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Organizational Determinants and Idiosyncrasies of Firms' Absorptive Capacity in a developing country context: preliminary results.

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Abstract
The paper analyzes the organizational determinants of Absorptive Capacity (AC) and its idiosyncrasies for firms from developing countries. Theoretically, it was proposed a "vicious cycle" of limited AC in Latin-American firms. Empirically, it was identified different determinants of Brazilian innovative firm's AC, according to knowledge sources used to innovate: Academic AC is built by external relationship and individual abilities of firm's researchers, while Market AC is determined by better internal knowledge diffusion. Both ACs are not affected by the expenditure in internal R&D, but by the expenditure in the acquisition of external R&D. Both results reinforce the argument of a limited AC in developing countries.

Key-Words: Absorptive Capacity; Developing Countries; Organizational Innovation; Brazilian Innovation Survey (PINTEC); Bivariate Probit.

Resumo
Este artigo analisa os determinantes organizacionais da Capacidade da Absorção (CA) e suas idiossincrasias para firmas de países em desenvolvimento. Em termos teóricos foi proposto a existência de um "ciclo vicioso" quanto à CA limitada das firmas latino-americanas. Empiricamente foi identificado que as firmas inovadoras brasileiras apresentam determinantes da CA diferentes de acordo com a fonte de conhecimento utilizada para inovar: (1) CA Acadêmica é construída através de interações externas e habilidades individuais dos pesquisadores da empresa; (2) CA do Mercado é determinada via melhor difusão do conhecimento internamente. Ambas CAs não são construídas via dispêndios em P&D internos mas sim através dos dispêndios na aquisição de P&D externos. Esses resultados reforçam o argumento de uma CA limitada em países em desenvolvimento.

Palavras-Chave: Capacidade de Absorção; Países em Desenvolvimento; Inovação Organizacional; Pesquisa de Inovação (PINTEC); Probit Bivariado.

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Introduction

Firms are the locus of innovative process but do not innovate independently. Their actions and capabilities are shaped by their interactions with other organizations – universities, governments, competitors etc. – and by institutions and policies. In other words, firms innovate embedded in an "Innovation System".

This paper focuses in one of these firms' capabilities: the capabilities to absorb external knowledge. The absorptive capacity (AC) was firstly discussed by Cohen and Levinthal (1989, 1990) as the firms' abilities to identify the relevant external knowledge, assimilate and exploit it commercially. This concept assumes that the external knowledge don't flow directly and without cost to the firm. Firms need to make some internal efforts to search and use them. Each firm recognize external knowledge as different opportunities and uses them for specific objectives. Firms with high absorptive capacities analyze these opportunities faster and better than others (VAN DEN BOSCH; VOLBERDA; DE BOER, 1999), reducing the uncertainty and improving their expectations about external advances (COHEN; LEVINTHAL, 1990).

Thus, the study of AC permits to criticize the adoption of "supply innovation policies" by developing countries such as Brazil after 2003. These policies focus on the improvement of scientific and technological knowledge and on the development of institutions to enhance university-firm interactions (CASSIOLATO; SZAPIRO; LASTRES, 2015). So, beside the important role of this type of policy, its results are limited if firms do not have real incentives to foster internal capabilities, as AC, that permit them to get benefits from external knowledge. Therefore, the comprehension of AC characteristics permit us to develop more effective innovation policies for developing countries.

However, many of the articles about AC and its determinants focus on developed country context – such as European context (JANSEN; VAN DEN BOSCH; VOLBERDA, 2005; SCHMIDT, 2005) – or did not have a sufficient discussion about idiosyncrasies of AC in the developing country context, as Brazilian studies of De Negri (2006) and Bittencourt and Giglio (2013).Here, we contribute to the literature analyzing determinants and idiosyncrasies of absorptive capacity (AC) of firms from developing countries, especially in Latin America. To do this, the paper is divided in more four sections.

Firstly, the discussion is about concepts and main determinants of AC. In the second section are debated some characteristics of the innovative system in developing countries that indicated idiosyncrasies of the AC's development by firms in these context. The main conclusion is that there is a "vicious cycle" of limited AC in these context. Third, an empirical analysis is presented. It is based on Brazilian Innovation Survey (2009-2014) and it focus on firms' organizational determinants of AC, separating the AC in two: Academic AC and Market AC, similar to De Negri (2006), Schmidt (2005) and Murovec and Prodan (2009). In the end, there are conclusions and limitations

1. Firms' Absorptive capacity: concepts and organizational determinants

1.1. Concept of Absorptive Capacity (AC)

The concept of Absorptive Capacity (AC) was developed primarily by Cohen and Levinthal (1989, 1990) as the firm's abilities to value the new external knowledge, assimilate and apply it commercially. The development of AC is a kind of learning that permits the firm to acquire and to use external knowledge to develop new product, process etc. AC is cumulative, path-dependent and dependent of the prior knowledge base (COHEN; LEVINTHAL, 1989, 1990). However, this concept was refined some years after them.

Zahra and George (2002) redefine AC as a dynamic capability composed by a set of organizational routines and processes by which firms acquire, assimilate, transform and exploit external knowledge in order to get competitive advantages. As a dynamic capability, AC is difficult to imitate and its development should be considered a strategic decision of the firm, must be aligned with business objectives and integrated with different areas of the firm (TEECE; PISANO; SHUEN, 1997).

In addition, Zahra and George (2002) divide the AC into two subsets: potential AC and realized AC. The potential AC enables the flexibility of the firms to undertake changes and to reconfigure its operations, being formed by the acquisition and assimilation dimensions. The first permits firms to recognize the value of the new external knowledge and to acquire them. The second dimension enable the firm to analyze, process and interpret the external knowledge, given the previous knowledge base (ZAHRA; GEORGE,

2002). The realized AC reflects firms' ability to use the acquired knowledge to their objectives, increasing their performance and competitive advantage. This is composed by the transformation and exploitation dimensions. The first refers to firm's ability to develop and refine routines that facilitate the combination of old and new assimilated knowledge, recognizing inconsistencies between them. The second ability refers to routines by which firms change competences and apply commercially the new knowledge (ZAHRA; GEORGE, 2002).

According to Zahra and George (2002), the AC will be efficient when the ratio of Realized and Potential AC is higher, *i.e.* when firm has the capability to apply the new external knowledge, get by Potential AC, to its main objectives. This efficient ratio is determined by the social integration mechanism that connected the potential knowledge with organizational processes to transform and exploit those knowledge. This mechanism will be detailed in next subsection.

The third interpretation of AC is developed by Lane, Koka and Pathak (2006). Criticizing the AC's division of Zahra and George (2002), they consider AC as composed by three learning process. The first – *exploratory learning* – is related to search and experimentation process , bringing variety and new knowledge to firm whose results tend to be observed in the long term (MARCH, 1991). Lane, Koka and Pathak (2006) assume that this first process allows firm to realize the first step of knowledge absorption defined by Cohen and Levinthal (1990): identification of valuable external knowledge. The second process – *transformative learning* – is determined by the process of combining firm's previous knowledge with the new external knowledge, encompassing the assimilation and transformation capability described Zahra and George (2002). The process described is intended to connect the first learning process (exploratory) with the last process (*exploitative learning*). Using March (1991), this exploitative learning is related with short term benefits and the application of this new external knowledge into the development of, for example, new products, new process etc.

