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The innovation and its territorial factors: An analysis in the micro-regions of São Paulo.

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Working Paper

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Abstract

This paper aims to examine empirically, through the application of the Knowledge Production Function, how the innovation in micro-region of São Paulo can be affected for some territorial factors. In the literature, and assumed here, the innovative results, measured by patents, are linked to the quantity and quality of innovative inputs and characteristics of the regions that are configured as an input. In this sense, stands the importance of positive externalities that are generated by the spatial concentration of producers and support institutions that are able to contribute to the efforts of innovative firms. In addition, this paper emphasizes the role of local production structures in the regions of São Paulo, since both the regional diversification and regional specialization are mentioned as important factors in the innovation process. The main results suggested that although the level of R&D investments were important for generating local innovation, ie, the generation of local patents, this relationship does not occur clearly in the regions of São Paulo. In addition, local productive structure or density linkages of firms that interacts are certainly important factors and compensatory for innovation process.

Key-words: Geography and Innovation; Knowledge Production Function; Patents, Production Structures.

JEL Classification: O31; O18; R12

Introduction

The ability of firms to innovate is the subject of many studies in recent years. The literature points that innovation process is highly related to the ability that companies have to absorb and transform the resources linked to knowledge. The knowledge, especially tacit, is the element that puts geography as an important factor of innovation. This is because knowledge is largely conditioned to the perception of who passes and who receives it. So its sharing often requires maintaining frequent interactions between agents and contacts face to face, factors that are facilitated by geographic proximity or other ways in which proximity can be express (social, cultural, institutional, etc.).

Thus, space is seen as the medium in which knowledge can overflow and strengthen the innovative capabilities of firms, which makes different patterns of spatial configuration of innovative activities, generated by several factors, an important source of differences in regional patterns innovation.

In this context, the location is highlighted as an important element of the innovation process and became the object of study of many studies. Among them may be quantitative studies proposing formulations of indicators of production and innovation to aid analysis of the relations of innovative activity and spatial point.

In Brazil, most of the studies that attempted to relate geography and innovation are concerned with understanding how innovative activities are distributed in the regions. However, there are few studies that sought to understand how the different distribution of geographical regions and factors can help or not innovative activity.

In this sense, this work aims to contribute to the understanding of these factors in Brazil to asses empirically, through the application of the Knowledge Production Function, as the level of local innovation as measured by patents, can be affected by some territorial factors and its distribution on regions of São Paulo. The main assumption of the work is that innovative regions results are linked to the quantity and quality of innovative inputs, as well as the spatial distribution of these and also the characteristics of the regions, such as crowding, productive structure.

The results of this analysis are embodied in three sections besides this introduction. The first section covers the review of the literature on the relationship between geography and innovation; the second section presents the methodology and empirical mode; the third section discusses the estimation results of models, and finally we have the conclusions.

1. Literature Review

The process of generation and diffusion of innovations has been studied by several authors. The main motivation of these studies is to evidence that innovations and technological advancements are essential for creating competitive advantages for firms. In addition, knowledge has been defined as the most important base for innovation. Thus, understanding the role, characteristics and forms of generation and diffusion of knowledge has become an important issue in the literature (NELSON and WINTER, 1982; JAFFE, 1993).

It is this knowledge that adds innovation an important factor, location, since part of it cannot be articulated or codified, being conditioned by the perception and awareness of your receiver and transmitter (Maskell and Malmberg, 1999).

According to Krugman et al. (1999), there are two forces at work in shaping the patterns of location of innovative activity. They are: agglomeration and dispersion. For the authors, the agglomeration force justifies the trend of innovative activities concentrate geographically. Have dispersion forces are opposite forces of agglomeration, which prevents all economic activities are concentrated in a single point in space. Thus, the activities focus until from which congestion induces activities to disperse so as to exempt the relevant costs.

The benefits generated by the agglomeration were interpreted by Marshall (1920) in his pioneering study. In this study, the author argues that the spatial concentration of firms in the same industry generates demand for skilled labour directed to the predominant industrial activity. This demand promotes the attraction of skilled workers to the site in the expectation of better jobs and salaries, for example. This concentration of skilled labour generates a space of constant learning of new knowledge that can give conditions for the occurrence of innovations that overflow to other firms.

To Breschi and Lissoni (2001), the externalities generated by the agglomeration can be identified as technological and pecuniary externalities. The pecuniary externalities are those that can be transmitted through market mechanisms and therefore are measured by their impact on cost and price. Thus, economies of specialization and economies of the labour market can be classified as pecuniary externalities origin. Already technological externalities are propagated directly by the companies and are characterized by lack of control over who transmits and who receives it (incidental) and "materialize through non-market interactions and, in principle, accessible to all members of a local community" with some requirements for absorption. Thus, knowledge spillovers can be classified as an externality of technological origin (ibid. p.977).

