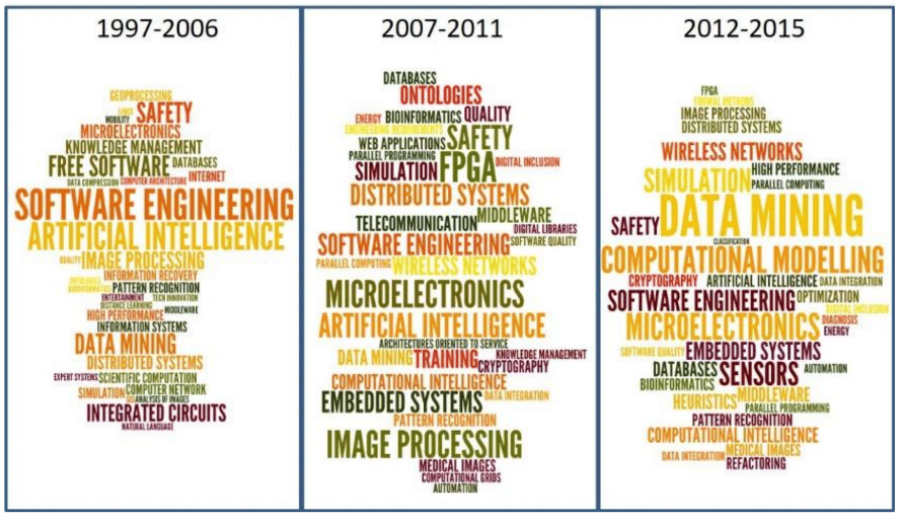

Figure 2.
Main terms found in projects funded in all Brazilian states and in the Federal District
Source: Research data

As of 2012, there has been maintenance of investments in projects related to artificial intelligence, with emphasis on data mining and computational modeling. Figure 3 illustrates the configuration of the themes (in English) that permeated the projects prioritized in the period involving data mining. Based on the terms extracted from the funded

projects, the techniques used in the projects involving data mining in the period are characterized, in addition to some of the areas of recurring applications, such as in themes related to the identification and treatment of cancer.

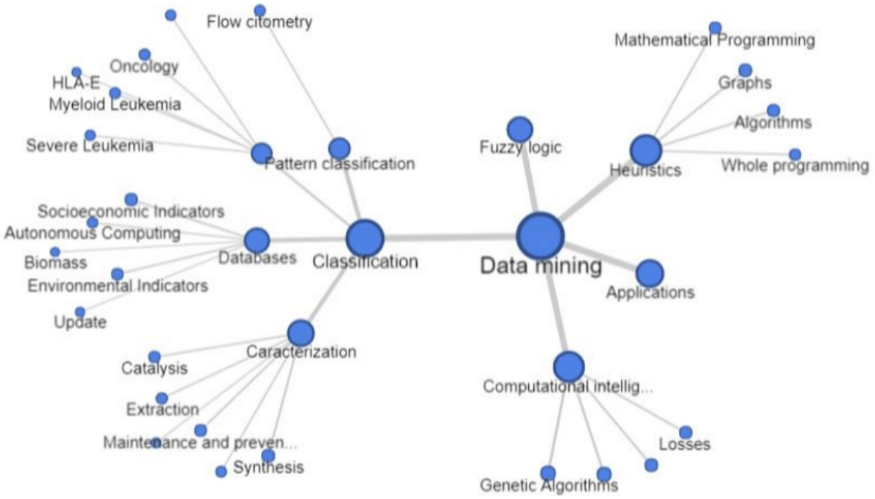

Figure 3.
Extract of themes addressed by projects related to data mining, funded between 2010 and 2012 by FNDCT
Source: Research data

Terms to characterize the projects financed in the state were extracted, focusing on the scope of the research, which proposed the analysis of the convergence of projects in the ICT sector funded in Santa Catarina with the national priorities. Figure 4 illustrates the priority themes (in Portuguese). A direct relation with national priorities (such as the emphasis on projects involving artificial intelligence, image processing, free software), but also an emphasis on themes that did not, such as digital television, innovation management, agricultural research, quality of life, public security, among others depicted in the Figure 4. Such terms were not frequently mentioned on the analysis of projects financed in other states.

