Territorial aspects of the degree of novelty of the innovation in Brazil

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Abstract. The debate on Brazil's innovation performance has given little attention to the role of geography. Based on the broader literature about geography of innovation, this paper addresses this gap, applying knowledge function approach in two levels to examine the effects of the territorial factors on innovation in Brazil. The empirical results suggest that the territorial factors are strong predictors of innovation performance, even in developing and emerging countries, such as Brazil, where innovations tend to be mostly new to the firm, whereas a larger proportion of innovations in advanced economies is new to the world as a whole. In particular, the availability of skilled labour, the economic agglomeration and the specialization have played a fundamental role to foster degree of novelty of the innovation on Brazil, whereas the spillovers or population agglomeration have no significance.

Keywords: Geography and Innovation; Local Knowledge Spillovers; Agglomeration; Regional Productive Structure; Local Productive Labour.

JEL: O31; O18; R12

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1. Introduction

This paper investigates empirically how locational factors affect degree of novelty of the innovation in Brazil. The aim is to deepen and, at the same time, complement the discussion of how regional specificities factors in which the firm is part can generate innovative differential to them. That is, as firms similar in some aspects may differ degree of novelty degree of novelty due to its location. The main hypothesis of this study is that regional characteristics, such as knowledge spillovers, agglomeration, regional production structure and the availability of local resources can affect innovation.

The ability of firms to innovate is the subject of several studies in recent years. The literature suggests that innovation is highly related to the ability that firms have to absorb and transform the resources related to knowledge. These capabilities are closely linked to the firms’ financial and human resources and its internal organization. In addition, external factors, such as production structure and knowledge spillovers, can also affect innovative performance of the firm. It should be noted that knowledge, especially tacit knowledge, is an important factor of the geography of innovation. Knowledge is largely tied to the perception of those who transfer and those who receive, so that the proximity between the agents tend to facilitate the acquisition and dissemination of knowledge and thus innovation. Locational factors can also affect innovation, as several studies pointed it out. Empirical studies have proposed indicators of production and innovation to analyse the relations between innovation and territory.

Econometric analysis of the relation between regional characteristics and innovation is widespread and widely discussed. However, these studies focus on analysing the importance of the location of firm in aggregated form. This paper tries to contribute by using the knowledge production function to correlate innovative inputs at the firm and regional levels and the results of innovation at the firm level, thus making it possible to examine how local factors affect innovation in Brazil.

Therefore, this paper can be able to advance the debate on innovation in Brazil in two specific dimensions. The first relates to the understanding of how the features and characteristics of firms influence their innovations. The second is focused on understanding how the territorial factors can shape the innovation process. Thus, this study can be able to advance in the small but growing debate on economic geography about the dynamics of innovation in emerging countries, as Brazil.

2. Background

The relationship between innovation and geography has been studied by several authors in different contexts (JAFFE et al., 1993; FELDMAN and AUDRETSCH, 1996; CARLINO et al, 2007; CRESCENZI et al., 2007). In general, the main assumption for the importance of geography lies in the fact that the knowledge, main input of innovation, often requires spatial proximity to be better understood and shared. This is because the knowledge, especially the tacit, is conditioned to the perception and awareness of receiver and transmitter. Thus, the proximity between the agents can facilitate the assimilation of tacit and complex knowledge, that would otherwise be impossible and very expensive to encode (POLANYI, 1966; MARSKELL and MALMBERG, 1999; STORPER and VENABLES, 2004; BRESCHI and LISSONI, 2001; GERTLER, 2007). In this sense, the innovation process is characterized by severe degrees of division of labour and knowledge flows that are more easily accessible in a locality where the actors interact more frequently and have direct contacts. Therefore, the innovative activities are strongly influenced by local context. Thus, in certain circumstances, a location can enhance or limit the innovative results of the firms.

Although it is understood that the mere exposure to knowledge does not guarantee that the firm will innovate, it is emphasized that the concentration of agents tends to increase possibilities for combination and lower costs of knowledge exchange which make individuals (firms) more productive and innovative than in other places. Thus, the literature points out that even within regions that spend the same amount on R&D, the innovation levels may differ, especially when they have different degrees of agglomeration. In other words, a "critical mass" of agglomeration is necessary in order to expect substantial local economic effects of the innovation efforts (AUDRETSCH and FELDMAN, 1996; VARGA, 2000; DURANTON and PUGA, 2001; CARLINO et al., 2007). Thus, it is expected that firms inserted in drivers centres of innovation enjoy advantages in comparison with firms in other regions. This explains the perpetuation and deepening of geographic concentration in the world of expanding markets, weakened barriers and sharper and inexpensive communication technology.

The importance of local agglomerations was initially treated in Marshall's work. For Marshall (1920) the spatial concentration of firms is justified by the easy access to a range of benefits that are important to increase market competitiveness of these firms. It is argued that the agglomeration of firms in the same industry generate a demand for skilled labour to the specific activity of the industry. This demand promotes the attraction of skilled workers in anticipation of better jobs and wages, for example. The concentration of skilled labour generates a space of constant learning of new knowledge that can give conditions for the occurrence of innovations that spillover to other firms. However, the externalities are limited in space promoting agglomeration. Thus, there is a circular causality between the concentration and its externalities, since the spatial concentration of activities in space generates benefits to firms that in turn tend to attract more firms to the region leading to more concentration in space (MARSHALL, 1920; JAFFE et al., 1993; AUDRETSCH and FELDMAN, 1996; ROSENTHAL and STRANGE, 2001; CARLINO et al., 2007; VARGA, 2000; FRITSCH and SLAVTCHEV, 2010).