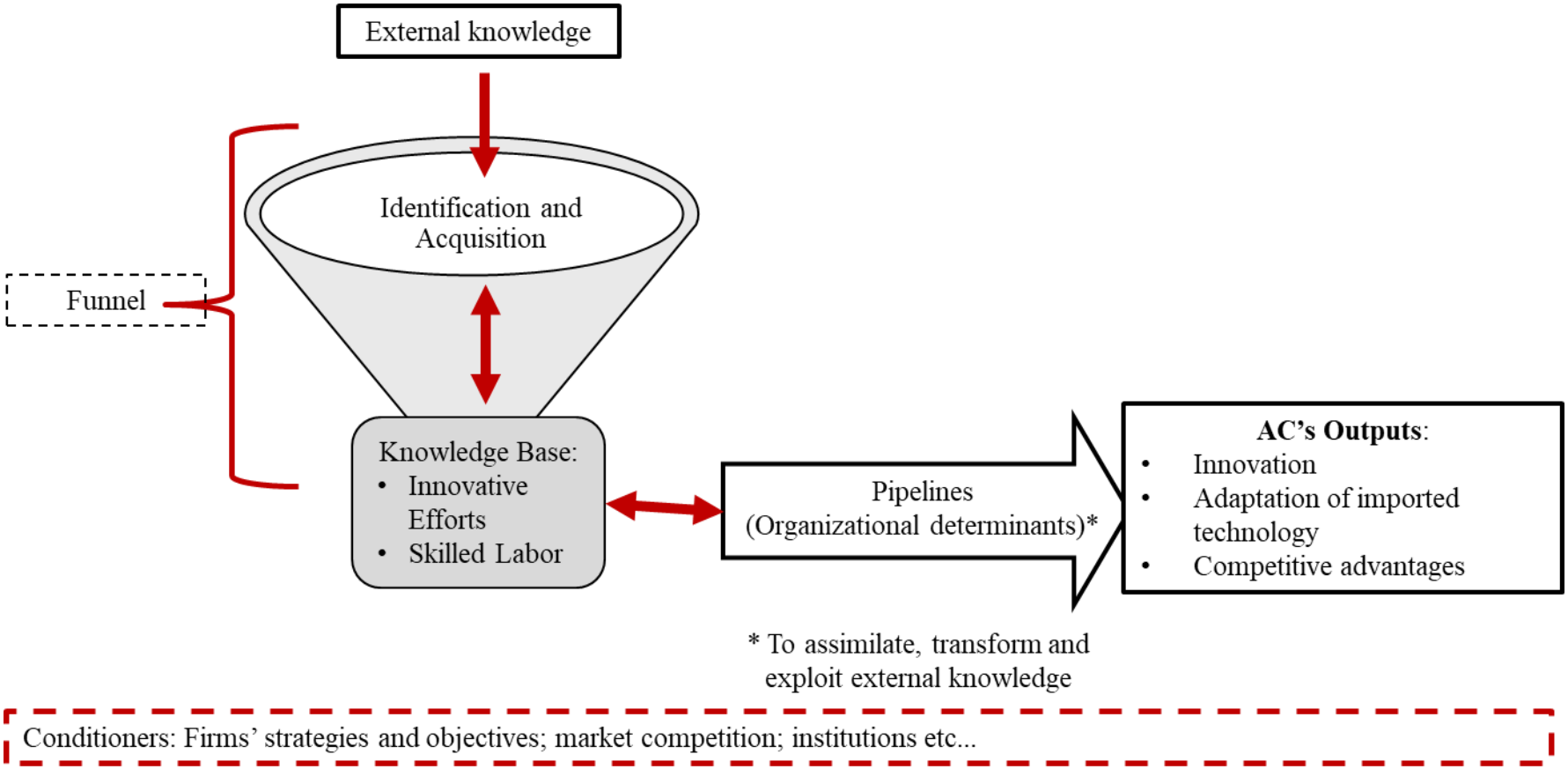
In addition, Lane, Koka and Pathak (2006), analyze AC as a combination between a "funnel" and "pipeline" parts. The "funnel" is related with the first step of AC, when firms search for relevant external knowledge and acquire them. The "pipeline part" represents the internal process to understand, transform and exploit this external knowledge. It is composed by different knowledge management practices and techniques to integrated firm's areas and workers. A well combined functioning of the funnel and pipeline parts of AC allows the firm to get competitive advantage from external knowledge (*i.e.* exploitative dimension) (LANE; KOKA; PATHAK, 2006). The figure 1 represents the AC process, summarizing the discussion.. Its components will be detailed in the next subsection, but the general idea is: (1) First, the firm search for new external knowledge, especially the knowledge close to their knowledge base, which is determined mainly by skilled labor and internal innovative efforts to develop new internal knowledge; (2) second, the "pipelines part" represents organizational practices to internalize the external knowledge, being determined by organizational practices to diffuse knowledge internally and to favor the assimilation, transformation and exploitation of external knowledge; (3) all AC's process is affected by general strategies of the firms and the external environment (as institutions and competition).

1.2. AC's determinants

This section discusses some – not all – intrafirm determinants of AC. A review about this was done by Volberda, Foss and Lyles (2010). The outside determinants will be discussed in the section 2. Following the figure 1, we divide the inside determinants of AC in two sets: knowledge base and organizational determinants.

As suggested by Cohen and Levinthal (1990), firms have a specific knowledge base determined by innovative efforts and by abilities of their workers. Given the cumulative characteristic of AC, firms tend to search and to absorb external knowledge close to their previous knowledge base. More distant is the external knowledge *vis a vis* internal knowledge base, higher is the internal innovative efforts required to absorb then (COHEN; LEVINTHAL, 1990). Many authors found that different external knowledge need different internal areas (BOGERS; LHUILLERY, 2011), innovative efforts (DE NEGRI, 2006; MUROVEC; PRODAN, 2009) or organizational process (SCHMIDT, 2005; VEGA-JURADO; GUTIÉRREZ-GRACIA; FERNÁNDEZ-DE-LUCIO, 2008) to be absorbed.

Figure 1 – Representation of Absorptive Capacity



Source: Own elaboration

Regarding to the first determinant of knowledge base – innovate efforts – the most traditional is R&D. It's responsible to generate new internal knowledge that permits the firm to follow technological frontier closely (NELSON; WINTER, 1982) and to absorb knowledge from market (as customer and suppliers) and universities (MUROVEC; PRODAN, 2009), especially for the last (SCHMIDT, 2005). However, R&D is not the unique. Training efforts improves the "relational empowerment" between workers, favoring the absorption of knowledge (EBERS; MAURER, 2014), especially from the market (BITTENCOURT; GIGLIO, 2013; MUROVEC; PRODAN, 2009). Engineering efforts also influence the absorption of external technologies in the first steps of catching up process (KIM, 1999).

About the workers' abilities (second determinant of knowledge base), De Negri (2006) says that the share of employees with higher degree has bigger effect to absorb complex knowledge than R&D efforts in Brazil. These qualified workers can act as gatekeepers, monitoring, translating and accessing external knowledge and networks (COHEN; LEVINTHAL, 1990). This is especially evident for researchers inside the firm who use their "academic network" (MURRAY, 2004) to solve firm's problems and to access "academic culture" (BRUNEEL; D'ESTE; SALTER, 2010), improving firms' relative capacity to absorb academic knowledge (LANE; LUBATKIN, 1998). In this way, qualified workers realize an important role in the "funnel" part of absorptive capacity, exemplified by the Hyundai's case of AC development (KIM, 1998).

According to Zahra and George (2002), the knowledge base defines the "contents" of AC that drives what kind of knowledge firm tends to absorb. However, this knowledge base is not sufficient to a full development of AC; it is necessary internal organizational process to disseminate knowledge internally, to refine and apply the knowledge base to firm's objectives. These organizational aspects are the "pipelines" in the figure 1 (p. 4), discussed hereafter.

For Zahra and George (2002), internal triggers and social integration mechanism favor the internal knowledge dissemination and the AC's efficiency. These internal triggers incentive the search for new external knowledge and the exploitation of them, exemplified by the internal crisis realized by the South Korean managers during the catching up process of their firms (KIM, 1998, 1999). About the internal dissemination of knowledge between workers, different internal processes are relevant for this, such as: (1) informal mechanisms; (2) internal seminars and workshops; (3) quality circle control; (4) job rotation (SCHMIDT, 2005; VEGA-JURADO; GUTIÉRREZ-GRACIA; FERNÁNDEZ-DE-LUCIO, 2008).