According to Breschi and Lissoni (ibid.), by this definition that distinguishes pecuniary externalities of technological externalities can be seen that it is much easier to measure pecuniary externalities than technological. The reason for this is that, as noted by Krugman (1991), the knowledge spillovers, in contrast to the pecuniary externalities "knowledge flows are invisible, they leave no paper trail by which they may be measured and tracked" (Ibid. p 53 in Jaffe et al. 1993, p.578).

However, according to Jaffe et al. (1993), it is possible, rather, to obtain evidence of knowledge spillovers. These evidences occur through patent citations. According to the authors, to request a patent it is mandatory to cite correlated existing patents, and inform the geographical information(s) of the inventor(s). Thus, according to Jaffe et al. (ibid.) if assessed by geographical location patent(s) quoted(s) and citing patent can get an idea of how occur the knowledge spillovers. The authors pointed out that knowledge spillovers tend to be geographically located. Since their results showed that there is a higher probability of inventor(s) of a citing patent being co-located(s) to inventor (s) of the cited patent.

After the study of Jaffe different variants and other indicators of knowledge spillovers have been developed and adapted to the diverse needs and analysis groups. According to Audretsch and Feldman (1996), there is a reciprocal relationship between the agglomeration and the spillovers generated by geography. Since the spatial concentration of firms is justified by the easy access to a range of benefits that are important to increasing market competitiveness, promote agglomeration externalities such as spillover, creating these benefits. At the same time, the spillovers are limited geographic, promoting agglomeration. In other words, agglomeration may result from knowledge spillovers, which, in turn, are facilitated by the agglomerations (Marshall, 1920, Jaffe et al, 1993;.Audretsch and Feldman, 1996 Breschi and Lissoni, 2004; Crescenzi et al, 2007).

The agglomeration can occur in places with diversified production structure or specialized. Marshall is the reference by stating that agglomeration in more specialized production structure - which operates mainly a specific industry - that generate externalities, commonly called Marshallian externalities. Across Jacobs excels at presenting the advantages of diversification of productive agglomerations. In the view of Jacobs, agglomeration of different and diverse industries that promotes and encourages imitation sharing and recombination of ideas and practices between complementary agents, and therefore externalities would come from a diverse regional industrial structure, so call Jacobian externalities.

So, some authors emphasize that specialized clustered regions are potentially the best of the knowledge creation and diffusion process, whereas other authors suggest that diversity is best facilitators of this process.

The empirical literature works in this context provide evidence supporting both theories. Audretsch and Feldman (1999), Carlino et al. (2001) and Co (2002) studies support the Jacobs theory, noting the positive effects of diversity to leverage innovations. In contrast, Penne (2004), in their study on the determinants of innovation, measured by counting the innovation, made possible by a questionnaire sent to companies, found that industrial specialization in the regions is important for fostering innovation (MONTENEGRO et al., 2011).

In turn, the study of Crescenzi et al. (2007), which analyzed and compared the dynamics of innovative regions in the United States and Europe, pointed out that, apart from differences in the amount and quality of innovative inputs, policies and institutions - that lead to innovative regions gap, as well as different patterns of spatial organization of innovative activities also presented as important factors causing innovative differential in both regions. However, in Europe, the externalities of diversity showed up developers of innovative activity, while the externalities of specialization were damaging the dynamics of innovative regions. In the United States, both externalities, diversity and specialization, are extreme importances to foster regions innovation.

In Brazil, efforts have been made in an attempt to understand the dynamics of innovation in Brazil. Among these studies are related to the geography of innovative activity. However, these analyzes are still recent, and reveal the obstacle generated by scarcity, heterogeneity and difficulty to obtain the databases.

The study by Albuquerque et al. (2002) was the first to treat the distribution of patents in Brazil. In this study the authors sought to evaluate the distribution and co localization of scientific and technological activities. According to the authors, only 16 % of Brazilian municipalities held a patent. In addition, there was a large concentration, with only 10 cities containing more than 50 % of total patents.

Another analysis was to Simões et al. (2005) who adopted a methodology to regionalize aggregated information of R&D in Brazil and pointed out that both sectoral and regional distribution is highly concentrated. According to the authors, only 5 among the 23 sectors analyzed are found 58 % of the amount spent on R & D in Brazil. Moreover, in general, according to the authors, the expenditure on R & D in Brazil are located in regions that have infrastructure that allows more intense development of innovative activity, which can be justified by the presence of economies of agglomeration present in these states (ibid., p. 182).