In this context, knowledge spillovers are seen as an important element that reinforces the importance of local context appropriate for innovation. That is, important portions of the knowledge generated in the firms go beyond their limits and become available to other agents in surroundings. In this sense, through knowledge spillovers, the firms' innovation efforts may end up benefiting the innovative activities of all agents nearby. Similarly, the new knowledge generated in the local is more accessible to local agents. Thus, if firms have the ability to take ownership of knowledge from different sources, the knowledge spillovers become an essential source of knowledge for innovation (COHEN and LEVINTHAL, 1990; BRESCHI and LISSONI, 2001; AUDRETSCH and FELDMAN, 2003).

However, on industrial context of innovation, agglomerations and its externalities, two distinct views emerge. On the one hand, there are those who argue that the interactions between firms and individuals of similar skills and that respond to common concerns that generate the externalities. These advantages stems from the fact that specialized regions in a particular industry enjoy benefits originating in the expertise of suppliers, the existence of skilled labour on site and the availability of knowledge involved in the innovation process. Thus, the interactions between agents and skills providers and workers endow firms in specialized areas conditions to develop their activities more efficiently and even better carry out of innovative activities than their competitors elsewhere. Therefore, it is the specialization of agents that ensure externalities that support innovation, commonly called Marshallian advantages in view of the seminal work of Marshall (1920)[1].

On the other hand, backed by Jacobs's work, there are researchers that claim that the variety of industries located near each other in a region is what supports the innovation and growth, generally referred to as Jacobian externalities. In this way, it is the proximity of diverse and distinct industries, not specific, that promotes imitation and fosters sharing and recombination of ideas and complementary practices between

[1] Also called by the acronym MAR due to the work Marshall, Arrow and Romer that dealt with the importance of spillovers between firms in the same sector

agents. Therefore, the diversification is most important in this process. Thus, innovations are associated with exchanges of knowledge between agents in different sectors.

The empirical literature provides evidence supporting both theories. The studies by Audretsch and Feldman (1999) and Carlino et al. (2001) for American regions, Van Oort et al. (2002) for Netherlands regions, Co (2002), Fritsch and Slavtchev (2010) for German regions, highlight the benefits of diversity to promote the innovation. Furthermore, according to the authors, specialized agglomeration can be harmful innovation, since it can lead to lock-in, preventing the emergence and development in other essential areas to innovation. In contrast, Henderson (1999) to the United States, Van der Panne (2004) for the Netherlands, Cabrer-Borrás and Serrano (2007) for Spain and Crescenzi et al (2012) for Chinese's regions, emphasize that it is more important the industrial specialization in the regions to foster innovation, therefore, the performance of innovative regions depends on the specialization of its scientific and technological base. Joint evidence for both types of production structure have also been found by Paci and Usai (1999, 2000) and Greunz (2004) that point out that regional innovation is affected positively by both externalities (specialization and diversification). Thus, the best production structure (industry) that supports innovation can differ from one place to another.

In short, capacity that firms have to innovate is determined by its accumulated knowledge generated from past activities, coming from R&D efforts, human capital, organizational structure and environment. This is, the firms' internal efforts that enables them realize and take advantage of new knowledge, providing them competitive advantage. Furthermore, it depends on a number of external factors that may or may not accelerate innovation. In other words, firms do not innovate just with their internal resources, but also depend on the availability of a set of factors that may or may not speed up innovation. Therefore, innovation should not occur in the same way everywhere, usually with heavy reliance of the surroundings where the company is located.

3. Empirical Model

3.1 Data

To examine how the territorial factors affect innovation in Brazil, a specific data set, with 7,145 firms, derived mainly from **two** data sources is exploited.

First, the firm-level data was gathered from the Innovation Research in Brazil (PINTEC[2]) which is conducted by the Brazilian Institute of Geography and Statistics (IBGE). This data set, according to the IBGE, is a cross survey that covers the

[2] The IBGE conducted and published a total of five editions of Innovation Research, which were PINTEC 2000 that covers the triennium 1998-2000, PINTEC 2003 (triennium 2001-2003), PINTEC 2005 (triennium 2003-2005), PINTEC 2008 (triennium 2006-2008) and PINTEC 2011 (triennium 2009-2011).

information about activities of innovation in Brazil, such as expenditure, sources of financing, the impact of innovations. **Second**, the regional-level data was collected from the Annual Report on Social Information (RAIS) of the Ministry of Labour. This data set contains the register of all establishments and its employees, which allows constructing regional variables. This register is also used at the firm level to allocate a region (city or micro-region) to a firm (using code of the firm headquarters identifier), since PINTEC data does not allow to identify firm location.

For this research, it was used PINTEC and RAIS 2008, and PINTEC 2011. So, it was studied in this work only the firms present in both PINTEC surveys. The main reason for the use of both surveys is the fact that innovative efforts (inputs) do not translate into innovation output straightaway, requiring some period. In this sense, the PINTEC 2011 is used as innovation outputs, while the PINTEC 2008 and RAIS 2008 are used as inputs[3].

3.2 Dependent variable.

A cross-section is estimated for 2008- 2011 on this data set to examine how the firms' innovation capacity can be affected by your location in Brazil.

The firms innovation capacity ($\boldsymbol{INNOV_{i,T}}$) is the dependent variable which is an ordinal variable that takes value 1 if the firm did not innovate; 2 if the firm introduced product and/or process new for the firm, but existing in the domestic market; value 3 if the firm introduced product and/or process new for the national market; and value 4 if the product and/or process is new for the world market.

