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ASYMMETRY

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THE ROLE OF INNOVATION SUPPORT AGENTS IN THE DEVELOPMENT OF NEW TECHNOLOGY- BASED FIRMS FROM THE PERSPECTIVE OF INFORMATION ASYMMETRY

***O PAPEL DOS AGENTES DE SUPORTE À INOVAÇÃO NO DESENVOLVIMENTO DE EMPRESAS DE BASE
TECNOLÓGICA NA PERSPECTIVA DA ASSIMETRIA DE INFORMAÇÕES***

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ABSTRACT

The aim of this paper is to analyze the role of innovation support agents (ISAs) in the development of new technology-based firms (NTBFs) from the perspective of information asymmetry among economic agents. It was performed a qualitative cross-case analysis about two business incubators, two business accelerators, and two science parks. According to the empirical data collected and posterior analysis it was found that ISAs contribute to the development of NTBFs in the following ways: distributing market information to them, reducing their search costs; enabling their social capital formation; borrowing reputation to them; reducing the search costs of market agents to access their NTBFs. Furthermore, these roles vary to the nature of the ISA investigated. Lastly, this research can be used as a reference by both, ISAs and NTBFs, regarding the development of the informational and social aspects of this latter.

Keywords: information asymmetry, NTBFs, science parks, business incubators, business accelerators.

RESUMO

O objetivo deste artigo é analisar o papel de agentes de suporte à inovação (ASIs) no desenvolvimento de empresas nascentes de base tecnológica (ENBTs) a partir do conceito de assimetria de informações entre os agentes econômicos. Para isso, foi utilizada a abordagem qualitativa de análise comparativa de múltiplos casos em duas aceleradoras de empresas, duas incubadoras e dois parques tecnológicos. De acordo com os dados obtidos e sua posterior análise, foi verificado que os ASIs contribuem para as ENBTs da seguinte maneira: distribuindo informações do mercado, reduzindo, assim, seu custo de pesquisa; favorecendo a formação de suas redes de relações sociais; emprestando sua reputação; e reduzindo o custo de pesquisa de agentes de mercado no que tange o acesso às ENBTs. Não obstante, esses papéis variam de acordo com a natureza

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do ASI investigado. De resto, esta pesquisa pode ser usada como referência para ambos, ASIs e ENBTs, no que se refere ao desenvolvimento de aspectos informacionais e sociais desta última.

Palavras-chave: assimetria de informações, ENBTs, parques tecnológicos, incubadoras de empresas, aceleradoras de empresas.

INTRODUCTION

The innovation is one of the most important aspects of the development of modern societies (Dosi *et al.*, 1990; Grossman and Helpman, 1991). It is directly related to the process of economic development, wealth accumulation and social welfare of the developed countries (Aloi and Lasselle, 2007; Rogers, 2003). An important kind of agent in the promotion of the development and diffusion of innovations in the economy is the new technology based firm (NTBF). Although, at the beginning of its life-cycle this agent face several challenges to access many resources that go beyond the technical aspects (Batjargal, 2003; Paradkar *et al.*, 2015; Rubin *et al.*, 2015).

However, for the development of any kind of firm, not only the NTBF, it is necessary more than technical resources, that is, it is necessary other complementary competencies such as social capital (Grigoriou and Rothaermel, 2013; Hughes *et al.*, 2007; Nicolaou and Birley, 2003; Paradkar *et al.*, 2015; Wang, 2016), positive reputation (Lange *et al.*, 2011; Rindova *et al.*, 2007; Wæraas and Sataøen, 2015), access to information (Felin and Zenger, 2011; Kyriakopoulos, 2011), managerial knowledge (Coster and Butler, 2005; Lockett *et al.*, 2005; Maehler *et al.*, 2009; Luggen, 2004; Paradkar *et al.*, 2015; Rubin *et al.*, 2015) and financial resources (Bertoni *et al.*, 2011; Lindstrom and Olofsson, 2001; Santiago *et al.*, 2014; Wonglimpiyarat, 2016).

To cope with these many challenges, social agents (such as local, regional and national governments, universities, research institutes, etc.) have created or sponsored agents such as business accelerators (BAs), business incubators (BIs) and science parks (SPs) (Campanella *et al.*, 2014; Khorsheed *et al.*, 2014; Ratinho and Henriques, 2010; Schwartz and Hornyh, 2008; Scillitoe and Chakrabarti, 2010; Sternberg, 2014) in order to support the development of NTBFs. Henceforth, these three types of agents will be labeled as innovation support agents (ISAs). Regarding the necessary competencies to the development of NTBFs and the basic role of ISAs cited above, it is possible to infer that the latter have to support the former, facilitating their access to the complementary competencies cited.

Overall, the literature which studies the role of ISAs in the development of NTBFs considers that the purpose of these agents is to provide physical support, basic services, managerial support, and access to social networks (Carayannis e Zedtwitz, 2005). Owing to the social network this literature is

widely developed, approaching elements such as diffusion of knowledge (Choi *et al.*, 2013), social ties formation (Grigoriou and Rothaermel, 2013; Hughes *et al.*, 2007), use of social ties to access important assets to NTBF (Koçak and Can, 2014) and the gain of legitimacy to membership in a ISA (Totterman and Sten, 2005). In the other hand, in the extant managerial literature, there are several articles which address the importance of information and knowledge flows in the development of firms (e.g. Aalbers and Dolfma, 2015; Back and Kohtamaki, 2015, 2016; Batjargal, 2003).

With regard to this, it is necessary to emphasize that the information asymmetry concept has been used as an important instrumental to better understand the development of markets and firms (e.g. Felin and Zenger, 2011; Negro *et al.*, 2015; Skaggs and Snow, 2004). In the context of NTBFs it is recent the studies which analyze the effects of information asymmetry on the development of NTBFs. However, these studies are focused on topics related to the investment flows of investors for NTBFs (Courtney *et al.*, 2017; Freiburg and Grichnik, 2012). Despite its relevance, it was found no article which employs the role of ISA in the development of NTBFs from the perspective of information asymmetry. Particularly, the use of this theoretical lens will permit a systematic analysis of the many roles of the ISAs in the development of NTBFs, thus allowing a better understanding about how ISAs mediate the relationship between NTBFs and the agents of the innovation environment, providing new and valuable insights about this context.