Gonçalves (2007) conducted an exploratory analysis to examine the pattern of innovative activity in the regions of Brazil. The author analyzes the dependence and spatial heterogeneity of innovation in Brazil, by calculating the statistics Moran's I and Local Moran, with data from patents per capita in 1999-2001 (base INPI). The author concludes that there is no randomness in the distribution of patents per capita in Brazil, and there is a scheme for North-South polarization, in which the regions North, Northeast and Midwest are marked by homogeneity in terms of low technological activity and, conversely, the regions south and southeast are those with the highest standard of innovation.

Montenegro and Betarelli Junior (2009) sought to understand some determinants of innovative activity in the regions of São Paulo. According to the authors, regions which have better structure and university research higher degree of agglomeration tend to be more innovative. Furthermore, the authors point out that there is a spatial dependence of innovative activities by showing that local innovation is directly linked to innovations from neighbouring counties, thus underscoring the importance of knowledge spillovers for innovation.

Another analysis was performed by Montenegro et al. (2011), which sought to understand the determinants of innovative activity in regions of the state of São Paulo. The authors showed that the presence of local production systems specialized and diversified, are important for the promotion of innovation. Furthermore, the educational level of the population employed in industries proved a fundamental variable ability of firms in the region to transform research and innovation development.

Another job was of Fajardo and Gonçalves (2011) that evaluated the innovation in Brazilian regions measured by patents. According to the authors, the crowding, the ability of university research and industrial R & D are factors that tend to positively affect innovation in Brazilian regions. Also, indicate that the proximity of region with more innovative performance is an important factor that can raise local innovations.

Finally, the work of Araújo (2013) assesses the dynamics of innovation in Brazilian micro-regions. According to the author innovation depends on a number of factors for the process to be successful, which include local levels of industrial R & D and university research, urban agglomeration and the local productive structure. Furthermore, innovation in Brazilian micro-regions is directly related to geographical proximity, where more innovative micro tends to also be more innovative neighbouring regions. That is, the proximity of particularly innovative regions may explain why some regions innovate more than others.

Thus, this study aims to contribute to the debate in Brazil to assess how the level of innovation of São Paulo regions is affected by territorial factors.

2. Model and Methodology

Empirical analysis is based on the Knowledge Production Function, formalized by Griliches (1979), adapted by Jaffe (1989), which can takes the form:

$$\log(P_{ikt}) = \beta_{1k} \log(RD_{ikt}) + \beta_{12} \log(U_{ikt}) + \beta_{31k} [\log(U_{ikt}) * \log(C_{ikt})] + \varepsilon_{ikt}$$

In this equation, P is the measure of patent, RD is the industrial research, U is the academic research; C is the measure of geographic coincidence of industrial research and university, and ε is the error, now determined in the region *i* (the study of Jaffe, 1989, states), *k* is the technological area and *t* is the time. This variant of the Knowledge Production Function proposed by Jaffe (1989) was extremely important for the development of studies related to the geography of innovation because it allowed the transformation of observation unit of the firm to the geographical, as used Audretsch and Feldman (1996), Feldman (1994), Crescenzi (2007), among others.

In good measure, a portion of these studies bothered to understand how the location of innovation activities can impact in generating innovation. As part of that, understand the relationship of local knowledge spillovers and the geographical proximity of actors involved in the innovation process (Jafffe; 1989, Feldman and Audretsch, 1999; Crescenzi et al, 2007.). To this end, a large portion of the literature suggests patents as proxy of innovation and varied inputs.

Thus, this proposed work should take a form very similar to the model presented by Jaffe (1989) extended by Crescenzi et al. (2007):

$$\begin{aligned}\ln(P_{i,T}) = \alpha + \beta_1 \ln(RD_{i,T-t}) + \beta_2 \ln(WrRD_{i,T-t}) + \beta_3 \ln(Aglom_{i,T-t}) + \beta_4 SocialFiltro_{i,T-t} \\ + \beta_5 IndexKrugman_{i,T-t} + \beta_6 \ln(IntUE_{i,T-t}) + \beta_7 \ln(P_{i,T-t}) + \beta_8 distCapital_{i,T-t} + \varepsilon \quad (1)\end{aligned}$$

Where $P_{i,T}$ is innovation or rate of innovation a micro i at time t=2005, measured by patents per capita require in INPI (Instituto Nacional de Propriedade Intelectual - Brazil)[1].

Patents, as previously mentioned, are used as a proxy for innovation in several international studies, as in Jaffe (1989), Crescenzi et al. (2007) and Carlino et al. (2000). However, the use of patents as a measure of innovation has some shortcomings and limitations. Such limitations include the fact that a patent is only one of the mechanisms available regarding the appropriation of the economic benefits of knowledge. The use of this instrument depends on the nature of the innovation process and technological, and therefore may vary significantly from sector to sector.