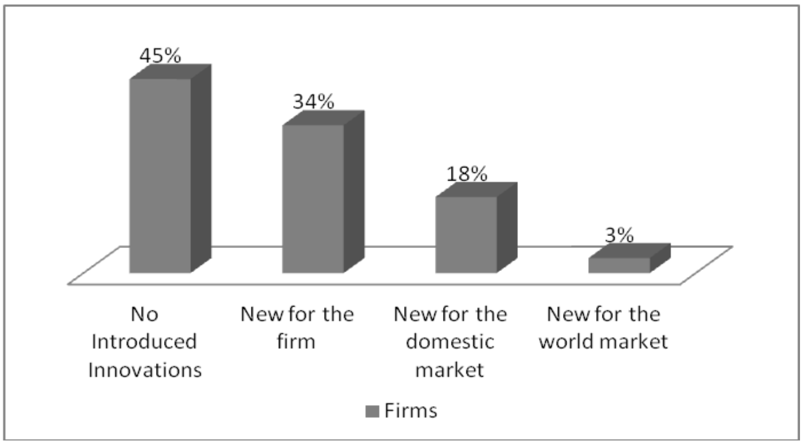

Figure 1: Innovation in Brazil - 2011.

3 It should be pointed out that time references are made of different ways for the different variables. In general, the variables which do not involve value record are accounted in three consecutive years, i.e, from 2006 to 2008 for PINTEC 2008 and from 2009 to 2011 for PINTEC 2011. Variables with value are measured in the last year of the reference of the survey.

Figure 1 illustrates the innovation in Brazil. What stands out in Figure 1 is the low number of firms that have introduced innovations, for the world market only 3% the total firms. On the other hand, there are a high number of firms that did not present innovations. This shows the low level of innovation in Brazil.

Figure 2 shows the distribution of innovation in Brazil. Similar to those of other countries, Brazil's regions differ significantly in terms of their distribution of innovation capabilities. The distribution of innovation exhibits a tendency towards concentration in south and southeast regions, also the most developed regions. In 2011, 40% of all firms that introduced innovation (new for firms, domestic market or world market) were in São Paulo state (or Federative Unit – UF), followed by Rio Grande do Sul, with 11%, Santa Catarina and Minas Gerais, both with 9%, Paraná, with 8% and Rio de Janeiro, with 6%. These six UF alone compose almost 85 % of the complete of innovation numbers in Brazil that features 27 UFs.

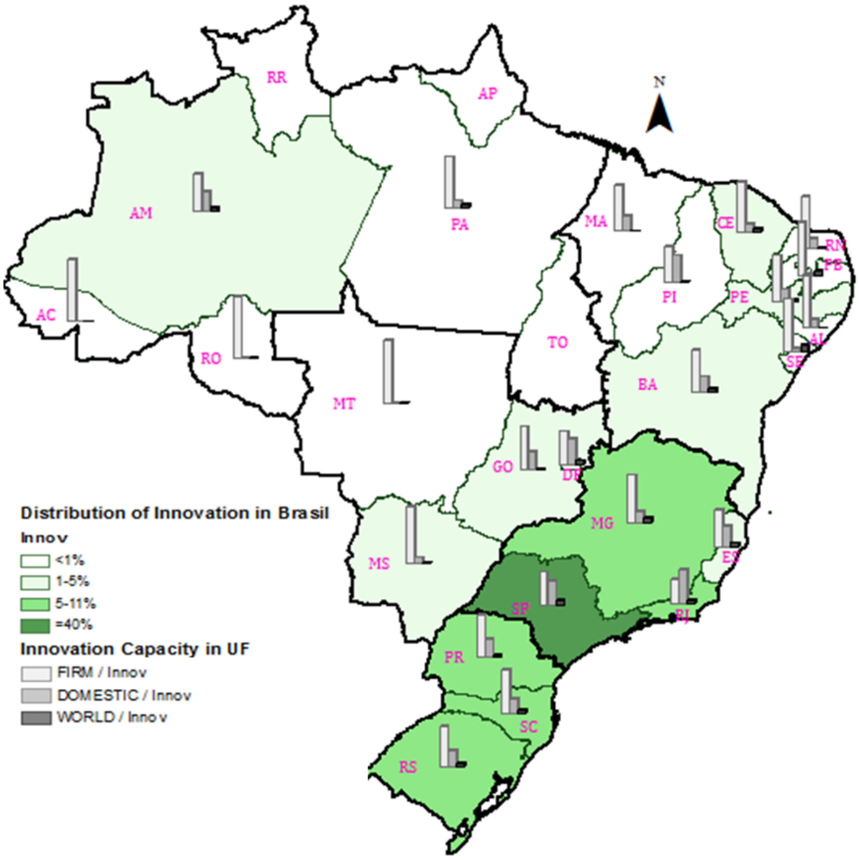

Figure 2: Distribution of Innovation in Brazil’s regions and Innovation Capacity in UFs

The innovation, like all complex reality, depends on a wide range of factors that enable this process to be successful or not. In Brazil, this is not different, thus the reasons for the low innovative dynamism can be several. Among them, we can point the weak engagement of firms in technological activities, particularly in Research and Development (R&D). In contrast to what is seen in other countries, the universities, not the firms, which account for most of the expenditure on R&D and employ scientists and engineers. In addition, the competitive conditions in the economy combined the heterogeneity of Brazilian regions also affect technological activities. Looking at innovation from the point of view of location, the drives are diverse and can vary. It is for this reason that several works, like this, are seeking to understand how and why different local factors can make firms more prone to innovate.