Other kinds of "pipelines" are the combinative capabilities. These capabilities synthesize, apply and combine firms' previous knowledge and external knowledge acquired (KOGUT; ZANDER, 1992). Jansen, Van Den Bosch and Volberda (2005) consider 3 types of them. The first – systems capabilities – represents the "formalization and codification degree" of rules to absorb external knowledge (e.g. use of manuals). This formalization has ambiguous effect on AC because it favors the identification of external knowledge by defining specific guidelines (VEGA-JURADO; GUTIÉRREZ-GRACIA; FERNÁNDEZ-DE-LUCIO, 2008), but it reduce the flexibility and creativity (JANSEN; VAN DEN BOSCH; VOLBERDA, 2005). The second – coordination capabilities – influencing all AC's dimensions, promoting the integration and communication between the employees. The third – socialization capabilities – is related to the building of an internal culture that favors the development of a dense internal network that incentives the knowledge sharing and dissemination between employees, improving the transformation and exploitation of the new external knowledge (JANSEN; VAN DEN BOSCH; VOLBERDA, 2005).

Therefore, the internal determinants of AC are not restricted to R&D or to qualified workers but it is dependent on different organizational process. In this sense, the adoption of new organizational practices (1) to improve learning, knowledge sharing and codifying (e.g. new training systems), (2) for distributing responsibilities and decision power between employees (e.g. adoption of work team) or (3) to integrate different business activities can influence positively or negatively the absorption of external knowledge. According to the Oslo Manual, these new organizational practices are, theoretically, organizational innovations (OI)[4], where practices 1 indicates OI in the business practices and practices 2 and 3 indicate OI in the workplace organization. An OI need to be a strategic decision of managers and it refers to an

[4] OI is the implementation of a new organizational method in the firm's business practices, workplace organization or external relations" (OECD/EUROSTAT, 2005, p. 51).

implementation of a method did not used before by the firm (OECD/EUROSTAT, 2005). This new method can influence AC. This hypothesis is empirically tested in this paper.

2. Idiosyncrasies of AC for firms from developing countries

The previous section focused in studies from developed countries – as the ones from European context (JANSEN; VAN DEN BOSCH; VOLBERDA, 2005; SCHMIDT, 2005) – or from developing countries without a specific discussion about idiosyncrasies of AC in this context, as the Brazilian studies of De Negri (2006) and Bittencourt and Giglio (2013). The main question here is: If firm develops their capabilities embedded in an Innovation System, what are the idiosyncrasies of the AC of firms from developing countries, especially Latin-America?

The start-point is the Lundvall et al. (2009)'s definition of National Innovation System (NIS). They define NIS as an open, complex and evolutionary system, composed by relationships between organizations, institutions and economic structures, which define the innovation trajectory and the capability building by learning processes. They define two kinds of connected learning: (1) based on the creation and utilization of scientific and technological knowledge (STI learning); (2) based on experience and learning by doing, using or interacting (DUI learning). For Jensen et al. (2007), the *STI learning* is realized by formal R&D and university-firm partnerships and the *DUI learning* is realized by informal interactions with customer or suppliers and by organizational practices in favor of the internal relationship, as job rotation and project teams, which also influence AC (JANSEN; VAN DEN BOSCH; VOLBERDA, 2005). The combination of these types of learning is relevant to develop higher innovative capabilities especially in developing countries context as found by Figueiredo, Cohen and Gomes (2013)[5].

Chaminade et al. (2009) argue that developing countries has an "emergent" NIS restricted by the absence of agents or by their limited capabilities. According Albuquerque (1999) and Dutrénit and Katz (2005), there are these agents in the Latin America, but they are limited by an insufficient educational system and lower innovative efforts and capabilities. Both of them are related to firm's AC development. Therefore, to understand firms' AC for an emergent NIS, we can divide its limitations in three points: (1) capabilities building; (2) agents relationship; (3) institutions in general.

In the first point, we will discuss idiosyncrasies about: R&D efforts; skills; intra-firm organizational aspects. About agents' relationship, we focus on university-firm interaction[6]. We start with the third point (institutions), focusing on macroeconomic context and intellectual propriety regime. In the final subsection (2.6) we summarize the discussion.

2.1. Macroeconomic context and intellectual propriety regime

The external conditions affect firms' strategies and their absorptive capabilities consequently, as spillover and appropriability degrees (COHEN; LEVINTHAL, 1990). They act as "external triggers" to AC development (ZAHRA; GEORGE, 2002).

Bilgili, Kedia and Bilgili (2016) quantitatively relate "environmental conditions" and AC of emergent nations. Using the 2015-2016 Global Competitiveness Report[7] to build indicators about the development degree of institutions and market factors (including education indicators), these authors divide the emergent economies into 3 groups – traditional, mid-range and newly developed– with a growing correlation between AC and "institutional and market development degree".

For these authors, traditional emerging economies have the lowest AC because they face a weak intellectual property system, a scarcity of skilled labor and funding, inducing them to focus on short-term activities. On the other hand, newly developed economies are characterized by low level of those restrictions and a higher competitive market, fostering a high AC. In an intermediate stage are mid-range emerging economies, as Brazil, in which firms focus on the adaptation of external knowledge to improve

[5] These authors didn't use these definitions explicitly but they found that the combination of external cooperation (e.g. with universities) and internal efforts to diffuse knowledge (e.g. use of internal seminars and work group) improves the innovation capability.

[6] Next version of this paper will discuss how the relationship between local firms and multinational firms can impact the development of AC by the first.

[7] More information about this research is in http://reports.weforum.org/global-competitiveness-report-2015-2016/

productive efficiency locally. These firms combine internal generation of knowledge with external knowledge, which is characterized as "intermediate AC" (BILGILI; KEDIA; BILGILI, 2016). However, we need to investigate each components of these analysis.

About intellectual property regime (IPR), there are evidences that a flexible or weak IPR influences positively the AC in the developing countries. First, Cohen and Levinthal (1990) argued that high spillovers between competitors incentives the AC's development as a way to benefit from them. Second, the first step of the AC's development is based on engineering efforts – not on R&D – to absorb mature external technology and not to generate completely new technologies (KIM, 1999). Therefore, a stronger IPR can hamper this first absorption, being a high cost to AC development rather than an incentive (CHIARINI; RAPINI; SILVA, 2016). Third, Mazzoleni and Nelson (2007) suggest that all countries that completed catching up process benefited from a weak IPR. Thus, it's probably that weak IPR incentives spillovers, imitation of external technology and, so, investments in AC.

About macroeconomic policy, Coutinho (2005) argue that the Brazilian combination of bigger interest rate and overvalued exchange rate is "malefic" to long-term investment, as innovative capabilities building. This occurs because the present value of the innovative projects is reduced, there are fewer incentives to export and imported goods are cheaper. Therefore, firms tend to adopt defensive strategies, where innovation is not the priority. In addition, Albuquerque (1996) considers the Brazilian (and Latin-American) market as "non-effectively selective", *i.e.*, the market doesn't select innovative firms, allowing the survival of firms with conservative trajectories, where the search for innovative is less relevant. In this way, the market and macroeconomic context of Latin-American countries (especially in Brazil) do not incentives AC development and long-term strategies adoption.

2.2. Skilled Labor and AC

The abilities and experience of the employees is one crucial point for AC building. They act as gatekeepers, improving the relationship with external agents, and contribute to all dimensions and process of AC. However, the labor in developing countries is affected by the "*learning divide*" (AROCENA; SUTZ, 2010). This "break" in the labor's learning process occurs because of the disconnection between two kinds of learning: (1) learning by studying; (2) learning by solving problems. The first is related with knowledge from formal education, as under graduation or PhD programs. The second is the knowledge from the practice in the solution of problems. Arocena and Sutz (2010) argue that the last is determined by the demand of agents (as firms) for application of scientific and technological knowledge to solve their innovative problems. Fewer technological demands by firms imply less knowledge from learning by solving problems and, thus, provokes the learning divide. However, we can qualify this learning divide effect using two indicators from Unesco dataset for 2010: (1) share of researchers employed in firms (for learning by solving problems) and (2) population with superior degree[8].