Considering the theoretical gap aforementioned the purpose of this paper is to examine the role of ISAs in the development of NTBFs, from the perspective of information asymmetry among economic agents. The data were collected through in-depth interviews, visits and document analysis of ISAs and NTBFs located in Brazil, configuring a qualitative cross-case research. In line with Paradkar *et al.* (2015), the motivation for this article is based on the assumption that studies in NTBFs in development markets (how is the Brazilian innovation market) are welcome, because of the many specificities and challenges faced by these firms in such environments.

This research was guided by the following research questions: what are the informational roles played by ISAs in the development of NTBFs? and, how do they work? Based on these research questions the following roles of ISAs in supporting NTBFs and their effect were found: (i) distribute market

information to them, reducing their search costs; (ii) reduce the search costs of market agents for facilitating their access to NTBFs; (iii) enable their internal and external social capital formation; (iv) borrow reputation to them, directly or indirectly. In addition, these roles can vary according to the type of ISA and due to its idiosyncratic aspects. Thus, it is presented a deep view of the informational roles of ISAs, rather than the extant literature. Lastly, this research could be used as a reference for both, ISAs and NTBFs in the development of the informational and social aspects of this latter.

CONCEPTUAL BACKGROUND

This section is organized in two parts. First, it is outlined a view of the extant literature about business accelerators (BAs), business incubators (BIs) and science parks (SPs), addressing the main differences and commonalities among these agents. After, the elementary aspects of economic agents' behavior in the real economy is presented through the lens of information asymmetry theory. As search criteria, it was sought by articles related to the three types of ISAs analyzed in this paper, NTBFs and the recognized articles about information asymmetry.

THE ROLE OF ISAS IN THE DEVELOPMENT OF NTBFs

The basic role of the three kinds of ISAs, that is, BAs, BIs, and SPs is to support NTBFs in their development cycle (Bruneel *et al.*, 2012; McAdam and McAdam, 2008; Sofouli and Vonortas, 2007). Therefore, they enable the interaction of their NTBFs with other agents (Aalbers and Dolfsma, 2015; Hansson *et al.*, 2005; Hughes *et al.*, 2007; Rubin *et al.*, 2015; Tötterman and Sten, 2005), allowing the formation of their social capital.

Geographic proximity is a fundamental enabler for the formation of social capital. According to Schiavone *et al.* (2014), this situation enables knowledge flow and enhances the intellectual capital of the NTBFs. Hence, it leads to a collective learning process among NTBFs hosted in the same ISA (Choi *et al.*, 2013), establishing what could be labeled as internal social capital.

The ISAs may give support to its tenants in issues such as public image (Chan and Lau, 2005) and the access to external environment agents, what could be named as external social capital. For instance, ISAs can facilitate the access of their NTBFs to financial agents to obtaining financial support (McAdam and McAdam, 2008; Santiago *et al.*, 2014). In other hand, ISAs can mediate the contact between their NTBFs and university's agents in the sense of the use of laboratories and consulting services in technical or managerial issues (Maehler, 2009; Villasalero, 2014).

In addition, ISAs can facilitate the access of their tenants to information about market agents, clients and so forth (Hughes *et al.*, 2007; Jones and Jayawarna, 2010; Sofouli and Vonortas, 2007). In short, the common point among these

three kinds of ISAs is to provide a positive ecosystem to the development of NTBFs (Khorsheed *et al.*, 2014). Hence, a kind of beneficial result of grouping firms in an ISA is the positive effect of industrial districts (Cooke, 2002; Gebhardt, 2013; Gnyawali and Srivastava, 2013), as a way to obtain synergies through more interaction among firms. Some examples of positive effects are equipment sharing, knowledge sharing (Koçak and Can, 2014; Pauwels *et al.*, 2016), and the creation of specialized services for their tenants (Santos *et al.*, 2015; Schwartz and Hornych, 2008).

Once BAs, BIs, and SPs have been labeled here under the same terminology (*i.e.* as innovation support agents), there are among them common points, already cited above, but there are differences too. While BAs and BIs are dedicated to supporting NTBFs in their early development stage, in fundamental aspects such as physical support and strategic and managerial orientation (Khorsheed *et al.*, 2014; Rubin *et al.*, 2015; Schwartz and Hornych, 2008; Scillitoe and Chakrabarti, 2010; Vanderstraeten and Matthyssens, 2012), SPs give support to NTBFs that already overcome their early development stage. They also provide Sphysical structure for their tenants, but in this case, the physical space is considerably larger and more developed than in BAs and BIs (Campanella *et al.*, 2014). Additionally, these parks can play a strong role as social capital catalysts to their NTBFs (Hansson *et al.*, 2005).

Lastly, what distinguishes BAs from BIs is that the former has normally a private nature, whereas there is a more proactive action of these in their tenant's life, due to the fact that they have part of the ownership of their tenants (Pauwels *et al.*, 2016) and consequently a clear incentive to their economic development.

THE ECONOMIC AGENT'S BEHAVIOR UNDER ASYMMETRIC INFORMATION

According to the assumptions of Classical Economics, a market is characterized by homogeneous suppliers with not differentiated products; the agents have complete information about the products and full rationality in their decisions; the behavior of other agents is always reliable and there is no opportunistic behavior (Samuelson and Nordhaus, 1989; Sowell, 2006).

Nonetheless, these assumptions were systematically contested by scholars along to the 20th century. Thus, firms as well as products and clients are generally heterogeneous in real markets (Andersén, 2011; Barroso and Giarratana, 2013; Guedri and McGuire, 2011; Harrison and Kjellberg, 2010; Porac *et al.*, 2011; Porter, 1980).