3.3 Explanatory Variables.

It is possible to divide the independent variables into two levels: region and firm. At the level of the region, the main focus of this paper, four are the characteristics of the regions that are studied.

The first characteristics is knowledge spillovers - $\boldsymbol{WRD_{i,T-t}}$. The literature suggests that the R&D efforts not only increase the capacity to generate new knowledge, as also, it can give them the ability to internalize knowledge from other sources. In this sense, if the firms have this capability, the knowledge spillovers can represent an important input of your innovative activity[4]. To measure the knowledge spillovers it was used the sum of innovation efforts in the city where the firm is located, except innovation efforts of firm itself.

The second characteristic is agglomeration. We use two agglomerations: population and/or economic. The degree of local agglomeration is proxied by the population density -$\boldsymbol{AggP_{i,T-t}}$, as customary in the literature. In addition, the degree of economic agglomeration is proxied by the GPD per capita of the firm's city - $\boldsymbol{AggE_{i,T-t}}$.

The third variable is the productive structure of the region in which the firms operate, $\boldsymbol{Kindex_{i,T-t}}$[5]. This variable captures the degree of local specialization or diversification where the firm is located. To do this, it is used the Krugman index, calculated in **two** ways: first by the number of employees in the manufacturing in the regions - ***KindexM***, and the second by the number of employees in all sectors in ***KindexT*** regions. The Krugman index is calculated as follows:

$$kindex_{i,T-t} = \sum abs\left(v_{i,t-T}^{k} - v_{i,t-T}^{-k}\right) \qquad with \quad v_{i,t-T}^{k} = \frac{\sum_{j \neq i} x_{i,T-t}^{k}}{\sum_{k}\sum_{j \neq i} x_{i,T-t}^{k}}$$

Thus, $\boldsymbol{v_{i,T-t}^{k}}$ is part of a sector *k* in the region *i* on all firms in this region and $\boldsymbol{v_{i,T-t}^{-k}}$ is part of the same industry of all other different regions of *i* divided by all firms of other regions of different *i*. The index has a value close to zero if the micro-region is more

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[4] This indicator may be represent by the functional form following: $\boldsymbol{WRD_{r_i} = \sum_{r_i} \left[RD \big/ Gross\ \ Sales \right]_i ,\ \ i \neq j}$

[5] It should be pointed out that unlike other regional variables this variable is calculated for micro-regions, and not city, since that indicator is the better represented at this level.

diversified and a maximum of 2 if more specialized. The inclusion of this variable seeks to assess whether there is a different impact on the ability to innovate in firms located on regions with specialized or diversified productive structure.

Rounding out the list of variables at the region level there is an indicator that aims to capture the structure of productive resources available in firm's city, named Social Filter Index - $\boldsymbol{SF_{i,T-t}}$, as Crescenzi et al, 2007 and 2012. The Social Filter Index is constructed through Principal Component Analysis (PCA)[6] of the individual variables that represent the labour force employed in firm's city and that should make a firm more or less innovation prone. The individual variables are:

- the qualification of employees measured by share of the labour force who have completed tertiary education (include masters and PhDs) in firm's city -***Educ***.

- the resources in Science and Technology measure by percentage the labour force employed in technological and science occupations in firm's city- ***ST***[7]**.**

- the demographic structure of employment measured by share of employees who are age between 15 and 24 in firm's city - ***Age***.

The combination of individual variables into one single composite indicator (*the 'Social Filter Index'*) develops a quantitative variable of the local structure of labour force, making it possible to compare the social filter conditions of different regions. We use the first principal component. All the variables enter the first principal component, which explain 46% of variation in the variables with the expected sign. The tertiary education and S&T variables are positively associated with the composite social filter variable, while the percentage of young employees has the negative sign. The level of educational attainment of the employees has the strongest association with the composite variable whereas the weakest is related to the percentage of young employees (Appendix A).

Regarding at the level of the firm, we employ a number of control variables which are correlated with the creation of knowledge and thus with innovation. The first variable is the innovation efforts - $\boldsymbol{RD_{i,T-t}}$ that represent total (internal and external) R&D expenditure. This variable is measure by the sum R&D expenditure divided by gross sale.

The second variable is the size of the firm- $\boldsymbol{Size_{i,T-t}}$. This variable allows capturing differentials generated by more staff which can raise the possibility of combinations of knowledge.

[6] The Principal Component Analysis is a technique which combines measures in a non-correlated order of importance, and describes the data variation.

[7] The data were selected from the 2002 Brazilian classification of Occupations (CBO2002) at subgroup level: 20-Polyscientific Researchers and Professionals; 21-Professionals in the exact sciences, physics and engineering; and 22-Professionals in the biological sciences, health and related.

The third variable is the measure of productivity of the firm - $\boldsymbol{Prod_{i,t\text{-}T}}$. As shown by Cohen and Levithal (1990) and Teece and Pisano (1994) innovations are dependent on the trajectory of accumulation of firms, thus enabling differentiated gains. In this sense, this variable is measured by industrial added value divided by total employees.

The fourth, fifth, sixth and seventh variables are dummies to control regions, sector, collaborations and capital origin. So, $\boldsymbol{Coll_{i,t\text{-}T}}$, the fourth variable, is a measure of collaboration between the agents involved in the innovation process. According to Teese and Pisano (1994), collaborations and partnerships can be a vehicle to learning for the firm. Thus, this variable assumes binary value, 1 if the firm has been involved in cooperative arrangements with other(s) organization(s) for developing innovative activities and zero otherwise.