Acs and Audretsch (1988) pointed that industries in which the cost of imitation is relatively low have more number of patents compared the industries of high cost of

[1] Patents here refer to the sum of invention patents and utility model.

imitation, once the patent is used as a mechanism for protection of industrial property. In this sense, it should be noted that the choice of patenting does not always happen by entrepreneurs, as there are other mechanisms of appropriation.

Other deficiency of this measure is that, as already indicated, knowledge can be divided into tacit and codified knowledge (explicit). A patent, in turn, is part of the knowledge of coding possible, or is a result of innovative explicit character. Thus, not all knowledge can be measured for a patent. In addition, can point out is that there are inventions that do not translate into innovations.

It can be said, therefore, that patents represent only a part of the product from the innovative efforts. Thus, as emphasized Acs and Audretsch (ibid., p. 682), "they are an imperfect measure of innovative results, mainly because not all innovations are patented and can differ greatly in their economic impact".

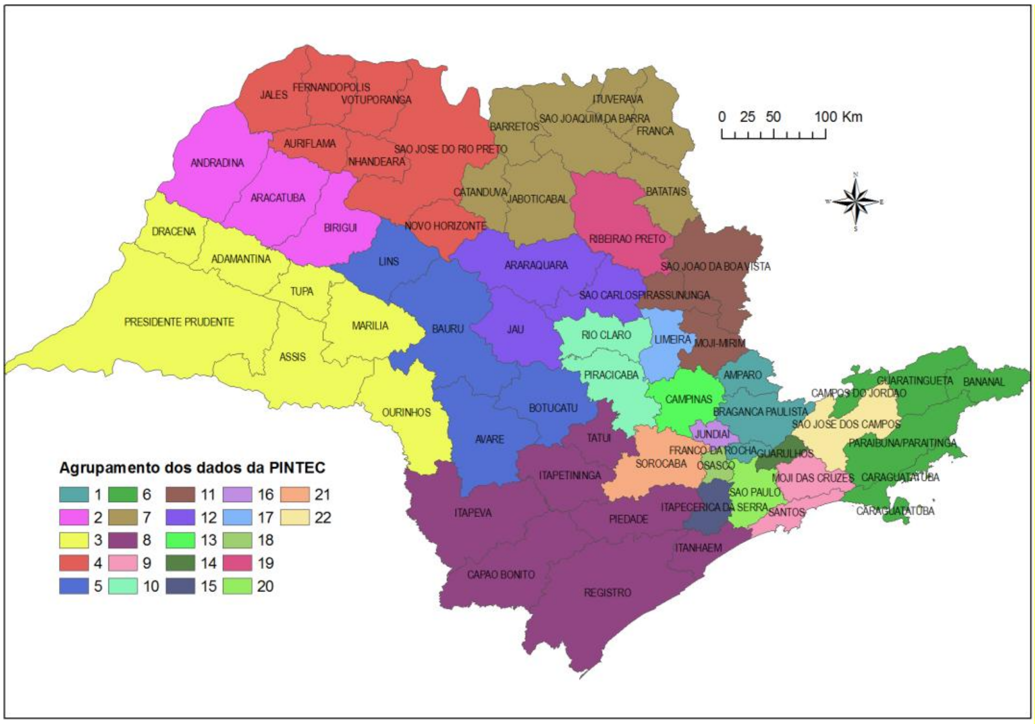
However, the use of the patent as an outcome measure innovative has certain advantages. Patents enable broad disintegration, both regional and sectors, since this information must be included for publication of the patent. This question is of great importance to make possible the measurement of knowledge spillovers. Another issue is that patents provide a broad basis for comparison with several studies that use them. In addition, Acs and Audretsch (ibid.) tested the reliability of patents as a proxy for innovation and their results showed that the use of patents is presented as a fairly reliable measure of innovation.

Regarding the explanatory variables, in model 1, $RD_{i,T-t}$ are R&D investments; $WRD_{i,T-t}$ are the knowledge spillovers of R&D investments in neighbouring regions. $Aglom_{i,\ T-t}$ is agglomeration of the region and the $SocialFiltro_{i,\ T-t}$ is composed of characteristics of individuals. Index $krugman_{i,\ T-t}$, is the productive structure, diversified or specialized, and $IntUE_{i,T-t}$ is the density of interactions between universities and firms. All measurements in micro i at time t-T. Still controlled are: Innovations in region i at an earlier time T-t, $P_{i,T-t}$, and the distance of the region to the state capital - $distCapital_{i,T-t}$, where are concentrated the most innovative efforts.

You should point out that the database used in this work was constructed from the assembly and use of different sources.