In this same vein the remaining premises, *i.e.*, complete information, full rationality and no opportunistic behavior were carefully investigated by many contemporary economists. Starting from the complete information premise, George Stigler in a seminal paper (Stigler, 1961), using two

hypothetical examples of consumers searching for prices of dealers, suggests that information is not regularly distributed through the market. Thus, to obtain certain information an agent will incur in a search cost. Accordingly, the economic system is marked by considerable information asymmetries among economic agents (Akerlof, 1970; Skaggs and Snow, 2004). This situation many times leads people as well as the whole economic system to seek ways to reduce the search costs (Chiou and Droge, 2006; Harris and Blair, 2006). A relevant aspect of the search costs is that depending on the situation, the cost of a complete search in a market is not economically feasible. According to Stigler (1961), a way to cope with this problem is to develop specialized traders, whereas he cites car dealers as market agents who reduce the search costs. Finally, another agent that can play the role of linkage agent is the broker (Aval and Maimon, 1978; Johnson and Schneider, 1995). Although the brokerage process frequently is used in the context of economic transactions, it can also refer to knowledge and information brokerage, mainly in the context of high-tech firms (Larsson *et al.*, 2011; Verona *et al.*, 2006).

Regarding to the decision process the economic agents are bounded due to their cognition, as well as, by the information available to them (Simon, 1957; Tversky and Kahneman, 1974). As such, in a decision the individual will use judgment heuristics as a way to facilitate their decisions. In addition, the transactions between economic agents in real life are susceptible to opportunistic behavior. In fact, bounded rationality and opportunistic behavior are the two fundamental premises of Transaction Costs Economics (Williamson and Winter, 1993; Williamson, 1996) which assumes that the transactions between economic agents are subject to costs due to these two aspects. For cope with this situation, the economic agents will seek to establish a positive reputation in their environment (Williamson and Winter 1993; Williamson, 1996). From the perspective of information economics, these efforts could be interpreted as information signaling (Spence, 1973).

Particularly, the problem of opportunistic behavior renders important the social ties in the real economy. These ties are established through the time between economic agents, which establishes mutual trust what will facilitate the information flow, exchanges and cooperative activities among them (Back and Kohtamaki, 2015; Back and Kohtamaki, 2016; Hughes *et al.*, 2007; Koçak and Can, 2014; Robson *et al.*, 2008). Freiburg and Grichnik (2012) studied the context of investment in NTBFs and concluded that many of these firms attempt to reduce the information asymmetry between investors, through the establishment of direct or indirect social ties and building mutual trust.

In this context, the individuals will seek to build a positive reputation about their behavior (Rindova *et al.*, 2007; Wæraas and Sataøen, 2015). Thus, the reputation will give credibility

to the individual in his social context, facilitating their relationship with other agents of his environment (Freiburg and Grichnik, 2012; Lange *et al.*, 2011) and as consequence favoring the realization of economic transactions (Clots-Figueras *et al.*, 2016).

Lastly, in a environment susceptible to the opportunistic behavior, in the competitive scenario the agents will try to build differentiation from their competitors (Tan *et al.*, 2001), emitting market signals (Spence, 1973). This signals refer to purported actions which communicate a given positive aspect of the agent to the market (Skaggs and Snow, 2004; Sorenson, 2013; Negro *et al.*, 2015). Thus, emitting these signals firms can increase its probability of attain the preference of customer, investors or other kind of agents in the context (Gao *et al.*, 2016). In the NTBFs' scenario Courtney *et al.* (2017) find out several efforts of NTBFs to reduce asymmetry between investors, through the use signals. Additionally these authors also consider the importance of the endorsement of important contextual players in rendering legitimacy to these firms and facilitate their funding by investors.

Relating this present article to the concept of information asymmetry, it is important to investigate how ISAs attenuate the information asymmetry aspects for NTBFs and agents of the innovation context. In this vein, there are introduced three constructs (pure informational aspects; informational aspects from perspective of social capital; informational aspects from the perspective of reputation) which guided the data collecting and analysis which the main elements are presented at Table 1.

Table 1. *The three constructs elicited a information asymmetry.*

Construct	Related elements
Pure information aspects	The real economy is marked by the heterogeneous distribution of the information among the economic agents; to obtain information the agents will incur in search costs; to reduce the search costs the individual normally will use judgment heuristics.
Informational aspects from the perspective of social capital	The social relationship between two agents based on mutual trust will decrease the costs and improve the information and knowledge flow between them.
Informational aspects from the perspective of reputation	The firms in a competitive environment can seek to develop a positive reputation and as consequence to obtain the preference of customers and other kinds of agents, in the sense of improve their situation.

METHOD

In this research, the term ISA means the agent which the purpose is to give support to the development of NTBFs in a determined stage of their life-cycle. It was researched three types of ISAs, namely: business accelerators (BAs), business incubators (BI) and science parks (SPs). A fundamental aspect of data collection in a research is to choose key people to interview (Paradkar *et al.*, 2015). In this regard in the ISAs visited were interviewed professionals directly related to their board, with deep knowledge about the historical process of their respective agent. The basic aspects of the ISAs visited are presented in Table 2. It was visited a total of six agents, divided into two BAs, two BIs, and two SPs, all located in Brazil.

To avoid the bias of building the data analysis in the evidences of only one kind of respondent, for obtain more reliability to the findings it was visited thirteen NTBFs located within the ISAs researched. This approach was used as triangulation strategy (see Cabigiosu *et al.*, 2015; Pauwels *et al.*, 2016; Wæraas and Sataøen, 2015) allowing the comparison of data of multiple sources. In each NTBF was interviewed at least a member of this board. The data about the NTBFs visited and their professionals interviewed are presented in Table 3. The empirical data collected in ISAs, as well as in NTBFs were of three types, semi-structured interviews by the use of a research protocol (see Appendix), documents provided by the interviewed, or accessed at the websites of these agents and direct observations.

The choice of these research objects was according to their accessibility and representativeness to this research. The data were collected from the second half of 2015 until the first half of 2016. The interviews lasted between 40 and 75 minutes and were tape-recorded and after coded. All interviews were

conducted in Portuguese and the quotations presented in the Results section were translated from Portuguese to English.