First, the average share of researchers employed in firms for Latin America[9] is 15.9%, while in South Korea is 76.5% and in developed countries[10] is, in average, 55.3%. This difference indicates the low demand of private sector for skilled labor in Latin-American context, suggesting the "demand side" of learning divide (limited learning by solving problems).

The problem is also from the "supply side" (learning by studying). First, in 2010, only 13.37%, in average, of adult population (older than 25) in Latin America have almost bachelor degree, while in South Korea the share was 35.32% and in developed countries is, in average, 30.17%. Second, the average share of graduated students in one year in the scientific and technological areas[11] in Latin America was similar to the average for developed countries (21.1% for the former and 23.2% for the last[12]) but less than South Korea (33.5%). Although, the biggest difference was observed in Natural Sciences, Mathematics and

[8] Source: http://data.uis.unesco.org/ . The 2010 year was chosen due bigger availability of countries. Future version will try to actualize information. The completed table is at disposal if solicited.

[9] It was considered these countries: Chile, Colombia; Ecuador; México; Uruguay; Brazil.

[10] It was considered these countries: Canada; France; Germany; Italy; Japan; United Kingdom; USA

[11] Similar to Lall and Pietrobelli (2005), we considered these areas: (1) Natural Sciences, Mathematics and Statistics; (2) Engineering, Manufacturing and Construction; (3) Information and Communication Technologies; (4) Agriculture, Forestry, Fisheries and Veterinary (added by us because of Latin-America specificities).

[12] In this case, the developed countries considered was France; Italy; United Kingdom; USA.

Statistics. For Latin America, in average, 2.3% percent of the graduates in one year are from these areas, while in developed countries this percent is, in average, 6.6% and in South Korea is 4.3%. As suggested by Mazzoleni and Nelson (2007), the new technologies have been based more in the science, and, so, the formal education in this area is crucial to the learning by doing that help in absorption of external technologies, as pointed out by Kim (1999).

To summarize, in developing countries, especially Latin American ones, the learning divide occur in both side: low of demand for researchers and a limited offer of skilled labor, in terms of quantity and "quality", especially in areas of natural sciences and math. Both aspects limited the firms' capability to absorb frontier knowledge and technology.

2.3. Innovative efforts

In general, R&D effort is considered as the main innovative effort to build AC. However, R&D isn't the only innovative effort and, as we will discuss in this section, they have specificities in developing context.

Besides the general effect of R&D efforts in innovate capability, in the developing context they aren't designated to innovate *stricto sensus* but to adapt, control and improve imported technologies (LALL; PIETROBELLI, 2005; TEITEL, 1987). In addition, other authors argue that R&D effort can be less important in the first step of AC development than engineering or training efforts (CHAMINADE et al., 2009; KIM, 1999). This occurs because the AC is, initially, destined to adapt external technologies and not to innovate radically (KIM, 1999). Analyzing the Hyundai's case, Kim (1998) show different phases of AC and what kind of effort was important in each one. In general, in the first steps the intensive reverse engineering and the training of employees (inside the firm or by international mobility) was more relevant to absorb external technology than R&D. R&D efforts was important mainly when Hyundai started to develop its own design and products.

However, besides these characteristics, we can't affirm that R&D efforts designated to an exploratory learning and to innovate aren't relevant to improve AC. As highlighted by Katz (1987) and Bell and Pavitt (1993), during the process of import substitution, the Latin American firms focused only in the adaptation of imported technology and didn't pursued the generation of own technology, as South Korean firms did. This strategy limited the benefit of R&D for innovative capabilities building, as AC.

Finally, Kim (1998) argues that, independent of the type of internal effort realized, they need to be intensive to maintain a higher level of AC. In the case of South Korean firms, it was done by "crisis" imposed internally by managers or externally by the government demand or exportation strategies (KIM, 1999). The first represents the relevance of organizational aspects to develop of AC and their possible idiosyncrasies in developing countries context. It will be discussed in the following section.

2.4. Organizational process idiosyncrasies

According to Dutrenit (2004), the improvement of organizational process inside Latin American firms is crucial to qualify them to compete in the technological frontier. The author emphasis that these firms are latecomers, with an "embryonic technological capabilities", *i.e.,* they developed an important internal knowledge base in different areas, but they didn't use them completely as the main competitive force. To realize this and to build a dynamic capability[13], they need to realize organizational changes in favor of a better connection between the departments, improving the combination of existing knowledge and new knowledge generated by, for example, the R&D department. The absence of this connection is an obstacle to the development of AC, as discussed in the section 1.2. Three examples points out the importance of organizational changes for AC.

First, South Korean firms, during the catching up process, used internal crisis as a way to maintain high innovative efforts and to promote an internal cohesion in terms of objectives. Second, Figueiredo, Cohen and Gomes (2013), studying 13 Brazilian firms from cellulose and paper industry, show that the use

[13] To this author, the "embryonic technological capability" is a step before dynamic capability, as defined by Teece, Pisano and Shuen (1997)

of new learning mechanism (or existed mechanism but in an intense way)[14] was determinant for those firms to absorb knowledge from external partnerships and to develop high innovative capabilities, in response to "external triggers" (ZAHRA; GEORGE, 2002), as the openness of the national market and the *Genolyptus* research project coordinated by *Embrapa* (Brazilian Agricultural Research Corporation). Third, Furtado and Freitas (2004), suggest that an important technological result of nationalist innovative projects realized by *Petrobras* (Brazilian Petroleum Company) was the cooperation between the departments of R&D and Production and Sale, which helped it to absorb external knowledge.

Therefore, these three examples goes on line with the Dutrenit (2004)'s argument: organizational changes are important for firms from developing countries to improve their technological capabilities (as AC) as a way to get better competitive position.

In addition, these three examples show one important point in developing countries: the role of public policy as "external triggers" to AC development. In South Korean firms' catching up, the government's demand induced firms to invest intensively in the AC development (KIM, 1998, 1999). In Brazil, the research project of *Embrapa* – a R&D public institution – forced firms to engage in more partnerships and to increase internal efforts to absorb knowledge from them (FIGUEIREDO; COHEN; GOMES, 2013) and nationalist projects induced Petrobras to develop different kinds of internal absorptive capabilities (FURTADO; FREITAS, 2004). Therefore, public procurement can be a way to encourage AC's development.

2.5. University-Firm interaction

The universities are important agents to the NIS. They are supplier of skilled labor, prototypes, new firms and technological opportunity (MOWERY; SAMPAT, 2006). Besides, they have special role in developing context.

Albuquerque (1999) highlights two special roles of Universities in this context: as focusing device and "antenna". First, universities can indicate the feasible trajectory to country development process and, second, they connect the scientific and technological frontier with local knowledge. Academic researchers can act as "bridging researchers", bringing international knowledge to local firms (GIULIANI; RABELLOTTI, 2012). In this way, the partnership between university and firm helps the "funnel part" of AC, reducing the "blindness" of firms' search process and, thus, "directing" the funnel.

This fact improves the importance of personnel with academic knowledge – e.g. PhD workers inside the firm – to promote this connection. For Brundenius, Lundvall and Sutz (2009), the main function of universities in developing countries is the labor force trainmen to solve practicable problems and to establish external connection. As stressed by Mazzoleni and Nelson (2007) formal scientific education is precondition to the learning by doing in the new technologies. Therefore, the universities help in the building AC by qualified personnel to realize both STI and DUI learning, whose combination is crucial for innovative developing process (LUNDVALL et al., 2009). In Brazil, this kind of personnel qualification aren't developed yet, where the scarcity of skilled labor is a hamper for university-firm interaction until now (RAPINI; CHIARINI; BITTENCOURT, 2017), despite the individual character of this interaction in Brazil (LEMOS; CARIO, 2015).