The fifth variable is $\boldsymbol{CCO_{i,t\text{-}T}}$ that control specificities of the firm's controlling capital origin, and assumes value 1 if the firm's controlling capital is national; 2 if firm's controlling capital is foreign; and 3 if firm's controlling capital is both.

The sixth variable is industry dummy - $\boldsymbol{Sector_{i,t\text{-}T}}$ that controls the idiosyncrasies of each sector that may affect the ability of firms to innovate. To select the sector we used Castellacci typology and added the extractive industry.

Finally, the seventh variable at the firm level is the firm's macro-region - $\boldsymbol{MacroR_{i,t\text{-}T}}$ which controls the idiosyncrasies of each region.

Thus, the model in this work can be represented by the following form:

$$\begin{aligned} \boldsymbol{INNOV_{i,T}} &= \boldsymbol{\beta_0} + \boldsymbol{\beta_1 ln\left(WRD_{r_i,T-t}\right)} + \boldsymbol{\beta_2 ln\left(Aggl_{r_i,\,T-t}\right)} + \boldsymbol{\beta_3 kindex_{r_i,T-t}} + \boldsymbol{\beta_4 SF_{r_i,T-t}} \\ &+ \boldsymbol{\beta_5 ln\left(RD_{i,T-t}\right)} + \boldsymbol{\beta_6 ln\left(Size_{i,T-t}\right)} + \boldsymbol{\beta_7 ln\left(Prod_{i,T-t}\right)} + \boldsymbol{\beta_8 Coll_{i,T-t}} \\ &+ \boldsymbol{\beta_9 CCO_{i,T-t}} + \boldsymbol{\beta_{10} Sector_{i,T-t}} + \boldsymbol{\beta_{11} MacroR_{i,T-t}} + \boldsymbol{\varepsilon} \end{aligned} \tag{1}$$

In table 1 is shown the summary of the variables.

Table 1 :Summary of the variables.

VARIABLE	DESCRIPTION	DEFINITION/PROXY	SOURCE
INNOV	Innovation in Product or/and Process	The firm no introduced new product and/or process	PINTEC
		Product and/or process new for the firm	PINTEC
		Product and/or process new for the domestic market	PINTEC
		Product and/or process new for the world market	PINTEC
WRD	Spillovers	Total all other of firms' R&D expenditure/Gross Sales in firm's city	PINTEC
AggE	Economic Density	GDP per capita in firm's city	IBGE
AggP	Population Density	Population/ region area in firm's city	IBGE
KindexT	Measure of specialization regional	The index is calculated by the share employment on all 87 industry divisions (2 digit) of the CNAE - Brazilian Standard Industrial Classification in firm's micro-region	RAIS
KindexM	Measure of specialization regional	The index is calculated by share employment on the basis of the 29 major industry divisions (2 digit) - manufacture and extractive of the CNAE - Brazilian Standard Industrial Classification in in firm's micro-region.	RAIS
SF	Social Filter	% employees with completed tertiary education in firm's city	RAIS
		% of employees aged 15-24 in firm's city	RAIS
		% of employees in technologies activities in firm's city	RAIS
RD	R&D	Total expenditure on R&D as a % of Gross Sales	PINTEC
Size	Size of Firm	Number of Employees	PINTEC
Prod	Productivity	Industrial Added Value/ Number of employees	PINTEC
Coll	Dummy for Collaboration with others agents	Not	PINTEC
		Yes	PINTEC
CCO	Dummy for Firm's controlling capital origin	National	PINTEC
		Foreign	PINTEC
		Both (National and Foreign)	PINTEC
Sector	Dummy for industries (Typology Castellacci + Extractive)	AKP	PINTEC
		Extra	PINTEC
		MPG	PINTEC
		Others	PINTEC
		PGS	PINTEC
		SIS	PINTEC
MacroR	Dummy for firm’s Brazilian macro-region	N	RAIS
		NE	RAIS
		S	RAIS
		SE (without SP)	RAIS
		CW	RAIS
		SP	RAIS

4. Analysis of Results

The results are presented in Tables 1 and 2. Table 1 gives the main results. In the estimates (1) through (6) each territorial factor was included singly. In the estimates (I) through (VI) are exhibited full models for different agglomeration and specialization index. On Table 2 the social filter index is decomposed into its constituent elements and include in the full models (I' to VI' estimation).

Table 2: Ordered Probit Estimation - Innovation in Brazil, Social Filter Index (FS), 2008-2011.