Given that the main purpose of this article is to analyze the role of ISAs from the perspective of information asymmetry, the following research questions guided this work: what are the informational roles played by ISAs in the development of NTBFs? and how do they work? Thus, the research protocol contains questions about three referential points: (i) pure informational aspects; (ii) informational aspects from the perspective of social capital; and, (iii) informational aspects from the perspective of reputation. This type of research questions, beginning with "what" and "how", demanded a deep investigation of the research object, thus, the qualitative case study approach was considered most appropriated to carry out this research (Eisenhardt, 1989; Voss *et al.*, 2002; Yin, 1994).

The qualitative research normally allows a deep view of the interaction between researched agents and their external context (Larsson *et al.*, 2011; Voss *et al.*, 2002; Yin, 1994), what is in consonance with the purposes of this research. Another purpose is to allow the comparative analysis (e.g. Bäck and Kohtamäki, 2015, 2016; Cabigiosu *et al.*, 2015; Pauwels *et al.*, 2016). In fact, the analysis of two agents in each class of ISAs (i.e. BAs, BIs, and SPs) allows a comparative view between the individuals of the same class, as well as a comparative view between individuals of different classes. In another hand, the analysis of different types of ISAs leads to the identification of differences and common points among each type.

DATA ANALYSIS AND VALIDITY

The open coded was used as approach to analyze the data (e.g. Jennings *et al.*, 2005; Tenzer and Pudielko, 2015). Accordingly, the data analysis was performed in the following steps. Firstly the record of the interview was coded, whereas a semantic code was assigned to each minute of recording, referring to the respective issue approached. In the second step it was coded the notes generated during the visits and the documents released by interviewees or obtained through the visits to websites of ISAs and NTBFs studied. From these codes it was compiled the roles of ISAs in the development of NTBFs, whereas the researchers also sought to identify differences and similarities according to each specific type of ISA. The third step lead to group the results according to the three constructs which guided this analysis, i.e. pure informational aspects, informational aspects from the perspective of social capital and informational aspects from the perspective of reputation. To perform the triangulation of data two separated documents were generated, where one contained the data compiled from the ISAs and other containing data from the NTBFs. This allowed the triangulation process and the generation of a final synthesis about the role of the ISAs in the development of NTBFs. An inherent aspect of the qualitative research is its limitation in allowing generalizable conclusions. It is also present in this research, what gives the inductive

Table 2. ISAs visited.

Name of the agent	Agent type	Professional interviewed
Alpha Business Accelerator (ABA)	Business Accelerator	CEO and shareholder
Beta Business Accelerator (BBA)	Business Accelerator	CEO and shareholder
Delta Business Incubator (DBI)	Business Incubator	Assistant CEO
Gamma Business Incubator (GBI)	Business Incubator	Assistant CEO
Epsilon Science Park (ESP)	Science Park	Assistant CEO
Zeta Science Park (ZCP)	Science Park	Executive CEO

Table 3. *NTBFs researched.*

Name of NTBF	Host	Interviewee	Industry and products
Beta-Eco (BE)	BBA	Two manager-partners	Software and hardware to control of waste produced by restaurants.
Beta-Broker (BB)	BBA	Two manager-partners	Software that allows brokerage between famous bloggers and malls.
Beta-Logistics (BL)	BBA	Manager-partner	Software and hardware to allow the management and scheduling of courtyard of big companies.
Delta-Education (DE)	DBI	Two manager-partners	Software to assist children and teenagers in their scholar activities.
Delta-Applications (DA)	DBI	Manager-partner	Consulting and development of applications to independent inventors.
Delta-Sites (DS)	DBI	Two manager-partners	Development of frameworks which allow the own firm develop this own website.
Gamma-Buss (GB)	GBI	Manager-partner	Software to control bus flow in urban areas.
Gamma-Sensors (GS)	GBI	Manager-partner	Sensors based on new materials.
Epsilon-Car (EC)	ESP	Manager-partner	Applications and hardware to extract data from cars during its usage.
Epsilon-Consulting (ECG)	ESP	Manager-partner	Development and application of managerial methodologies to support mature firms and NTBFs.
Epsilon-Nano (EN)	ESP	Manager	Development of carbon nanotubes.
Zeta-Education-Games (ZEG)	ZSP	Owner	Software (educational games).
Zeta-Agribusiness-Software (ZAS)	ZSP	Owner	Software (management information systems to support agribusiness).

character to it. Thus, it is not possible to generalize these findings to the entire population of Brazilian ISAs. Although, this assumption is true only regarding variations of specific aspects of these agents, as the presence of certain managerial services, or the intensity of the support to the social capital formation in NTBFs. Therefore, a purpose of the qualitative research is to allow the elaboration of new theories (Voss *et al.*, 2002; Yin, 1994). This occurs because normally qualitative research allows researchers to identify determined constructs that could be generalized to a class of agents. Additionally, the use of multiple case studies helps enhance the external validity of the findings of this research.

The conceptual generalization in this research is undertaken with the presentation of ISAs' general roles in the development of NTBFs, from the perspective of information asymmetry. Even though the found roles of ISAs can vary in intensity and form in each particular case studied, all of these are present in the ISAs (e.g. internal and external social capital; reputation;

etc.), independently of its specific type, which can give external validity for this research (Villarreal and Calvo, 2015) and can be used as reference to understand any type of ISA, regarding specifically its role in reduce the information asymmetry between NTBFs and agents of the innovation context.

RESULTS

This section is organized in three subsections. The first presents the informative roles of ISAs to the NTBFs. Next, it is presented the roles of ISAs in supporting the internal social capital formation among its NTBFs and the last subsection presents the roles of ISAs in their external social capital formation.

THE INFORMATIONAL ROLE OF ISAS

Table 4 summarizes the main informative roles of ISAs researched. All ISAs constantly receive information about the

external context and distribute them to their tenants, which in turn reduces the information asymmetries (Akerlof, 1970; Skaggs and Snow, 2004) between their NTBFs and the market. The most of them are associated with innovation promotion agencies, which constantly send to them, information about innovation events (funds; tournaments; ...), which is redistributed to their tenants. Regarding this, the interviewed CEO of GBI states: "From the moment that a new firm is registered here, all [information] we receive about innovation, entrepreneurship, events, courses, [etc...] is passed to them [NTBFs]". Some ISAs visited give support to their NTBFs performing market research. At this respect ZCP's manager cited that he have given support to one of these firms, which products were based on the intensive use of energy, in order to foresee the market trends and reevaluate its market, whereas he states: "We brought a specialist – an electrical engineer – for conduct a long-range viability study, in the sense of forecasting the marketing fluctuations in the next years". Additionally, the CEO of GBI states: "We have here trainees that work only searching about public support programs [...] to inform our NTBFs".