However, the possible contribution of universities to firms' AC isn't by skilled labor solely. Analyzing the Britain context, Bishop, D'Este e Neely (2011) affirm that there are there ways to firms develop AC by interaction with university: (1) source of new ideas and general knowledge about some discipline; (2) reduction of time to complete R&D projects and support to introduce products on the market; (3) training, assistance to solve problems and contracting of labor.

The first affect the explorative learning (BISHOP; D'ESTE; NEELY, 2011), improving the knowledge base and the identification of external relevant knowledge (LANE; KOKA; PATHAK, 2006), reinforcing the universities' role as antenna and focusing device, discussed before. In addition, the use of papers and reports is one of the main channel used by Latin-American firms to interact (DUTRÉNIT; ARZA, 2015), and, for Brazilian case, is related with short and long-term benefits, including AC

[14] This Project created an international research network about Eucalyptus Genome, where 7 universities and 13 firms participated. This project encouraged the firms to establish new partnerships and to use internal learning mechanism intensively. In Zahra and George (2002)'s words this project was an external triggers to develop of AC.

development (FERNANDES et al., 2010). The second improves the exploitation capability and the third contributes to both types of learning, where the assistance or consulting is a way used by Latin-American firms to solve practical problems and to reduce the bureaucracy in this interaction. However, the development of AC by university-firm interaction (UFI) can be limited by other idiosyncrasies of UFI in Latin America.

First, the universities in this region was created, in general, late and disconnected from local demand (DUTRÉNIT; ARZA, 2015). Second, the occurrence of UFI cannot be dependent of higher internal R&D of firms. Besides the relevance of R&D to AC and its particularities in developing context, Fernandes et al. (2010) found that R&D isn't determinant to Brazilian firms obtain long-term benefits and it is negatively related with short-term benefits. In addition, Rapini et al. (2009) identified a significant share of Brazilian firms that interact with universities to substitute their R&D efforts. As pointed out by Cohen and Levinthal (1990), the development of AC by acquisition of external knowledge, without an internal innovative effort, is limited. In this way, universities can help not to reduce the time of R&D projects, as suggested Bishop, D'Este e Neely (2011) for developed context, but they can substitute firms' R&D. Third, firms of developing countries tends to focus in short-term benefits, aiming productive capability (ARZA et al., 2015) and the adaptation of external technology rather than innovation (PINHO; FERNANDES, 2015).

Therefore, firms tend to interact with university focusing on the "final step" of AC – the exploitative learning – rather than the exploratory learning. The focus on this step implies the development of a specialized knowledge base by firms that can limit the firm's capability to establish new partnerships hereafter. March (1991) and Cohen and Levinthal (1990) had suggested the relevance of a diverse knowledge base to a strong and sustainable capability, as AC.

In this way, the contribution of university-firm interaction (UFI) to firms' AC development tends to be limited in Latin-American context by some combined factors: (1) firms' focus on exploitative learning because of the their short-term strategies and focus on adaptation of external technology rather than on innovation; (2) there is a lack of qualified personnel to promote UFI; (3) Universities are distant from local demand. These factors hinder the firm to develop a higher and diverse AC in the interaction with universities.

2.6. Synthesis

This paper suggests that firms from Latin-America (especially Brazil) have a 'vicious cycle' of limited Absorptive Capacity. First, the environment did not provide incentives for AC improvements and the adoption of long-term strategies. This implies a focus on exploitative learning rather than on exploratory learning besides innovative efforts focused on engineering rather than R&D, aiming to adapt and realize marginal improvements of external technology (PINHO; FERNANDES, 2015). So, both strategies reduce the variety of knowledge base (MARCH, 1991)[15] and implies a limited and specialized knowledge base, which limits AC.

This limited AC has two main effects. First, it implies lower technological demand by firms, which provokes the learning divide (AROCENA; SUTZ, 2010), hampering a virtuous cycle of skilled labor. Instead, low skilled labor implies low AC capabilities, which feedbacks the vicious cycle. Second, limited AC hinders the building of expectations about external advances by firms (COHEN; LEVINTHAL, 1990), inducing them to adopt short-term strategies, as the importation of mature technology rather than the development of own technologies, restarting the vicious cycle. Finally, it reduces the capability of firms to learn from university-firm interaction and/or induces them to interact for development of production capability mainly (or solve short-term problems), limiting the contribution of interaction to the development process.

However, as discussed in the section 2.4, public policies can be a way to break this vicious cycle of limited AC. Two examples from Brazil (FIGUEIREDO; COHEN; GOMES, 2013; FURTADO; FREITAS, 2004) and one from South Korea (KIM, 1999) indicated that public policy can act as 'external triggers', inducing firms to increase innovative efforts and to adopt intraorganizational process to improve internal

[15] The exploitative learning focuses on the refinement of existing knowledge base and short-term benefits while exploratory learning focuses on generation of new knowledge and long-term benefits (BISHOP; D'ESTE; NEELY, 2011; MARCH, 1991).

communication and learning. This public policy may give guarantees for firms – demand or finance ones – that incentives them to invest in long-term and risker strategies, as the building of a high and diverse AC.

3. Empirical analysis

The paper's empirical analysis has two objectives: (1) to identify econometrically idiosyncrasies of AC's determinants for firms in a developing country context (Brazil); (2) to test the effect of organizational changes (i.e. organizational innovation) on AC. For this, we use the Brazilian Innovation Survey 2011 and 2014 (*Pesquisa de Inovação* – PINTEC)[16] and the bivariate probit methodology, considering AC as latent to the use of the knowledge sources to innovate. The first subsection details the methodology, followed by the characterization of database and, finally, the discussion of results.

3.1. Methodology

There are many ways to measure Absorptive Capacity, such as: R&D efforts as proxy (COHEN; LEVINTHAL, 1990); specific surveys (JANSEN; VAN DEN BOSCH; VOLBERDA, 2005); knowledge sources used by firm to innovate as proxy. In this paper we opt in using the last strategy, assuming the existence of specificities about AC according to knowledge source used by firm to innovate (BOGERS; LHUILLERY, 2011; DE NEGRI, 2006; MUROVEC; PRODAN, 2009; VEGA-JURADO; GUTIÉRREZ-GRACIA; FERNÁNDEZ-DE-LUCIO, 2008).

Similar to Schmidt (2005), we consider two kinds of AC latent to firm's source of knowledge, as follow:

1) Academic AC: latent variable to the use of universities or research institutes as knowledge source to innovate;
2) *Market* AC: latent variable to the use of *consumer, suppliers or competitors* as knowledge source to innovate.

However, given that organizational processes used by firms (e.g. job rotation) can affect both Academic and Market ACs, there is correlation among these latent ACs. Probit bivariate model is suggested to fix it. Details about the method can be accessed in Cameron and Trivedi (2005). We can summarize the estimated model as below:

- Two y_{k}^{*} unobserved latent variables: Academic AC (y_1^{*}); Market AC (y_2^{*})
- Two y_{k} binary dependent variables: (1) $y_1 = 1$ if Universities or Research Institute was considered with high or medium importance to innovate and zero, otherwise; (2) $y_2 = 1$ if Consumer, suppliers or competitors was considered with high or medium importance to innovate and zero, otherwise;
- These variables are related by:

$$y_{\mathrm{k}}^{*} = x_k'\beta_k + \varepsilon_{\mathrm{k}}$$

$$y_k = \begin{cases} 1 \; if \; y_{\mathrm{k}}^{*} > 0 \\ 0 \; if \; y_{\mathrm{k}}^{*} \leq 0 \end{cases}; \; k = 1; 2$$

where: x_k represents the independent variables; $Cov[\varepsilon_1, \varepsilon_2 | x_1, x_2] = \rho$; $E[\varepsilon_1 | \mathrm{x}_1, \mathrm{x}_2] = 0 = E[\varepsilon_2 | \mathrm{x}_1, x_2]$; $Var[\varepsilon_1 | \mathrm{x}_1, x_2] = 1 = Var[\varepsilon_2 | x_1, x_2]$

The Likelihood-ratio (LR) test can be used to test significance of correlation ρ between equations. If the null hypothesis is rejected, the correlation is not zero and we need to estimate equations by bivariate probit.