Variables	Variable	1	2	3	4	5	6	I	II	III	IV	V	VI
R&D Spillovers	**WPD**	0.042 (0.028)						-0.039 (0.035)	-0.035 (0.036)	-0.044 (0.037)	-0.045 (0.038)	-0.051 (0.038)	-0.050 (0.038)
Agglomeration	**AggE**		**0.180** (0.077)**					**0.138* (0.076)**	**0.125* (0.076)**			**0.132* (0.074)**	0.113 (0.073)
	AggP			**0.041* (0.025)**						0.031 (0.030)	0.039 (0.031)	0.025 (0.030)	0.031 (0.030)
Krugman Index Diversification or Specialization	**KindexM**				-0.020 (0.163)			0.164 (0.163)		0.224 (0.175)		0.227 (0.174)	
	KindexT					0.0145 (0.199)			**0.356* (0.212)**		**0.504** (0.233)**		**0.451** (0.226)**
Social Filter	**SF**						**0.098*** (0.032)**	**0.120*** (0.042)**	**0.136*** (0.042)**	**0.120*** (0.040)**	**0.138*** (0.041)**	**0.110*** (0.042)**	**0.127*** (0.042)**
R&D	**RD**	**0.480*** (0.174)**	**0.487*** (0.173)**	**0.487*** (0.174)**	**0.501*** (0.174)**	**0.501*** (0.175)**	**0.450*** (0.174)**	**0.446*** (0.171)**	**0.451*** (0.172)**	**0.448*** (0.172)**	**0.457*** (0.172)**	**0.449*** (0.171)**	**0.457*** (0.171)**
Size	**Size**	**0.283*** (0.036)**	**0.277*** (0.036)**	**0.282*** (0.036)**	**0.289*** (0.037)**	**0.289*** (0.036)**	**0.280*** (0.035)**	**0.274*** (0.035)**	**0.276*** (0.035)**	**0.278*** (0.035)**	**0.280*** (0.035)**	**0.272*** (0.034)**	**0.275*** (0.035)**
Productivity	**Prod**	**0.385*** (0.102)**	**0.367*** (0.101)**	**0.386*** (0.101)**	**0.398*** (0.105)**	**0.398*** (0.105)**	**0.373*** (0.100)**	**0.357*** (0.098)**	**0.360*** (0.097)**	**0.375*** (0.098)**	**0.375*** (0.097)**	**0.359*** (0.097)**	**0.362*** (0.096)**

Continued.

Table 1: Continued.

Collaboration	**Coll**	**0.240*** (0.078)**	**0.236*** (0.077)**	**0.246*** (0.077)**	**0.242*** (0.080)**	**0.243*** (0.080)**	**0.238*** (0.078)**	**0.236*** (0.077)**	**0.239*** (0.077)**	**0.245*** (0.077)**	**0.249*** (0.076)**	**0.240*** (0.076)**	**0.244*** (0.075)**
Controlling Capital Origin	**CCO_F**	**0.296*** (0.099)**	**0.261*** (0.096)**	**0.283*** (0.099)**	**0.294*** (0.100)**	**0.295*** (0.100)**	**0.285*** (0.098)**	**0.261*** (0.093)**	**0.263*** (0.093)**	**0.280*** (0.097)**	**0.277*** (0.097)**	**0.257*** (0.094)**	**0.258*** (0.094)**
	CCO_B	-0.182 (0.201)	-0.212 (0.204)	-0.180 (0.198)	-0.189 (0.205)	-0.188 (0.205)	-0.188 (0.197)	-0.206 (0.194)	-0.203 (0.196)	-0.181 (0.190)	-0.178 (0.193)	-0.201 (0.191)	-0.197 (0.193)
Sector	**Sector**	X	X	X	X	X	X	X	X	X	X	X	X
Macro-region	**MacroR**	X	X	X	X	X	X	X	X	X	X	X	X
cut1	**Constant**	1.615*** (0.271)	2.022*** (0.342)	1.749*** (0.299)	1.561*** (0.315)	1.589*** (0.286)	1.594*** (0.266)	2.071*** (0.367)	2.075*** (0.350)	1.913*** (0.374)	1.999*** (0.344)	2.206*** (0.434)	2.205*** (0.405)
cut2	**Constant**	2.639*** (0.274)	3.049*** (0.346)	2.775*** (0.302)	2.583*** (0.321)	2.612*** (0.292)	2.622*** (0.270)	3.102*** (0.373)	3.106*** (0.355)	2.944*** (0.377)	3.031*** (0.346)	3.238*** (0.439)	3.238*** (0.410)
cut3	**Constant**	3.775*** (0.270)	4.187*** (0.348)	3.909*** (0.302)	3.716*** (0.310)	3.744*** (0.284)	3.764*** (0.265)	4.246*** (0.369)	4.251*** (0.355)	4.082*** (0.374)	4.171*** (0.348)	4.379*** (0.438)	4.381*** (0.412)
Number of Obs	**N**	4,058	4,058	4,048	4,058	4,058	4,058	4,058	4,058	4,048	4,048	4,048	4,048

***** p<0.01, ** p<0.05, * p<0.1**

Table 2: Ordered Probit Estimation - Innovation in Brazil, individual components of the social filter (FS), 2008-2011.