Another informational role identified is when the ISA supports its tenant to reach some market resources. Some examples of resources are investors, specialists (as in the case of ZCP cited above), clients, among others. In many of these situations, information about market resources is already in the ISAs' memory, that is, in the mind of its workers and distributed to its NTBFs reducing their search costs (Stigler, 1961). Hence, when some activity is required by a tenant, the ISA may support it with specific information. It is useful to highlight, that in this case there is more than simple information at the situation, that is, the ISA will make use of its social network to facilitate the access of one of its tenants to such resources. As an example of this, it is presented the following quote of the BBA's manager:

So, whether a firm needs to receive an investment. I see its profile, the investment funds' profiles and perform the match [between the firm and investor] and tell [to this firm]:

– Look to this fund, it could be a good fund for you. And I personally present the firm to the fund (BBA's manager).

Lastly, another ISAs' information role identified is to become a reference to external agents, as a place which gathers innovation firms, hence, acting as a technological broker (Larsson *et al.*, 2011; Verona *et al.*, 2006), reducing the social searching costs (Stigler, 1961). In this case, the ISAs become a reference agent to external agents who seek to some specific resource based on innovation. With this respect the manager interviewed in the ESP told that due to the fact that currently the concept of SP is well known, when a determined agent needs to access a determined innovation resource, he seeks for this SP, as follows: "In another day, the [A world big company] made contact with us and said: 'We would like to present ourselves, we would like to present how we are now, we would like to hear your companies'". In this case, the purpose of this big company was to attempt to establish ties with this SP and its NTBFs.

The search of ISAs by external agents can be interpreted as an instance of the availability heuristic (Tversky and Kahneman, 1974), once these agents assume a direct association between NTBFs and ISAs and do not consider NTBFs which are not installed within ISAs.

THE INTERNAL SOCIAL ROLE OF ISAS

Another role of ISAs is to provide a basic environment to the development of the social capital among their tenants. The many ways that this role was performed are presented in Table 5.

Firstly, it is well known in the literature the importance of the provision of physical space and basic services of ISAs to their tenants. In all cases, the ISAs interviewed related to provide these resources. Further, all interviewees stressed the importance of these aspects to the development of firms. However, in two cases, the ABA and ESP, the CEOs interviewed indicated that it is accepted non-resident

Table 4. Types of ISA's information services.

Information role	Content
Information Hub	Receives information about the external environment and distributes to their incubates and vice-versa.
Environmental Search	Gives support to their tenants to seek marketing resources.
Market Resources Broker	Gives support to their tenants to access marketing resources.
Environmental Reference	Becomes reference to external agents.

Table 5. *Types of support of ISAs to internal social capital.*

Social role	Content
Providing physical space	Facilitates the formation of a social system within and among tenants.
Periodical advisory or control meetings	Allow the formation of social ties between tenants and ISAs professionals.
Internal Speeches	Promotes indirectly the interaction among tenants.
Support informal flows	The constant interaction allows the information flow among the tenants in aspects such as market opportunities, managerial and technical.
Facilitates formal partnership	The constant and near contact of tenants could favors the establishment of formal partnerships.

NTBFs, that is, it is accepted NTBFs that are not located within the sites of this agents.

As a general view, all interviewed believe that the physical space is fundamental to allow the formation of social ties within and among NTBFs. In this regard, the CEO of ABA stated: "Our tutors are here. It is not useful the tutor stays here and a startup stays abroad throughout all the working period that the persons are here". According to him, the proximity facilitates the contact between the accelerator and its tenants and consequently streamlines the activities of these agents. In another hand, owing to the interaction between firms of an ISA the owner of ZSP states "I am in a science park, I seek a science park believing that the relationship between NTBFs can enhance the development of all them". Except in the case of ESP, it was observed in all remaining ISAs the performing of periodical advisory or control meetings, with their tenants. It was observed in the cases of BAs and BIs control meetings, and in the case of ZSP was observed more frequent advisory meetings and annual control meetings. Besides the substantial purpose of a meeting, that is, to advise or control the activities of a tenant, as an involuntary result, it is established a social tie between the professionals of NTBFs and ISAs, which facilitates the day-to-day contact and the interaction between these agents.

All ISAs' managers reported they promote internal business meetings, with the purpose of empowering its tenants and promote more interaction among them. The behavior indirectly can shape the internal social capital among the ISAs' tenants (Aalbers and Dolfsma, 2015; Hansson *et al.*, 2005; Hughes *et al.*, 2007; Rubin *et al.*, 2015; Tötterman and Sten, 2005). As a result of social interaction, it was frequently reported by the interviewed the frequent exchange of information about marketing, business opportunities and even technical issues among tenants, what is in consonance with literature (Koçak and Can, 2014; Pauwels *et al.*, 2016).

In more mature developments of internal social capital among NTBFs, it was found the establishment of formal contracts among some of them. These relationships were expressed in the form of consulting services provided by a tenant to another, such the case of ECG, who provided managerial and strategic counseling to the EN, both hosted within the ESP. Another type of formal relationship found was the establishment of formal partnerships to the development of products. An example of this situation was found in the ZAB which established a partnership with another firm of the ZSP (It was not visited in this research) to develop a specific software to one client.

THE EXTERNAL SOCIAL ROLES OF ISAS

Table 6 summarizes the social roles of ISAs as the linkage agent between its NTBFs and the external environment, that is, as the function of technological broker (Larsson *et al.*, 2011; Verona *et al.*, 2006). Firstly, mentorship is an approach commonly used by BAs and BIs. A mentor is a person with recognized competence and expertise in a determined issue, acting in the market and/or the academy. In this respect, a manager partner of BE states: "Every week they [ASI] brought some specialized professional of market [mentor] to talk of some interesting issue with us. This week came a professional to talk about social network, wherein we can ask him about some topic...". Thus, the ISA typically seeks to mentors in the sense of obtaining general or specific advisory counseling to its tenants. However, this approach was not found in the case of SPs, whereas host firms are in a more advanced stage of development than those hosted in BAs and BIs.