The analysis of the prioritization of ICT research funding in Santa Catarina was later carried out in the light of the priorities established by the PDIC, as proposed in the research objectives. The result of the analyses is presented in the next section.

Figure 4.
Main terms present in funded projects in Santa Catarina
Source: Research data

As mentioned above, the PDIC identified a set of priorities for the development of the ICT sector in the state by 2022. These priorities are synthesized in key technologies and priority sectors. Based on these definitions, the research sought to identify the level of alignment between the FNDCT funding agenda and the priorities identified by the local actors mobilized to prepare the PDIC.

The funded projects were summarized based on the terms extracted from the descriptive elements (such as title, abstract, purpose, and keywords) and then confronted with the definitions of key ICT technologies shown in Table 1.

Table 1.
Key-technologies identified in the PDIC

Key-technologies	Description
Connectivity technology	Development of a telecommunication infrastructure, using technologies such as IPx68 optical fiber, PLC9 and mobile bandwidth, facilitating the adoption of cloud computing, big data, mobility, ubiquitous computing and public services for smart cities.
Cloud computing	Several different devices connected to the network, using the cloud for storage and processing information.
Big data	Using structured and non-structured data to develop customized solutions, according to the needs and desires of the consumer.
Mobility	Use of devices and mobile applications for professional and personal ends and to integrate other systems and devices.
Social business and collaboration	Deep changes in the way professionals, companies and clients interact, using technologies such as UCC10, co-creation and open innovation.
Short distance communication	Devices with short distance communication technology connected through NFC11, ZigBee, Z-wave, promoting environment automation.
Software defined data center (SDDC)	Use of SDDC in IT architecture and infrastructure.

Source: FIESC, 2014

Figure 5 illustrates the level of convergence of projects funded, with the key technologies identified in the PDIC. It can be seen that 50% of financing did not meet the priorities established for the state. When

looking at the projects that are adherent to the key technologies described in Table 1, it is observed that cloud computing (corresponding to 20% of investments) and technologies for connectivity technologies (i.e. 15% of investments) were prioritized in funded projects. Big data also has representative percentage (i.e. 8% of the investments). The other key technologies do not present significant convergence in the analyzed period.

The data show, therefore, what Pacheco et al. (2017) called a detachment between federal policies and regional technological demands. If, according to Malerba (2007), it is necessary to consider the coexistence of the geographic and sectoral differences when it comes to develop policies, the data suggest a gap to be filled. These findings are in line with what Nelson (2006) characterized as fragmented policies and with Salerno's (2017) finding regarding the lack of policies that are articulated with development in Brazil.

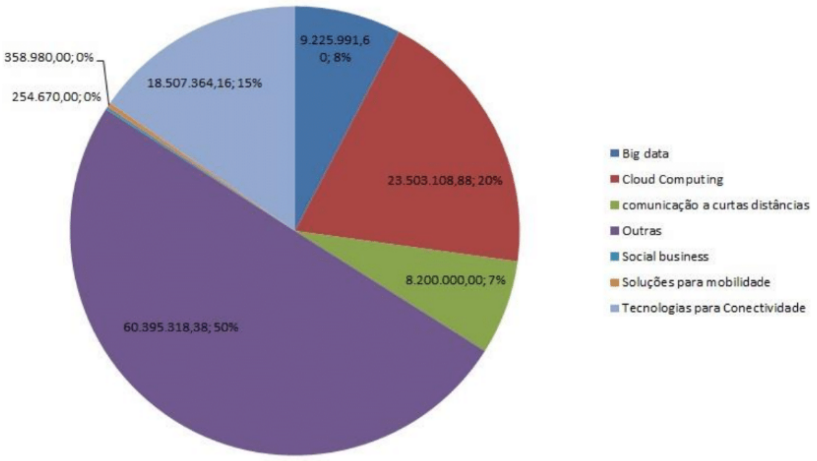

Figure 5.
Funding from the FNDCT in the ICT sector vis-a-vis the key-technologies established in the PDIC
Source: Research data