Variable	I'	II'	III'	IV'	V'	VI'	I"	II"	III"	IV"	V"	VI"	I"	II"	III"	IV"	V"	VI"
WPD	0.038 (0.032)	-0.010 (0.032)					-0.019 (0.037)	-0.049 (0.040)					0.002 (0.034)	-0.022 (0.036)				
AggE		0.162** (0.070)	0.181** (0.075)	0.158** (0.069)	0.149** (0.068)			0.137* (0.074)	0.124* (0.075)	0.128* (0.073)	0.111 (0.071)			0.113 (0.077)	0.107 (0.077)	0.112 (0.076)	0.0967 (0.074)	
AggP		0.019 (0.029)		0.027 (0.028)	0.034 (0.028)	0.053* (0.031)		0.017 (0.027)		0.016 (0.026)	0.023 (0.027)	0.033 (0.029)		0.014 (0.028)		0.017 (0.028)	0.024 (0.028)	0.031 (0.029)
KindexM	-0.084 (0.228)		-0.005 (0.224)	0.216 (0.174)		0.0217 (0.229)	-0.083 (0.228)		-0.020 (0.224)	0.207 (0.174)		-0.015 (0.225)	-0.052 (0.226)		-0.004 (0.223)	0.187 (0.173)		0.005 (0.227)
KindexT	0.354 (0.317)		0.273 (0.310)		0.408* (0.239)	0.428 (0.314)	0.406 (0.285)		0.352 (0.273)		0.421* (0.221)	0.483 (0.296)	0.309 (0.300)		0.251 (0.294)		0.348 (0.226)	0.381 (0.301)
Age	-1.554 (1.166)	-1.152 (1.137)	-1.985* (1.097)	-1.137 (1.101)	-1.565 (1.158)	-1.353 (1.186)												
Educ							2.226*** (0.688)	1.646** (0.711)	1.596*** (0.555)	1.116** (0.565)	1.358** (0.559)	1.558*** (0.532)						
ST													10.33*** (3.803)	7.229* (3.840)	8.280** (3.281)	6.131* (3.378)	6.822** (3.454)	8.393** (3.264)
RD	0.480*** (0.172)	0.477*** (0.172)	0.478*** (0.170)	0.467*** (0.171)	0.478*** (0.171)	0.484*** (0.172)	0.452*** (0.174)	0.456*** (0.174)	0.451*** (0.173)	0.447*** (0.172)	0.455*** (0.173)	0.456*** (0.173)	0.463*** (0.171)	0.466*** (0.171)	0.463*** (0.170)	0.456*** (0.171)	0.466*** (0.171)	0.465*** (0.171)
Size	0.282*** (0.035)	0.273*** (0.036)	0.273*** (0.035)	0.269*** (0.035)	0.272*** (0.035)	0.279*** (0.035)	0.286*** (0.035)	0.277*** (0.035)	0.277*** (0.035)	0.272*** (0.035)	0.275*** (0.035)	0.281*** (0.034)	0.282*** (0.035)	0.276*** (0.035)	0.276*** (0.035)	0.272*** (0.035)	0.275*** (0.035)	0.279*** (0.035)
Prod	0.379*** (0.102)	0.359*** (0.099)	0.356*** (0.099)	0.356*** (0.097)	0.358*** (0.098)	0.380*** (0.099)	0.383*** (0.100)	0.364*** (0.098)	0.363*** (0.098)	0.360*** (0.097)	0.363*** (0.097)	0.378*** (0.098)	0.376*** (0.099)	0.364*** (0.099)	0.363*** (0.098)	0.361*** (0.097)	0.364*** (0.097)	0.376*** (0.098)

Continued.

Table 2: Continued.

Coll	**0.248*** (0.077)**	**0.241*** (0.076)**	**0.244*** (0.076)**	**0.244*** (0.075)**	**0.249*** (0.074)**	**0.256*** (0.075)**	**0.235*** (0.079)**	**0.231*** (0.077)**	**0.233*** (0.077)**	**0.235*** (0.075)**	**0.238*** (0.075)**	**0.243*** (0.076)**	**0.246*** (0.077)**	**0.240*** (0.076)**	**0.242*** (0.076)**	**0.242*** (0.075)**	**0.246*** (0.074)**	**0.250*** (0.075)**
CCO_F	**0.302*** (0.099)**	**0.260*** (0.094)**	**0.269*** (0.095)**	**0.266*** (0.095)**	**0.267*** (0.095)**	**0.291*** (0.098)**	**0.290*** (0.098)**	**0.256*** (0.094)**	**0.270*** (0.095)**	**0.267*** (0.095)**	**0.268*** (0.095)**	**0.286*** (0.098)**	**0.273*** (0.096)**	**0.251*** (0.093)**	**0.259*** (0.096)**	**0.259*** (0.096)**	**0.258*** (0.096)**	**0.271*** (0.098)**
CCO_B	-0.179 (0.201)	-0.208 (0.199)	-0.207 (0.201)	-0.196 (0.193)	-0.194 (0.196)	-0.169 (0.194)	-0.180 (0.197)	-0.206 (0.196)	-0.194 (0.197)	-0.191 (0.192)	-0.186 (0.194)	-0.169 (0.193)	-0.193 (0.198)	-0.211 (0.198)	-0.205 (0.198)	-0.198 (0.193)	-0.196 (0.195)	-0.182 (0.194)
Sector	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MacroR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Constant	1.443*** (0.381)	1.834*** (0.472)	1.815*** (0.428)	2.089*** (0.513)	2.023*** (0.475)	1.815*** (0.469)	2.021*** (0.320)	2.171*** (0.373)	2.286*** (0.375)	2.324*** (0.416)	2.369*** (0.397)	2.188*** (0.378)	1.909*** (0.316)	2.035*** (0.362)	2.146*** (0.371)	2.234*** (0.422)	2.243*** (0.399)	2.089*** (0.375)
Constant	2.469*** (0.392)	2.863*** (0.483)	2.843*** (0.438)	3.119*** (0.523)	3.054*** (0.485)	2.844*** (0.478)	3.049*** (0.324)	3.201*** (0.378)	3.316*** (0.381)	3.354*** (0.420)	3.400*** (0.402)	3.218*** (0.381)	2.938*** (0.319)	3.066*** (0.366)	3.175*** (0.376)	3.264*** (0.427)	3.274*** (0.403)	3.119*** (0.377)
Constant	3.607*** (0.376)	4.002*** (0.476)	3.985*** (0.426)	4.258*** (0.516)	4.194*** (0.481)	3.980*** (0.468)	4.191*** (0.318)	4.342*** (0.380)	4.460*** (0.380)	4.495*** (0.422)	4.542*** (0.407)	4.358*** (0.382)	4.080*** (0.318)	4.206*** (0.367)	4.318*** (0.375)	4.405*** (0.426)	4.415*** (0.407)	4.259*** (0.378)
N	4,058	4,048	4,058	4,048	4,048	4,048	4,058	4,048	4,058	4,048	4,048	4,048	4,058	4,048	4,058	4,048	4,048	4,048

In general, the results show three territorial factors that affect innovation positively, while others factors have no significance.