Another social role identified in some ISAs is that they facilitate the access of its tenants to specific resources which are in the external environment. It was identified especially in the case of the two BAs, which had constituted a solid network

of several kinds of agents, such as professional services and investors (McAdam and McAdam, 2008; Santiago *et al.*, 2014), and use this to favor its tenants, whenever they need some specific external resource. Owing to this the CEO of ABA argues about the role of this BA in select investors and introduces its NTBFs to them: "If the firm [NTBF] is able to receive investment, I assess the investment funds [...] and I personally introduce the firm to the investor".

Another important ISAs' social role is the facilitation of contact of tenants with big companies. These companies are widely known companies which operate in varied industries such as automobilist, mining, electric components, telecommunications, and so on. This type of relation with these companies was found in the SPs and one BA. This kind of contact could be used to facilitate the presentation of firms to big companies, hold business meetings and eventually establish partnerships.

Only in the case of GBI was verified the promotion of events to divulge the innovations concepts and values to the local community and to the university which it is installed.

The facilitation of access of tenants to universities resources was found in the case of the SPs and BIs. This access is mediated by the level of the relationship previously maintained by NTBFs with universities' researchers (Maehler *et al.*, 2009). But when necessary some ISAs' managers reported searching for university support in the sense of meet some tenant's demand. This aspect can be observed in the speech of the manager interviewed in the DBI that pointed out: "Whenever the firm needs a test in a laboratory or a consultancy of one researcher from here [university], we intermediate this need and get this support". He notes the case of an incubated firm who actuates in the polymer industry and got access to the laboratories of the university which this ISA belongs. Accordingly, in the case

of ZCP, all NTBFs assumes in the contract with this ISA the commitment to maintain at least one kind of contact with the university which this ISA belongs.

Lastly, another aspect widely observed in all ISAs is the importance of their reputation to their tenants. It was identified in a general form that tenants could "borrow" reputation of their hosts, in the sense of improving their reputation and then gain access to agents of the external environment as investors, potential clients, big companies, and so on. This borrowing process occurs in two main forms, by the use of own host's reputation, or by the use of the university's reputation which the ISA is associated. Regarding the second form, the manager of ZCP claims that is relevant the association of its NTBFs to the university which this park belongs, whereas the contract of these firms with this park allows them to mention explicitly its association with the park and consequently with the university. In this case, the NTBFs indirectly can "borrow" the reputation of the university which the ZCP belongs, what could be considered an indirect reputation borrowing process. In this same vein, a manager partner of DE claimed that: "the fact our being hosted in an incubator inside a university is particularly important for us in presenting ourselves for clients, whereas we bear the name of the [university]". Finally the manager of ESP claimed that the membership of small NTBFs to this park allows to them the access to big and important market players, which would not be possible to these firms in other situation.

DISCUSSION

Analyzing the data presented in the previous section from the perspective of asymmetric information, it is possible to conclude that as well as in real economy, the innovation

Table 6. *The external social role of ISAs.*

External social role	Content
Tutorship	Allows the flow of knowledge between tenants and the external agents with expertise in a determined issue.
Access to specific resources	Allows the tenant access external resources such as investors, professional services.
Access to big companies	Some ISAs seek to establish contact with executives of big companies to help their tenants to facilitate the contact in the corporate environment; some ISAs were sought by big companies to strengthen their ties thanks to their reputation.
Divulcation of events in the community	The ISA can promote events in the community to propagate innovation concepts and establish partnerships to its tenants.
Access to universities laboratories and researchers	The ISA can help its tenants to reach access to university laboratories and partnerships.
Reputation borrow	The tenant can borrow the image of the ISA or the university which it is associated to presentations to the external agents.

scenario is marked by information asymmetries, what corroborates the main considerations of Stigler (1961). As an example, if an innovation event is promoted by a foment agency, not necessarily all NTBFs for what this event is relevant will immediately know about that. For one NTBF to know everything about the innovation scenario by itself, it would have to incur in considerable search cost, that is, it would be necessary to maintain at least an employee to regularly monitor the innovation scenario, what would be an expensive and thus little feasible activity for this firm.

However, the association to one ISA will decrease considerably these search costs, what corroborates studies of Chiou and Droge (2006) and Harris and Blair (2006), once these agents receive innovation information from the agents of innovation scenario and transfer it to the NTBFs. Thus, follows the first proposition:

Proposition 1: The ISA has the function of gathering information of the innovation context and broadcasting it to their ntbf's, reducing their search costs.

From the market perspective, whereas the amount of ISAs is lesser than NTBFs, there is less effort of the agents of the innovation scenario to spread information to the ISAs, rather than to spread it to NTBFs directly. Thus, it is possible to assume that agents of the innovation context will reduce their costs to inform NTBFs whether they distribute information to ISAs, for subsequent transference to their NTBFs, what corroborate the broker role concept (Stigler, 1961). Also, it was possible to detect that agents of innovation context seek to one type of ISA when they need a determined solution. In this case, maybe to seek for innovation agents in a myriad of firms, the external agents look for ISAs to find an NTBF which can help them to solve a given problem.

In other hand, the ISAs usually also have privileged information about the market, which can be transferred to their residents when demanded. It was overt in the case of BBA, who reported that brokered the relationship of its tenants with investment agents. In a general way, the ISAs' experience and knowledge about the market can be used in the counseling their NTBFs. As a conclusion, ISAs act as linkage agents between NTBFs and the innovation context agents. Hence, they should be considered as innovation brokers, as cited in the literature (Larsson *et al.*, 2011; Verona *et al.*, 2006).

Considering the differences found in this respect concerning the different types of ISAs, SPs revealed to be sought by external agents to help them to find an NTBF to solve a specific need, what was not reported by BAs and BIs. This result is likely because that the external agents look for more developed NTBFs, that is, consolidated firms, and not beginners, as is the case of firms installed at BAs and BIs.