The R&D investments in the region, $RD_{i,T-t}$, were measured by total spent divided by the total number of firm innovative in the *micro-regions* (*i*) of state São Paulo at time 2000, data IBGE (PINTEC). This variable represents the most important input of innovation. You should point out that, as well as efforts in R&D, all explanatory variables are measured at t=2000, so there is a lag on the dependent variable. The main reason for this is because he innovative efforts can take some time for generates innovations.

You should point out that the state of Sao Paulo has 63 micro-regions. However, due to the low number of firms found in some micro and confidentiality of information provided by IBGE (PINTEC) these firms, the availability of data provided by PINTEC was limited 10 micro-regions and 12 groups of micro-regions. The Map 1 is shown the micro-regions and groups of data released by PINTEC.



Map 1: Division of the initial clustering of data PINTEC
Source: Authors'

To obtain as unit analysis the micro-regions it was adopted a procedure weighting from the share of employment in the region to groups of micro-regions data (12). Thus, all variables provided by PINTEC follows this pattern.

Emphasizes that the investments in R&D firms as well as improving their ability to generate new knowledge can give them the ability to internalize knowledge from other sources, such as the university R&D and/or other firms. Thus, as already pointed, knowledge spillovers may represent an important input of innovative activity of regions. Knowledge spillovers, represented by *WRD* in the equation 1, were calculated by weighting the expenditures on R&D on the queen matrix.

The *Aglom* is the degree of agglomeration of the local economy - as measured by urban population density, the IBGE / EMBRAPA. As already pointed out, the benefits of regional agglomeration are pointed out as an important factor that can generate innovative differentials in the region.

The S*ocialFilter* equation 1 is the variable that seeks to measure the characteristics of the population, present in the micro, which shape the behaviour of the population and the ability to obtain and absorb knowledge, to promote innovation in the regions. In this sense, attempts to capture three major aspects of the micro-region that are identified as very important by Crescenzi *et al*. (2007). They are:

i. the educational capacity of the population, or the qualification of the workforce in the micro-region to be measured by the number of people per capita on higher education - ***Sup***, INEP data. This aspect seeks to measure the accumulation of skills at the regional level.

ii. the structure of productive resources in science and technology, ***Tecn,*** measured by the number of employees in technology occupations by the total number of employees in the micro, data RAIS-MTE[2].

iii. demographic structure of the micro, ***Idade***, measured by per capita number of people aged between 15 and 24 years in the micro, IBGE data. Seeks to identify trends in population dynamics, under the assumption that young people contribute to the renewal of local society that will influence the attitude of innovation and social change in general.

The social filter is calculated by principal component analysis which combines the three measures in a non-correlated order of importance, and describes the data variation. It

[2] Were selected from the Brazilian classification of occupations 94 at the group level technology related occupations 011; 012; 019; 020; 021; 023; 024; 025; 026; 027; 029; 081; 082; 083.

should be pointed out that it may be necessary to incorporate more than one component, which will depend on the analysis of said component as a combination.

Specialization or diversification of the micro-region will be measured by the Krugman index, represented in equation 1 by *kindex* calculated through the employment data in manufacturing in the regions, RAIS-MTE. Krugman index was calculated as follows:

$$Kindex_{i,T-t} = \sum abs\left(v_{i,t-T}^{k} - v_{i,t-T}^{-k}\right) \qquad with \quad v_{i,t-T}^{k} = \frac{\sum_{j\neq i} x_{i,T-t\backslash}^{k}}{\sum_{k}\sum_{j\neq i} x_{i,T-t\backslash}^{k}} \quad (2)$$

Were $v_{i,T-t}^{k}$ is part of a sector k in region i on all businesses in this region and $v_{i,T-t}^{-k}$ is part of the same enterprise sector from all other regions different from i divided by all firms of other regions different of i. The index has a value close to zero if the micro-region is more diverse and maximum 2 if more specialized.

Finally, in equation 1, *IntUE* is density of interactions between universities and industry in the micro-region, measured by the number of interactions of firms with research groups by number of interactive firms in the micro-regions, Data Group Directory of *CNPq*. This variable seeks to capture the importance of interaction between enterprises and universities, since, as pointed out by Gertler (2007), the basis for innovation is to increase the interaction and flow of knowledge among stakeholders and are magnified by the physical proximity. Moreover, this variable can be of extreme importance for the understanding generation of innovation in Brazil, since the investment in R&D the firms are low in Brazil.

In addition to the variables presented above, two controls were added to the analysis. They are: The first, the time lag of innovative results, presented by $P_{i,T-t}$, measured by the initial number (2000) of patents per capita in the micro-region in the region. The main goal of incorporating this variable is to control the different initial patterns of technological capability in the region, which may also reflect differences in the propensity of the region's innovative capacity. The second, the road distance between a micro and the state capital. This variable attempts to control regional differences given the proximity of the micro São Paulo where it concentrates a significant part of the assets of the state of São Paulo.