After analyzing the relationship between the sectors that received the funding from the FNDCT and the priorities of the industry of Santa Catarina according to the PDIC, the study observed who were the proponents and executors of the financed projects. The data showed that approximately 53% of the resources were allocated directly to companies. These data are aligned with that of Bagattoli and Dagnino (2014), according to which national policies in the field of STI have created an institutional arrangement responsible for an increase in resources for innovative business activities. They contemplate principles of the chain-link model, which guides policies characterized by the emphasis on supporting the strengthening of companies' technological capacity (Viotti, 2003). This also finds resonance in the study of Thielmann and La Rovere (2017), who in the analysis of STI indicators from 1999 to 2010 in Brazil, identified the engagement of Brazilian companies in the production of knowledge, attesting that the private sector has

been increasing R&D expenditures as well as its share of total R&D expenditures in the country.

Considering that companies are the actors that effectively consolidate the phenomenon of innovation (Schumpeter, 1982), there is a favorable opinion of the technological development scenario of the country, based on the innovation capacity of the industry. The financing of projects presented by the business sector also ensures that the demands of the industry are met and, therefore, favors the convergence of agendas that characterizes the central concern of this study. Of the sectors funded by the FNDCT, 42% did not meet the industry priorities according to the PDIC. This may be explained by those who were the proponents and executors of the approved projects, but since the study did not covered the relationship between the authors of the proposals and the probability or not of obtaining funding, this cannot be confirmed.

On the other hand, it was found that almost half of the resources (43.77%) went to private and public education and research institutions, private and public science and technology institutions and support foundations. It is worth highlighting the importance of foundations in this scenario, which accounted for 38% of the total resources received.

The number of operating institutions shows that the funding goes to public HEIs, who receive 1.4% of the total resources when they are the proponent, and obtain 24.58% of the resources when they are the executors. In this sense, Leyden and Menter (2018) reinforce the importance of governments creating opportunities for innovation processes that integrate resources from basic and applied research.

Thus, a significant portion of the resources invested by FNDCT in the period studied was destined to funding academic research. The analysis of the global distribution concludes that, from the perspective of the systemic model of innovation (Freeman and Soete, 2008), there is a favorable scenario. The figures indicate that, unlike Vannevar Bush's thesis (Stokes, 2005), which proposes the centrality of academic research, Brazil advances in the construction of a national system of innovation, in which different actors operate in an interrelated way in favor of innovation actors, among which companies, educational institutions, ICTs, associations, foundations, government, financing agents, etc. In agreement with Stokes (2005), the data reveal a portfolio of funded projects that potentially balance scientific and technological relevance.

Final considerations

This article analyzed the convergence between the evolution of federal investments in STI in Brazil from 2002 and the industry agenda of the state of Santa Catarina for the ICT sector until 2022.

The results showed a lack of convergence between the federal agenda (in terms of financing STI projects) and the state (regarding the demand for resources for projects relevant to priority sectors). Only 50% of the state's key themes were included in the projects financed by the FNDCT in the analyzed period. The research data showed the need

to incorporate regional priorities into the federal agenda and, to that end, use mechanisms that allow the coordination of information among the spheres of government. In other words, the country's institutional structure needs to mature, which, as seen in Lundvall and Borras (2007), has direct implications for the type of technologies and sectors that thrive in the country. This issue is the central finding, directly related to the objective of the study.

A secondary result shows that in Santa Catarina 53% of the resources are earmarked for companies (R$ 41,410,955.59).). The remaining is aimed at higher education institutions, ICTs and related foundations. Analyzing the numbers based on Stokes' (2005) perspective, such a distribution of resources suggests a balance between research that excels in scientific, and technological relevance. However, the study did not investigate the interaction between academic research and industry, so it is not possible to formulate conclusions about the possible impact of the results of this part of the funded projects on the technological development of the industry in Santa Catarina.