Table 1 presents dependent and independent variables. First, there are two dependent binary variables, related with specific knowledge sources to innovate and their respected AC. Second, independent variables are divided in 2 groups: explanatory and control variables.

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[16] PINTEC is a triannual survey realized with enterprises with 10 or more employees and located in Brazil. It is conducted by the Brazilian official Institute of Statistics and Geography (IBGE), skewed to large or previous innovative firms. Details can be found in: < https://ww2.ibge.gov.br/home/estatistica/economia/industria/pintec/2014/default.shtm >

Table 1 – Description of Variables

Code	Description	Period
	Dependent variables	
ks_acad	=1 if Universities or Research Institute was highly or moderately important knowledge sources to innovate	2012-2014
ks_mark	=1 if Clients, suppliers or Competitors was highly or moderately important knowledge sources to innovate	2012-2014
	Explanatory Variables	
OI Business	=1 if firm implemented new organizational methods in business practices; =0 otherwise	2009-2011
OI workplace	=1 if firm implemented new organizational methods in workplace organization; =0 otherwise	2009-2011
OI external	=1 if firm implemented new organizational methods in external relationship; =0 otherwise	2009-2011
Internal R&D (%)	Expenditure in internal R&D/revenue	2011
External R&D (%)	Expenditure in acquisition of external R&D/revenue	2011
Training (%)	Expenditure in training to innovation/revenue	2011
Technicians in R&D (%)[1]	Number of technicians employed in R&D/Total number of employees	2011
Researchers in R&D (%)[1]	Number of Researchers in R&D/Total number of employees	2011
Num. info. Sources	Number of external knowledge sources highly important to innovate	2009-2011
Coop	=1 if firm cooperated; =0 otherwise	2009-2011
	Control Variables	
ln_employess	Ln (number of employees)	2011
Specialized Supplier	Dummies for **Sectoral Taxonomy**, based on Silva and Suzigan (2014)'s adaptation of Pavitt's Taxonomy for Brazil (Supplier dominated was omitted)	2012-2014
Scale Intensive		2012-2014
Science-based		2012-2014
Northeast	Dummies for **Federative Region** (North region was omitted)	2012-2014
Southeast		2012-2014
South		2012-2014
Midwest		2012-2014
Foreign	Dummies for **origin of controlling capital** (National capital was omitted)	2012-2014
Mix[2]		2012-2014

Source: Own elaboration. Note: [1]The number of technicians and researchers were calculated as "Full Time Equivalence", i.e. multiplying the number of individuals by their time dedication percent in R&D activities; [2]"Mix" refer to firms controlled by national and foreign capital.

Explanatory variables were separated into 3 groups:

(a) Organizational innovations (OI): it is composed by three kinds of organizational innovations. '*OI Business*' involve the implementation of new methods for business practices, affecting work routines and procedures inside a firm, such as: new training system, new knowledge or quality management techniques. '*OI workplace*' indicate the implementation of new methods for workplace organization, as new distribution of responsibility and decision-power (e.g. first implementation of formal work teams or changes in the hierarchy) or new integration between business activities (e.g. connection between R&D department with production). The last one, '*OI external*', is about the implementation of new ways to organize the external relations, as new integration with suppliers or new collaborations with universities/research institutes or competitors. To be an OI, the practices need to be new at least to the firm. These three variables evaluate the importance of organizational changes in period *t-1* to develop AC in period *t*[17].

(b) Innovative efforts: relative to internal R&D expenditure, expenditure to acquire external R&D, share of employees in R&D and training efforts. The first and second indicate respectively the efforts (in terms of percent of revenue) to realize R&D internally and to acquire external R&D . The second is especially relevant in developing countries where firms use universities' R&D infrastructure to substitute internal R&D rather than complementing them (RAPINI et al., 2009). The third one tries to identify different roles for researchers and technicians in R&D to absorb external knowledge. The central hypothesis is that the researchers are more relevant to academic knowledge, given their academic network (MURRAY, 2004), than technicians, who tend to absorb knowledge from market. Knowledge from market and industry tend to be more similar to previous firms' knowledge base than academic knowledge, demanding more practical knowledge to be absorbed than academic knowledge. This "practical knowledge" is descendant from the experience in the use of technologies and the learning by doing that are mainly realized by technicians. The last one is training eforts, which can be understood as a connection between the knowledge base and pipelines dimensions of AC, because they develop new knowledge, diffuse practices internally and help to assimilate and to exploit external knowledge (EBERS; MAURER, 2014; JANSEN; VAN DEN BOSCH; VOLBERDA, 2005).

(c) Knowledge base and cooperation: the variable '*Num. info. Sources*' indicates the variety of external knowledge sources highly important to the firm, which is related with a varied of internal knowledge base and with firm open search strategy. Both aspects favor AC (LAURSEN; SALTER, 2006). Therefore, the indicator also reflects the previous absorptive capacity and its effects on AC today. Second, the variable '*Coop*' indicates the effect of previous cooperation on AC. The cooperation is a bilateral relationship (OECD/EUROSTAT, 2005) involving mutual knowledge exchange (BISHOP; D'ESTE; NEELY, 2011; FERNANDES et al., 2010; MUROVEC; PRODAN, 2009)

It's important to highlight that all explanatory variables are from previous the period regarding dependent variables, allowing to infer causality. The last group of variables is composed by control variables, as firm's size, sectorial taxonomy and regional aspects. Firms from different sectors and regions has different technological opportunities and incentives to develop internal capabilities.

3.2. Database

PINTEC's database was used in two periods: 2009-2011 and 2012-2014. The sample here was restricted to manufacturing sectors and firms who realized technological innovative activities in both periods. The table 2 highlights specificities of the sample. In general, firms use more market knowledge sources to innovate and are from most-developed Federative regions in Brazil (South and Southeast regions).

[17] OI measurement adopted by Oslo Manual is generic and includes different organizational practices in the same variable (ARMBRUSTER et al., 2008). For example, 'OI workplace' can include practices to centralize the decision-making process and/or to integrate R&D with other areas. As discussed before, the first have doubt effects on AC while the second improves AC. In this way, we can interpret the result of these variables as a net effect of the implementation of new organizational practices.

Table 2 – Database general characteristics

Number of firms	2,076
% Firms that used the knowledge source to develop technological innovation	
Academic sources (ks_acad)	36.66
Market sources (ks_mark)	90.80
% Firms that implemented organizational innovation (OI)	
OI Business	72.69
OI workplace	63.92
OI external	30.06
Cooperative firms (%)	35.12
Sectorial Taxonomy (%)	
Supplier Dominated	37.24
Specialized Supplier	13.20
Scale Intensive	28.18
Science-based	21.39
Origin of Controlling Capital (%)	
National	77.89
Foreign	17.15
Mix	4.96
Region (%)	
North	3.37
Northeast	7.71
Southeast	52.26
South	33.29
Midwest	3.37

Source: Own elaboration. Note: the categories of OI are not excluded (e.g. 54.5% of all firms implemented OI in business practice and in workplace).

3.3. Empirical results and discussion

The table 3 presents econometric results from probit bivariate model, with the estimated coefficients and robust standard error (in parentheses). Positive coefficients imply positive effect on the latent AC and on the probability to use the knowledge source (CAMERON; TRIVEDI, 2005). Here, we will focus on the effect on latent AC.