3. Results

Before presenting the results of estimations for the model it is important to notice that the principal component analysis performed for the variable of social filter gave rise to two variables that were included in the model as *compFS1* and *compFS2*. The results of this component are in attached.

Also should point out the model already presented were estimated for patents per capita in regions in 2005 and patents growth rate in regions between 2000 to 2005. The estimation results are shown in Tables 1 and 2.

In the regressions 1-17 of table 1 and 2 the measure for local innovative efforts (*RD*), the proxy for knowledge spillovers (*WRD*), initial level of patent (P00) and capital distance (*distCapital*) variable are present and others variables relative to territory (agglomeration- *Aglom*, social filter - *comp1SF* and *comp2SF*, index krugman and density of interactions between university and industry - *IntUE*) are introduced on successively and/or sequentially. In the regressions 4–6 the individual components of the social filter are included separately in order to discriminate among them.

Table 1: OLS estimation of empirical model. Patents *per capita* in 2005 in micro-regions São Paulo

lnP05	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0,204	0,198	0,186	0,188	0,202	0,152	0,146	0,013	0,180	0,122	0,011	0,132	-0,00	-0,04	0,109	-0,00	-0,05
lnRD	(0,071)***	(0,072)***	(0,081)**	(0,077)**	(0,072)***	(0,087)*	(0,071)**	(0,087)	(0,082)**	(0,072)*	(0,088)	(0,080)	(0,102)	(0,081)	(0,080)	(0,103)	(0,096)
	0,069	0,084	0,104	0,097	0,072	0,046	0,030	0,062	0,122	0,055	0,052	0,060	0,064	-0,03	0,088	0,051	-0,03
lnWRD	(0,087)	(0,090)	(0,097)	(0,100)	(0,088)	(0,090)	(0,084)	(0,092)	(0,100)	(0,084)	(0,096)	(0,093)	(0,103)	(0,090)	(0,094)	(0,108)	(0,102)
		0,264							0,288	0,587	-0,18				0,604	-0,19	0,220
lnAglom		(0,397)							(0,404)	(0,384)	(0,401)				(0,391)	(0,415)	(0,404)
			0,018						0,015			0,014	0,033		0,008	0,032	0,026
comp1SF			(0,108)						(0,109)			(0,103)	(0,105)		(0,101)	(0,107)	(0,097)
			0,096						0,101			0,080	-0,01		0,088	-0,01	-0,02
comp2SF			(0,108)						(0,109)			(0,102)	(0,117)		(0,101)	(0,119)	(0,108)
				0,197													
lnSup				(0,338)													
					-0,64												
lnIdade					(1,165)												
						0,269											
lnTec						(0,260)											
							-1,10			-1,29		-1,08		-1,23	-1,28		-1,32
kindex							(0,428)**			(0,441)***		(0,436)**		(0,414)***	(0,447)***		(0,460)***
								0,920			0,933		0,987	1,019		1,017	1,090
lnIntUE								(0,505)*			(0,511)*		(0,594)	(0,461)**		(0,604)	(0,550)*
	0,358	0,361	0,337	0,337	0,365	0,345	0,360	0,307	0,340	0,368	0,305	0,342	0,293	0,294	0,351	0,290	0,282
lnP00	(0,142)**	(0,143)**	(0,148)**	(0,147)**	(0,143)**	(0,142)**	(0,134)**	(0,144)**	(0,149)**	(0,132)***	(0,145)**	(0,140)**	(0,154)*	(0,131)**	(0,138)**	(0,156)*	(0,142)*
	0,124	0,151	0,114	0,119	0,112	0,126	0,192	0,004	0,141	0,262	-0,01	0,182	0,014	0,057	0,251	-0,00	0,098
lnDistCapital	(0,122)	(0,129)	(0,128)	(0,123)	(0,125)	(0,122)	(0,118)	(0,115)	(0,134)	(0,125)**	(0,127)	(0,124)	(0,122)	(0,106)	(0,130)*	(0,134)	(0,127)
	-1,68	-4,15	-1,72	-2,75	3,232	-2,65	-0,90	-0,80	-4,41	-6,24	0,962	-0,95	-0,85	0,276	-6,44	0,981	-1,78
cons	(0,858)*	(3,812)	(0,885)*	(2,034)	(8,959)	(1,268)**	(0,866)	(0,837)	(3,869)	(3,605)*	(3,915)	(0,895)	(0,878)	(0,844)	(3,661)*	(4,067)	(3,823)
N. obs	53	53	53	53	53	53	53	44	53	53	44	53	44	44	53	44	44
	F(4, 48)	F(5, 47)	F(6, 46)	F(5, 47)	F(5, 47)	F(5, 47)	F(5, 47)	F(5, 38)	F(7, 45)	F(6, 46)	F(6, 37)	F(7, 45)	F(7, 36)	F(6, 37)	F(8, 44)	F(8, 35)	F(9, 34)
	=7,83	=6,28	=5,22	=6,24	=6,23	=6,48	=8,34	=4,65	=4,5	=7,53	=3,83	=5,87	=3,17	=6,15	=5,59	=2,74	=3,87
Prob > F	0,0001	0,0002	0,0004	0,0002	0,0002	0,0001	0	0,0021	0,0007	0	0,0045	0,0001	0,0101	0,0002	0,0001	0,0183	0,0019
R2	0,395	0,400	0,405	0,399	0,399	0,408	0,470	0,380	0,412	0,496	0,383	0,477	0,382	0,499	0,504	0,386	0,506
Adj R2	0,344	0,337	0,328	0,335	0,335	0,345	0,414	0,298	0,320	0,430	0,283	0,396	0,262	0,418	0,414	0,245	0,375
Root MSE	0,649	0,653	0,657	0,654	0,654	0,649	0,614	0,577	0,661	0,605	0,583	0,623	0,592	0,525	0,614	0,599	0,545