The results corroborate the conclusions of the study developed by Nelson (2006), according to which the public policy framework focused on promoting innovation in Brazil is fragmented, formulated without a broad vision that connects all the relevant factors to an active industrial policy. In the same sense, Salerno (2017), when analyzing the innovation policy in Brazil in the light of countries such as Germany, the United States and France, draws conclusions that highlight the need for changes in the governance structure of these policies, so that they have a horizon and are articulated with a development project. This study is based on the work by Malerba (2007), on the understanding of the coexistence of the different geographies, the sectoral specificities in the development of policies. Accordingly, the paper aimed to contribute to the advance of the literature focused on the interaction between different governance levels of STI policies (Okamuro et al., 2019) and the strategic priorities of management in developing countries sectoral innovation systems (Jin & McKelvey, 2019).

The findings of the research prove that there is a mismatch between the destination of federal resources and the demands of the industry of the state. Considering that the PDIC envisages the time horizon of 2022, there is time to use the evidence presented in this study to support a discussion between representatives of federal government and the state's industry in order to include among the criteria adopted by the funding agencies, those elements that are relevant to the industry of Santa Catarina and indicated in the PDIC. This measure can have a real impact on the allocation of resources in the coming years, favoring research connected to the demands of the state and, therefore, to its technological development.

The study also highlights the need to seek new strategies for the formulation and management of public policies in the field of STI in Brazil, in such a way as to foster greater alignment among the agendas and to contribute to the maturation of effective national innovation.

Such action requires a range of different policies and policy instruments, introduced at various points in time, with different motivations and a variety of labels, whether industrial policy, scientific policy, research policy or technological policy (Edler & Fagerberg, 2017). This might involve a multilevel governance approach where multiple stakeholders are involved in shaping an effective innovation policy (Kattel & Mazzucato, 2018; Okamuro et al., 2019). In addition, it brings up the need to implement mechanisms to stimulate the demand for innovation, allowing the advance of the current scenario characterized by the absence of coordinated policies that favor the demand (Pacheco et al., 2017).

The results can also contribute to the design of conscious and coordinated models for the evaluation of national STI policies. Specifically, it is suggested that evaluation initiatives incorporate as a dimension of analysis the convergence of agendas, in the perspective proposed in this work.

As limitations, the study did not focus on the sectors contemplated in the research developed in the academic context of the projects financed by the FNDCT. Nor did it analyze the interaction of these surveys with the business sector, which could culminate in technology transfer and a concrete impact on the development of the industry in the sectors prioritized by the PDIC. Thus, it is not possible to make inferences in this sense, and thus, new research is suggested in order to support the continuity of this discussion.

For future work, it is suggested to carry out related research applied to other sectors besides ICT and to develop studies focusing on methodologies that provide connections between the agendas and studies focusing on the proposal of indicators to build evaluation models that incorporate connections between federal and state agendas as a dimension of analysis. Considering that approximately half of the resources were allocated to higher education institutions and science and technology institutions either directly or through foundations, it is recommended that future studies investigate whether there is an alignment between the results of the research carried out at these institutions and the industry demands. In addition, it is suggested to investigate if there was an impact in the segments prioritized by the industry based on the research developed in these institutions with the resources under analysis.

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Notes

[1] http://www.finep.gov.br/a-finep-externo/fontes-de-recurso/fundos-setoriais/o-que-sao-fundos-setoriais

[2] The following economic sectors were considered: database activity; computing activity and similar; consulting on computing systems; software development; production of equipment to electronic machines and information treatment; production of electronic material and of communication devices and equipment; other non-specified computing activities; data processing, sector: database activity and sector: software development.

[3] http://www.mct.gov.br/index.php/content/view/725.html

[4] http://aquarius.mcti.gov.br/app/home/