Complementing this discussion from the insight of the Bounded Rationality, all economic agents will be limited in

their capacity to obtain all information about the objective reality. Thus, according to Simon (1957) they normally seek to a satisfactory solution, maybe optimal one. In the context of this research, it would be inferred that some external agents normally use the ISAs as a heuristic artifact to facilitate the search for one NTBF with a certain competence. By the insight of Tversky and Kahneman (1974), this type of search can be considered as an availability heuristic instance. In other words, when an external agent searches for an ISA for one given necessity or an NTBF seeks to an ISA to find some kind of external agent (that is, a mentor or an investor), they are using the availability heuristic. Thus, follows the second proposition:

Proposition 2: The ISAs are used by external agents and by their NTBFs as a form of availability heuristic to reduce their respective search costs.

Until here the treatment of the information concept received the connotation of a purely metaphysical phenomenon, that is, as the meaning of the state of an object in the reality. Indeed, the psychosocial aspects embedded in the information were not considered yet. In other words, it was accounted only its impersonal aspects, for instance as the existence of a public innovation tournament, or a financing, or another event of interest of an NTBF. However, although the meaning of the state of an object is relevant, that is, the information about it, from the perspective of a transaction between two economic agents, another concept is required, that is, the opportunistic behavior concept (Williamson and Winter, 1993; Williamson, 1996).

This situation is undercurrent in the case of negotiation between car dealers and clients, as showed in the "The Market for 'Lemons'" (Akerlof, 1970). Thus, as previously presented, in the real economy, the susceptibility to opportunistic behavior is a fact of the real life. As a consequence, the economic agents in their transactions can seek additional information about the conduct of agents involved in a transaction.

In the context of this research, it was observed that the reputation of ISAs is used for presenting NTBFs to potential clients. A belief of many interviewed is that the ISAs' reputation can "open the doors" of marketing agents, as clients, investors and other kinds, facilitating the access of NTBFs to them. It was observed that NTBFs "borrow" the reputation of the ISAs, whereas there is a general belief that the association to one ISA brought positive effects to NTBF's image. Thus, this situation is labeled as a first-grade borrowing situation.

Additionally, it was also observed what could be called as the second level borrowing reputation. In this case, the ISAs' reputation is tied to the reputation of the university which it is associated. Thus, it can be concluded that in some cases the NTBFs borrow reputation from the ISAs, and in turn from the university which it is associated. According to many NTBFs interviewed they believe that the association to the university

could be positive to their reputation, and due to this, they "use" its name, that could be considered as signaling phenomena to attain competitive advantage, which is in consonance with the literature (e.g. Skaggs and Snow, 2004; Sorenson, 2013; Negro *et al.*, 2015) and could be considered as a way to reach competitive advantage, reducing the transaction costs for an eventual client (Williamson and Winter, 1993; Williamson, 1996). Thus, with respect to this discussion we can conclude with the third proposition:

Proposition 3: In the attempt of attaining competitive advantage NTBFs "borrow" reputation from the ISAs where they are hosted, in the sense to issue signals to market agents.

Also, it is relevant to consider the influence of ISAs on the social life of their NTBFs. From an internal insight, that is, considering the relation among tenants, the sharing of common resources (Koçak and Can, 2014; Pauwels *et al.*, 2016), the commonplace, and the promotion of frequent meetings where their NTBFs were stimulated to participate enable the formation of a social capital among NTBFs hosted in the same ISA, what is in line with the literature (Aalbers and Dolfma, 2015; Hansson *et al.*, 2005; Hughes *et al.*, 2007; Rubin *et al.*, 2015; Tötterman and Sten, 2005). As a consequence, this internal social capital can be characterized which ties of trust and eventually friendship that produces cooperation among the NTBFs of an ISA. The cooperation can be manifested in aspects such as informal knowledge flows that can eventually evolve to formal partnerships. From this perspective, one ISA's role is to provide a common place which triggers a process of mutual reputation formation.

In other hand, the external social capital formation from the NTBFs is partially analogous to the internal situation described in the last paragraph. That is, the ISA enables the relationship of its NTBFs with its circle of acquaintances. These two prior situations show a strong dependence of the NTBFs in relation to the ISAs in their process of social capital formation. As a result follows the fourth proposition:

Proposition 4: The ISAs enable the formation of internal and external NTBFs' social capital.

As synthesis of this discussion Table 7 presents a resume of the main informative roles of ISAs in promoting the development of NTBFs. Overall, it is possible to conclude that ISAs play an essential role in the development of NTBFs, transmitting and receiving information to the market and their NTBFs, enabling the development of an internal social environment between their NTBFs, and aiding their NTBFs access external agents. However, the role of these agents varies according to the type, BAs and BIs tend to give more support to their NTBFs than SPs wherein their tenants are in their early development stage,

while the NTBFs hosted in SPs are more mature and require less this type of support. Additionally, this research reveals that the level of development of the ISA in the informational support to its NTBFs varies according to individual characteristics.

CONCLUSION

In this article, it was analyzed the role of ISAs in the development of NTBFs from the perspective of asymmetric information among economic agents. So, this analysis was performed with the focus in the mediator role of the ISAs in the development of relations of an NTBF with other hosted NTBFs and with external agents of the innovation context. As a main result, it will be possible to conclude under this analysis, that ISAs play a crucial role in the development of informational and relational aspects of NTBFs. Specifically these agents: reduce the marketing search costs of NTBFs and agents of the innovation context; they play a natural role as a hub that receives information of their external environment and distributes them to their NTBFs; they lend its reputation to their NTBFs to access agents of the innovation context; and they provide the basic requirements for the formation of external and internal social capital of NTBFs.

The contributions of this paper can be subsumed in two classes, namely empirical and theoretic: from the empirical perspective the use of the qualitative method allowed to understand in depth the informational role of ISAs in the development of NTBFs. As such, it was possible also to compare these roles in these three different types of ISAs, namely, BAs, BIs and SPs. Additionally this paper introduces new insights about the informational role of ISAs in the development of NTBFs. This task is performed under the three mains constructs, pure informational aspects, informational aspects from the perspective of social capital and informational aspects from the perspective of reputation which permitted a systematic and deep view about how ISAs play an important role in the innovation environment reducing informational costs between NTBFs and market agents.