Robust standard errors in parentheses. *significant at 10%; **significant at 5%; **significant at 1%.

Source: Authors'

Table 2: OLS estimation of empirical model. Patent growth rate 2000-2005, in micro-regions of São Paulo

P05/P00	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0,204	0,198	0,186	0,188	0,202	0,152	0,146	0,013	0,180	0,122	0,011	0,132	-0,00	-0,04	0,109	-0,00	-0,05
lnRD	(0,071)***	(0,072)***	(0,081)**	(0,077)**	(0,072)***	(0,087)*	(0,071)**	(0,087)	(0,082)**	(0,072)*	(0,088)	(0,080)	(0,102)	(0,081)	(0,080)	(0,103)	(0,096)
	0,069	0,084	0,104	0,097	0,072	0,046	0,030	0,062	0,122	0,055	0,052	0,060	0,064	-0,03	0,088	0,051	-0,03
lnWRD	(0,087)	(0,090)	(0,097)	(0,100)	(0,088)	(0,090)	(0,084)	(0,092)	(0,100)	(0,084)	(0,096)	(0,093)	(0,103)	(0,090)	(0,094)	(0,108)	(0,102)
		0,264							0,288	0,587	-0,18				0,604	-0,19	0,220
lnAglom		(0,397)							(0,404)	(0,384)	(0,401)				(0,391)	(0,415)	(0,404)
			0,018						0,015			0,014	0,033		0,008	0,032	0,026
comp1SF			(0,108)						(0,109)			(0,103)	(0,105)		(0,101)	(0,107)	(0,097)
			0,096						0,101			0,080	-0,01		0,088	-0,01	-0,02
comp2SF			(0,108)						(0,109)			(0,102)	(0,117)		(0,101)	(0,119)	(0,108)
				0,197													
lnSup				(0,338)													
					-0,64												
lnIdade					(1,165)												
						0,269											
lnTec						(0,260)											
Index							-1,10			-1,29		-1,08		-1,23	-1,28		-1,32
Krugman							(0,428)**			(0,441)***		(0,436)**		(0,414)***	(0,447)***		(0,460)***
								0,920			0,933		0,987	1,019		1,017	1,090
lnIntUE								(0,505)*			(0,511)*		(0,594)	(0,461)**		(0,604)	(0,550)*
	-0,64	-0,63	-0,66	-0,66	-0,63	-0,65	-0,63	-0,69	-0,65	-0,63	-0,69	-0,65	-0,70	-0,70	-0,64	-0,70	-0,71
lnP00	(0,142)***	(0,143)***	(0,148)***	(0,147)***	(0,143)***	(0,142)***	(0,134)***	(0,144)***	(0,149)***	(0,132)***	(0,145)***	(0,140)***	(0,154)***	(0,131)***	(0,138)***	(0,156)***	(0,142)***
	0,124	0,151	0,114	0,119	0,112	0,126	0,192	0,004	0,141	0,262	-0,01	0,182	0,014	0,057	0,251	-0,00	0,098
lnDistCapital	(0,122)	(0,129)	(0,128)	(0,123)	(0,125)	(0,122)	(0,118)	(0,115)	(0,134)	(0,125)**	(0,127)	(0,124)	(0,122)	(0,106)	(0,130)*	(0,134)	(0,127)
	-1,68	-4,15	-1,72	-2,75	3,232	-2,65	-0,90	-0,80	-4,41	-6,24	0,962	-0,95	-0,85	0,276	-6,44	0,981	-1,78
cons	(0,858)*	(3,812)	(0,885)*	(2,034)	(8,959)	(1,268)**	(0,866)	(0,837)	(3,869)	(3,605)*	(3,915)	(0,895)	(0,878)	(0,844)	(3,661)*	(4,067)	(3,823)
N. obs	53	53	53	53	53	53	53	44	53	53	44	53	44	44	53	44	44
	F(4, 48) =7,83	F(5, 47) =6,28	F(6, 46) =5,22	F(5, 47) =6,24	F(5, 47) =6,23	F(5, 47) =6,48	F(5, 47) =8,34	F(5, 38) =4,65	F(7, 45) =4,5	F(6, 46) =7,53	F(6, 37) =3,83	F(7, 45) =5,87	F(7, 36) =3,17	F(6, 37) =6,15	F(8, 44) =5,59	F(8, 35) =2,74	F(9, 34) =3,87
Prob > F	0,0001	0,0002	0,0004	0,0002	0,0002	0,0001	0	0,0021	0,0007	0	0,0045	0,0001	0,0101	0,0002	0,0001	0,0183	0,0019
R2	0,395	0,400	0,405	0,399	0,399	0,408	0,470	0,380	0,412	0,496	0,383	0,477	0,382	0,499	0,504	0,386	0,506
Adj R2	0,344	0,337	0,328	0,335	0,335	0,345	0,414	0,298	0,320	0,430	0,283	0,396	0,262	0,418	0,414	0,245	0,375
Root MSE	0,649	0,653	0,657	0,654	0,654	0,649	0,614	0,577	0,661	0,605	0,583	0,623	0,592	0,525	0,614	0,599	0,545