To ensure results' robustness, four models were estimated: (1) without organizational innovations (OI) and labor employed in R&D; (2) without OI but with labor employed in R&D; (3) with OI but without labor employed in R&D; (4) with OI and labor employed in R&D. The last model was chosen because it performed the lowest Akaike's Information Criteria (AIC) and it presented Bayesian Information Criteria (BIC) similar to another models. For each model, the first column is for Academic AC (ks_acad) and the second column is for Market AC (ks_mark). About robustness, two points are central. First, in all models, estimated correlations are significantly different than zero, indicating the relevance of the bivariate model. Second, we can observe robustness for all estimated coefficient for explanatory variable in terms of value and significance.

About the explanatory variables about **Knowledge Base and Cooperation,** both indicators suggest the relevance of previous AC to develop the actual AC. First, cooperating is an important way to develop Academic AC according econometric results. The relation between them is bilateral: (1) cooperation is a way to develop AC (BISHOP; D'ESTE; NEELY, 2011); (2) cooperative firms have higher previous AC than non-cooperative. Both suggest that firms that cooperated in the 2009-2011 period has higher previous AC than non-cooperative firms. Second, the significance of number of knowledge source to both AC indicates the relevance of the openness strategy of firm (LAURSEN; SALTER, 2006) besides previous AC to develop the present AC. Furthermore, it is interesting to observe effects of knowledge base and cooperation on AC are reduced when we add variables about organizational innovations and labor on R&D. Latter variables probably get some effects that would be 'hidden' in the former variables about previous knowledge base (number of knowledge source) and cooperation.

About the **Innovative Efforts**, an unexpected result is the limited importance of internal R&D effect on AC. In all models, expenditure on internal R&D is not significant for both AC while the share of workers

employed as researchers in R&D affect positively the Academic AC in model with or without OI[18]. De Negri (2006) also had found a strong effect of the share of employees with higher degree on more "complex" AC, as Academic AC. In addition, the acquisition of external R&D influences both AC, stronger Academic AC than Market AC.

Table 3 – Results of Bivariate models

	(1)		(2)		(3)		(4)	
	ks_acad	ks_mark	ks_acad	ks_mark	ks_acad	ks_mark	ks_acad	ks_mark
OI Business					0.0626	-0.233	0.0581	-0.236
					(0.0907)	(0.156)	(0.0909)	(0.156)
OI workplace					-0.0622	0.275**	-0.0591	0.272**
					(0.0900)	(0.135)	(0.0900)	(0.135)
OI external					0.238***	0.0471	0.232**	0.0502
					(0.0909)	(0.107)	(0.0907)	(0.108)
Technicians in R&D (%)			-0.0134	0.0335			-0.0122	0.0332
			(0.0127)	(0.0227)			(0.0132)	(0.0221)
Researchers in R&D (%)			0.0341**	0.0126			0.0324**	0.0132
			(0.0148)	(0.0213)			(0.0147)	(0.0214)
Internal R&D (%)	0.0110	0.00291	0.00236	-0.00490	0.0101	0.00138	0.00184	-0.00631
	(0.0100)	(0.0192)	(0.0101)	(0.0163)	(0.0104)	(0.0187)	(0.0105)	(0.0160)
External R&D (%)	0.120***	0.0577**	0.120***	0.0570**	0.124***	0.058***	0.124***	0.0574**
	(0.0233)	(0.0227)	(0.0232)	(0.0227)	(0.0236)	(0.0224)	(0.0235)	(0.0224)
Training (%)	0.165*	0.381*	0.168*	0.357*	0.153*	0.387**	0.156*	0.365**
	(0.0891)	(0.196)	(0.0882)	(0.186)	(0.0891)	(0.196)	(0.0882)	(0.186)
Num. info. Sources	0.068***	0.0595**	0.0666***	0.0585**	0.0596***	0.0515**	0.0580***	0.0505**
	(0.0167)	(0.0259)	(0.0168)	(0.0261)	(0.0174)	(0.0248)	(0.0175)	(0.0249)
Coop	0.186**	0.116	0.191**	0.102	0.150*	0.0961	0.155*	0.0829
	(0.0840)	(0.0969)	(0.0848)	(0.0971)	(0.0834)	(0.0966)	(0.0840)	(0.0969)
ln_employess	0.208***	0.0582	0.206***	0.0607	0.210***	0.0492	0.209***	0.0516
	(0.0334)	(0.0526)	(0.0336)	(0.0526)	(0.0329)	(0.0485)	(0.0331)	(0.0485)
Specialized Supplier	0.0382	0.178	0.0473	0.161	0.0396	0.171	0.0474	0.155
	(0.110)	(0.185)	(0.109)	(0.185)	(0.108)	(0.179)	(0.108)	(0.179)
Scale Intensive	-0.163*	0.0592	-0.167*	0.0541	-0.169*	0.0698	-0.173*	0.0647
	(0.0987)	(0.164)	(0.0989)	(0.164)	(0.0992)	(0.159)	(0.0994)	(0.159)
Science-based	0.279***	-0.0155	0.248**	-0.0501	0.278***	-0.0444	0.248**	-0.0804
	(0.103)	(0.163)	(0.105)	(0.164)	(0.104)	(0.150)	(0.107)	(0.151)
Northeast	0.559**	-0.0610	0.564**	-0.0657	0.601**	-0.0558	0.604**	-0.0589
	(0.247)	(0.311)	(0.249)	(0.313)	(0.254)	(0.304)	(0.255)	(0.306)
Southeast	0.188	-0.527*	0.193	-0.532*	0.220	-0.490*	0.224	-0.494*
	(0.199)	(0.297)	(0.200)	(0.299)	(0.209)	(0.275)	(0.210)	(0.276)
South	0.319	-0.269	0.328	-0.277	0.348	-0.253	0.355*	-0.259
	(0.202)	(0.277)	(0.202)	(0.278)	(0.212)	(0.265)	(0.212)	(0.266)
Midwest	0.196	-0.338	0.215	-0.327	0.217	-0.321	0.234	-0.310
	(0.310)	(0.355)	(0.312)	(0.356)	(0.328)	(0.349)	(0.330)	(0.350)
Foreign	-0.172*	-0.0850	-0.189**	-0.0931	-0.179*	-0.0914	-0.195**	-0.0987
	(0.0924)	(0.124)	(0.0929)	(0.126)	(0.0929)	(0.125)	(0.0934)	(0.127)
Mix	0.00219	-0.275	-0.0147	-0.274	-0.0407	-0.271	-0.0548	-0.271
	(0.149)	(0.190)	(0.148)	(0.189)	(0.148)	(0.200)	(0.147)	(0.200)
Constant	-2.12***	1.147***	-2.117***	1.140***	-2.204***	1.196***	-2.199***	1.191***
	(0.273)	(0.415)	(0.274)	(0.416)	(0.284)	(0.374)	(0.284)	(0.375)
Estimated correlation	0.286***		0.284***		0.291***		0.288***	
	(0.0594)		(0.0594)		(0.0597)		(0.0597)	
Observations	2,076		2,076		2,076		2,076	
Wald Test (χ^2)	144.5***		153.9***		152.9***		161.2***	
AIC	6438.71		6430.05		6402		6394.87	
BIC	6624.77		6638.68		6621.89		6637.31	

Source: Own elaboration. Notes: *** significant at 1%; ** significant at 5%; * significant at 10%.

[18] The correlation between them is 0.464 in the present study. This was the highest correlation.

Thus, we have the first empirical evidence about the limitations of AC in Brazilian innovative firms: they develop AC not by internal R&D efforts but buying external R&D. As discussed before, the development of AC by acquisition of external knowledge is limited (COHEN; LEVINTHAL, 1990). However, this effort need to be complement by different factors according AC's type.