From the theoretical perspective this paper presents as main contribution an analysis of the relationship of ISAs with NTBFs and agents of innovation environment under the theoretical lenses of information asymmetry. In this context, the four propositions introduced at the previous section make a synthesis which consider that the ISAs consists of a social agent that reduce substantially the information asymmetry between agents of the innovation environment, and enhance the efficiency of this economic context with actions that involve gathering and distributing information, and the formation of internal and external social ties between NTBFs and other agents of the innovation context.

Additionally, the use the theoretical lens of information asymmetry to research ISAs and NTBFs seems to be new. In effect, this approach permitted a systematic analysis of

Table 7. *Synthesis of the role of ASIs in reducing the information asymmetry of the innovation environment.*

Information issue	Role
Pure information	- The ISA acts as an information hub, receiving and gathering information of the environment and transmitting it to its NTBFs. - Particularly AEs and IEs can perform active market search monitoring relevant events in the market. - The ISA can facilitate the access of its NTBFs to market resources. - The ISA can serve as a market reference to external agents which seek to NTBFs with specific capabilities.
Informational aspects from the perspective of social capital	- A role of the ISA is to provide the basic element to the formation of an internal social environment among its NTBFs. - The internal social environment is enabled by the physical interaction and by the promotion of internal meetings. - The formation of internal social environment can leads the NTBFs to establish formal partnerships to meet specific market demands.
Informational aspects from of the perspective of reputation	- Particularly BAs and BIs intermediate the contact of its NTBFs with mentors. - The ISA can intermediate the contact of its tenants with investors. However AEs seems to play a more active role in this task. - The ISA can intermediate the relationship of its tenants with big companies. However, this situation seems to be more prominent in SPs, due to this tenants are in a more developed stage, which enable them to offer services required to big companies. - SPs and BIs play a more active role than BAs in intermediate the relationship of their NTBFs with universities. This situation probability occurs due to the greater proximity of relationship of these agents with universities. - The NTBFs can borrow reputation of their ISAs, in the sense of create a cognitive reference and a positive image to the market.

aspects such as searching costs, the effect of reputation and social issues on the development of NTBFs. Additionally, other contribution consists in propose several constructs inside these three categories, hence, providing more capillarity to the concepts of informational, social and reputational issues. Finally, a subjacent aspect of this paper is recognize that the intangible aspects related to the ISAs and NTBFs are extremely important to the development of this type of firm and as consequence shedding light on these issue.

The results presented in this paper have implications to the practice for both, ISAs and NTBFs. Owing to the ISAs, the revelation that these agents develop a relevant role in reducing the information asymmetries between NTBFs and agents of innovation environment and in the insertion of these firms in social networks, should lead to the development of deliberate plans, by both ISAs and NTBFs, approaching the development of these capabilities. Owing to ISAs this study can be used as a reference guide to the development of informational and social capabilities to continuously give better support to their NTBFs. Referring to NTBFs this study can guide their CEOs in the pursuit of continuous development as well as in the selection of the best ISA to stay, concerning its capacity

of development of its informational and social capabilities.

Due to the crucial role of the development of innovation on the economic development, the results of this paper can be used as a roadmap by public agents in the sense of the development of innovation ecosystems, such the kinds of the ISAs studied in this article, capable of providing to the NTBFs and other innovation agents the basic intangible and tangible elements to the development of these firms and as a result generating economic development by the introduction and diffusion of innovations in the society.

As a suggestion for future research avenues, the research protocol used here can be adapted to a survey with the aim of gain insights about the influence of information asymmetry in a larger amount of ISAs and NTBFs, in order to verify the validity of these findings for a larger number of agents. As another suggestion for future research, from a more proactive point of view this paper can provide the basis for the development of a model for assessment of the level of development of ISAs in supporting NTBFs in informational and social aspects, as well as the introduction of a roadmap for the development of the informational and social capabilities in NTBFs.

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APENDIX

RESEARCH PROTOCOL

General data of the organization visited:

- (a) Name
- (b) Activity
- (c) Foundation

General data of the interviewed:

- (a) Name
- (b) Educational background
- (c) Professional position at the organization
- (d) Time working in this organization

Research Protocol Applied in the ISAs

Informational Role

- (a) What is the role of this ISA in receiving and transmitting information to its tenants?
- (b) This ISA gives some kind of support to its tenants to seek and access some specific resource available at the market?
- (c) Is there some kind of advantage for the NTBF hosted here with respect to be located and accessed by external agents?

Internal Social Role

- (a) What is the role of the physical proximity in the interaction of your NTBFs?
- (b) This ISA promotes some kind of events (meetings, speeches, ...) which favor the internal interaction between NTBFs?
- (c) How does the interaction between the agents hosted here? Is it possible to present some forms?

External Social Role

- (a) What kind of activities do you take to promote the interaction of your NTBFs with external agents?

- (b) How do you support the interaction of your NTBFs with investors?
- (c) How do you support the interaction of your NTBFs with universities?
- (d) How do you support the interaction of your NTBFs with market professionals?
- (e) How can the reputation of this ISA help its NTBFs in their relationship with external agents?

Research Protocol Applied in the NTBFs

Informational Role

- (a) Do you receive information of this ISA?
- (b) When you need a given resource available in the market your receive support of this ISA to locate and access it?
- (c) Is there some kind of advantage for this NTBF in being hosted here?

Internal Social Role

- (a) What is the role of the physical proximity with the other NTBFs to their interaction?
- (b) This ISA promotes some kind of events (meetings, speeches,...) which promotes the internal interaction between the NTBFs?
- (c) How do you interact with other agents?

External Social Role

- (a) What kind of activities this ASI take to promote your interaction with external agents?
- (b) How can this ASI support your interaction with investors?
- (c) How can this ASI support your interaction with universities?
- (d) How can this ASI support your interaction with market professionals?
- (e) How can the reputation of this ISA help you in the relationship with external agents?