Specifically, the coefficient R&D spillover (***WRD***) is not significant. Although nothing can be said of the relationship between spillovers and innovation in Brazil, it should be pointed out that this result is inconsistent with the primary conceptual assumptions presented on the discussion which firms tend to take advantage of spillovers to innovate. We can point to two possibilities for this result. First, the innovative efforts of neighbour' firms are not potential inputs for innovation, since there are low amounts spent on R&D by firms in Brazil. Second, it is that the level of aggregation used to capture the spillovers is unable to measure them.

Looking at the role of agglomeration effects, the coefficient economic agglomeration (***AggE***) is positive and significant in almost all estimations, while the coefficient of population agglomeration (***AggP***) is positive and significant only singly. This result shows that firms located in economically dense regions are more likely to innovate than firms located elsewhere. Differently, the population density does not emerge as a differential innovative factor. Possibly, in a context of low labour mobility and skill as in the Brazil the local interaction density (population density) does not seem to stimulate innovation while the relative concentration of wealth can be a differential source of competitive advantage for firms to promote innovation.

This result is reinforced when looking that the social filter coefficient is positive and significant. This is, the local structure of productive resources seems to play an important role in explaining differential innovative performance of firms. This suggests the combination the resources available give a synergy that contributes to innovation. More specifically, the firms that are in areas with firms with more share of employees of higher education and in S&T activity and less young employees are more likely to innovate than others. In light of these results, it can be said that the agglomeration, through the more availability of inputs, encourages the flow of ideas that stimulate innovative activities, but is the best qualification of the individuals that tends to make the firms more prone to innovate, since increasing individual skills tends to raise the skill that the firm has to recognize the value of knowledge, assimilate them and apply them for commercial purposes, to innovate. So, it is not enough to have the resource available, the innovation needs skilful resources available.

Finally, only the coefficient for the Krugman Index in all sectors (***KindexT***) has a positive and significance connection to innovation. This denotes that, based on all sectors, the firms are more innovative in regions that have more specialized production structures. Regarding the productive structure based on manufacturing, diversification or specialization is not correlated with innovation.

The coefficients for firm level variables, in general, are positive and significant, except ***CCO_B***, in all specifications. This demonstrates the strong relationship between innovation and firms characteristics, as pointed out by several authors (POLANYI, 1966; NELSON and WINTER, 1982; COHEN and LEVINTHAL, 1990; TEECE and PISANO, 1994; AUDRETSCH, 1998; PENROSE, 2006). In particular, we find that firms that collaborate (***Coll***) with others agents are more innovation prone than the ones that do not. Besides, the greater is the chance to innovate when the firm is controlled by foreign capital (***CCO_F***) than national. Regarding R&D investment (**RD**), as expected, there is positive and significant relationship with innovation, reaffirming that firms are more likely to innovate when making greater efforts in R&D. In additional, the larger firms and more productivity are more innovative.

When the individual components of the social filter are assessed separately, the significant and positive effect of higher education (***Educ***) and S&T variable (***ST***) is apparent, while young employees (***Age***) are insignificant. Therefore, it is not just the joint effect of the components of the social filter that is powerful, but also the individual components. This results show that factors such as high levels of education of employees and employment in S&T, taken individually, have an important influence on innovation. From the inspection of Table 2, the key resource for firms seems to be the percentage of employment in S&T following the employees holding bachelors, postgraduate or professional degrees. The other results remained virtually unchanged, the only exception is the index of specialization that loses its significance.

Conclusions

The relationship between innovation and territory has been the subject of increasing attention in the literature because there is an increasingly perception that factors related to location can play an important role in fostering and stimulating innovation. However, this discussion has paid little heed in emerging countries. In this way, this paper sought to contribute to decrease this gap by examine how the territorial factors affect innovation in Brazil, applying the Knowledge Production Function (KPF) in two levels.

The main results that comes off of this analysis is that, even in developing countries where the innovation levels are low and characterized mostly by imitation strategies, the territorial factors are important predictors of innovation. More specifically, this result suggests that the combination of greater availability of more skilled and less young labour is a strong factor that can make firms more susceptible to innovation.

In addition, the economic agglomeration and specialized productive activities have played an important role for innovation in Brazil. Firms located in more economically agglomerated regions or that have production structure which operates mainly in a specific industry tend to be more innovative than others elsewhere. Meanwhile, population agglomeration or knowledge spillovers did not show significant in this process.

Therefore, more than a critical mass is necessary in order to expect substantial local economic effects of the innovation efforts. It is essential the skilled employees to absorb and disseminate the knowledge for the innovation to occur.

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Appendix A. Social Filter Analysis

Table A1: Principal component analysis: correlation matrix and principal components' coefficients

Component	SF1	SF2	SF3
Eigenvalue	1.383	1.027	0.590
Difference	0.356	0.437	.
Proportion	0.461	0.342	0.197
Cumulative	0.461	0.803	1

Eigenvectors PCA

Variable	SF1	SF2	SF3
Education of the labour force **- *Educ***	0.719	-0.006	0.695
Employment in S&T **- *ST***	0.517	0.673	-0.528
Young employ **– *Age***	-0.465	0.739	0.487

Obs.=5560 (*cities*)