For Academic AC, firms need to have a high share of researchers inside them to absorb knowledge from universities or research institutes. This variable was significant at 5%. In general, knowledge from these sources are more distant from firms' knowledge base than knowledge from market sources. Therefore, efforts to absorb them need to be higher. However, in Brazilian context, those efforts are not done increasing expenditure value on internal R&D, but by the share of workers employed as researchers in R&D. This result is explained by two facts: (1) efforts in internal R&D in Brazil is designated to adapt external technologies and not to generate a variety knowledge base; (2) the relationship between firms and universities is strongly dependent of the individual ability and network. In this way, Academic AC in Brazilian firms depends highly on individual abilities to understand the external R&D acquired.

The importance of individual abilities to develop AC is also represented by the positive effect of training efforts on both AC. The training permits to diffuse knowledge internally, improving the internal relationship between workers and, so, the capability to assimilate and to exploit the external knowledge. However, this effect was significant only at 10% for Academic AC and at 5% for Market AC, with higher impact on Market AC.

It can be observed that the Market AC is more dependent from a 'simpler' but diffused internal knowledge base (represented by training efforts) than Academic AC. The academic AC is more dependent on external relationship and individual abilities (represented by researchers in R&D and previous cooperation) than Market AC.

The results about **Organizational Innovations** complement this argument. Implementation of new methods for business practices (OI business) does not affect Academic AC and Market AC, but the implementation of new practices on workplace (OI workplace) contributes to Market AC while the implementation of new ways to organize the external relations (OI external) favors to Academic AC.

OI workplace can include adoption of many new practices that shift different aspects which influence AC, such as: internal hierarchy degree (VAN DEN BOSCH; VOLBERDA; DE BOER, 1999); departments interactions (COHEN; LEVINTHAL, 1990) and employees decision power (EBERS; MAURER, 2014). As a result of the high aggregation level of this variable (ARMBRUSTER et al., 2008), it is not possible to affirm what new specific organizational practice contributes to AC. However, it is possible to conclude empirically that changes in the workplace organization can be a way to innovative firms to improve their capabilities to absorb external knowledge, especially knowledge from market.

On other hand, OI external includes changes in the relationship with external agents as suppliers, competitors or universities. Besides high aggregated level of this variable, we may interpret this result combined with cooperation result: Academic AC is determined especially by external interactions rather than internal relations. Given the distance between academic knowledge base and firm knowledge base, probably Brazilian innovative firms develop their Academic AC not by intensive internal efforts, but combining a limited internal R&D (strongly dependent on researchers in R&D), with cooperation and external relationships.

Therefore, using the figure 1 (p. 4), we can conclude that Academic AC and Market AC is determined by "different" pipelines and knowledge bases. First, both ACs are built using external R&D rather than internal R&D, but this is not sufficient to develop ACs. In one side, to develop Market AC, firms promote workplace organizational changes and invest in training to diffuse external R&D and to generate knowledge internally. Both aspects favor the assimilation and transformation of the external knowledge. However, training efforts can generate less variable knowledge base for the firm than internal R&D, limiting the AC. In other side, the development of Academic AC is based on external relationships and especially on the tacit knowledge and network of researchers in R&D. Thus, firms use 'internal pipelines' to develop Market AC (i.e. organizational practices to improve internal relationship) while they use 'external pipelines' to develop Academic AC (i.e. organizational practices to improve interactions with external agents).

4. Conclusion

The aim of this paper was to identify idiosyncrasies of firms' Absorptive Capacity (AC) in a developing countries and the influence of organizational determinants on AC. To achieve this, first we discussed the AC's concept and its internal determinants, summarizing the discussion in the Figure 1 (p. 4), where AC has two parts: a "funnel" and "pipelines" (LANE; KOKA; PATHAK, 2006).

The "funnel part" is represented by the identification and acquisition AC's dimensions and highlights that firms recognize external knowledge and opportunities differently, according to their knowledge base (composed by skilled labor and internal innovative efforts). The "pipelines part" is determined by organizational practices to diffuse knowledge internally and to favor the assimilation, transformation and exploitation of external knowledge. The "pipelines part" represents organizational practices to internalize the external knowledge. Both parts are affected by external environment – e.g. macroeconomic policies, institutions – and firms' strategies.

Using this form to understand AC, we identify that firms from Latin America, especially Brazil, suffer from a limited AC's vicious cycle. First, the environment doesn't favor the adoption of long-term strategies, inducing firms to focus on exploitative learning strategies and on the adaptation of external technologies, where R&D efforts is less relevant than specific engineering efforts. Therefore, the knowledge base generated by firms is more specific and bounded, which implies a limited AC. This limited AC reduce the firm's demand for application of scientific and technological knowledge, inducing the learning divide, as suggested by Arocena and Sutz (2010). Together with a limited offer of graduated in sciences, this labor restriction contributes to reinforce the limitation of AC. Firms with a limited AC has difficult to establish long-term expectations, inducing them to adopt low-risker and short-term strategies, restarting the vicious cycle.

Future research could test this vicious cycle for other context and investigate mechanisms to break it. We didn't discussed this extensively, but some possibilities were pointed out, such as the use of public procurement and Research Institution as "external triggers" and "focusing device", reducing the uncertainty, directing the firms' search process and encouraging firms to search and use external scientific knowledge to their innovative process (i.e. to develop AC)

The relevance of external relationship to absorb academic knowledge was observed in the empirical analysis too. Using the last two Brazilian Innovation Survey (2009-2011 and 2012-2014) and the bivariate probit, we estimated the determinants of two kinds of AC: Academic AC *versus* Market AC. With a base of 2,076 innovative firms, we identify that firms develop both AC not by expenditure in internal R&D but by expenditure in the acquisition of external R&D, especially for Academic AC. This result complements the argument of the limited AC's vicious cycle, given that the development of AC mainly by the purchase of external R&D is limited (COHEN; LEVINTHAL, 1990), and reinforces the propositions of a passive learning in developing countries.

Besides this similarity, we identified that firms use different "pipelines" to develop each AC. Market AC depends more on the "internal pipelines", as the training efforts and workplace organization. Both help the integration and communication between the employees, disseminating external knowledge internally. In other side, Academic AC depends more on "external and individual pipelines", i.e. it is affected by the way of firm establish their external relationship, by previous cooperation and mainly by the individual ability of researchers employed in R&D activities. Thus, these results reinforce the argument of Dutrenit (2004) and Figueiredo, Cohen and Gomes (2013): shifts in the organizational process is relevant for firms from developing countries improve their technological capabilities.

In addition, this result for Academic AC complements the Lemos and Cario (2015)'s argument: university-firm in Brazil is dependent of individual abilities of researchers Probably, this result reflects firms' short-term objectives in this interaction – adaptation of external technology and solution for short-term production problems (ARZA et al., 2015; PINHO; FERNANDES, 2015) – which do not require the creation of internal routines to absorb knowledge from external interactions, keeping it restricts to the abilities and networks of researchers inside the firm to solve short-term objectives. The absence of routinization hampers the capability of firm to learn from UFI, inhibiting AC's improvement, at the same time that external interaction is important to develop Academic AC. This 'latent inconsistence' is a research opportunity.

Therefore, "supply side" policies that try to induce firms to interact with university can have partial results. Firms can increase their Academic AC by interact with universities, but firms need to have researchers inside them to help in the absorption of knowledge. Thus, this kind of public policies need to be complemented by policies that encourage firms to employ researchers and to invest in internal generation of knowledge.

Finally, this empirical analysis has some limitations that are research possibilities. First, we analyze only innovative firms that tend to have a higher AC than non-innovative. Second, the indicators of organizational innovation available at PINTEC are highly aggregated, hampering to identify the effect of a specific new organizational practices on AC. It was possible only to identify a net effect of them. Third, we didn't evaluate the effect of different cooperation on AC. Different partners tend to share different knowledge and be used for different objectives, being correlated with different ACs. Fourth, we didn't explicit econometrically the environment effect on AC, as macroeconomic and industrial policies.

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