Robust standard errors in parentheses. *significant at 10%; **significant at 5%; **significant at 1%.

Source: Authors'

As can be seen, in most cases, both the models, R&D investments exhibit positive and significant coefficient. This result is expected and indicates that as greater are the efforts of R&D higher local levels of innovations can be found.

Which refers to knowledge spillovers - *WrPD*, both models, the coefficient is not significant. This may indicate that the R&D expenditure of neighbouring micro-regions does not exert any statistically significant influence upon patent growth. The hypothesis raised for this result is that as pointed previously the patent is only part of the mechanism in which innovations are measured, so part of the innovation that occurs in a micro cannot be captured by this variable. For this reason it is not possible to show the impact of spillovers on innovation. A second scenario relates to the use of different data sources to measure this relationship. Patent data come from a source (INPI) different from R&D data (PINTEC).

Concerning the industrial structure, it is noted that the coefficient of the Krugman index (*kindex*) is negative and significant. This means that the more diverse regions are it improves the innovation performance of the micro-region. This can be seen as an indication that the benefits of Jacobian externalities are more important as generators of innovation than Marshallian externalities.

The coefficient of the density of interactions between university and firms (*IntUE*) was positive and significant. This reveals the importance of the density of interactions between the agents to generate patents. Thus, one can say that considering the density of interactions interactive firms as an input with the efforts in R&D, these are proving of great importance in the process of generating patents. You should point out that this result may be linked to the fact that there may be a relationship between sectors (firms) and patents. In sectors that most patents are also those who have more interaction. Ie, sectors (and firms) where little innovation relates to patents exhibit minor interaction between companies and universities.

Furthermore, it should be noted that introduction of variables *kindex* or *IntUE* makes not significant the R&D coefficient. This loss of significance may be a indication that low local R&D investment can be compensated by the characteristic of the local productive structure and/or intensity of interactions among agents in the regions and thus guarantee the generation of local innovation. In this sense, fostering forms of relationships among innovation actors across sectors can help raise the levels of regional innovation.

As regards the variables of social filter (*filtrosocial*) and density urban (*Aglom*) showed no significance.

Finally, the coefficient on the initial level of patenting was positive and significant in cases where the dependent variable is a measure of the absolute and negative and significant where dependent variable is measured by the rate of innovation. Thus, we can point out that the process of innovation of São Paulo is related to micro innovations stunted present in each region. That evidences the existence of temporal inertia of innovation.

Conclusion

The relationship between innovation and territory has been the subject of increasing attention in the international literature, since there is an increasing perception that factors related to location can play an important role in fostering and stimulating innovation.

This paper sought to put more light on this discussion in Brazil, examine empirically, through the application of the Knowledge Production Function, how the innovation in micro-region of São Paulo can be affected for some territorial factors. The main results suggested that although the level of R&D investments were important for generating local innovation, ie, the generation of local patents, this relationship does not occur clearly in the regions of São Paulo. In addition, local productive structure or density linkages of firms that interacts are certainly important factors and compensatory for innovation process.

Furthermore, as in the literature, the process of innovation of São Paulo is related to initial innovations present in each micro-region, evidencing the existence of temporal inertia of innovation.

Appedix

Table 1: Results of the principal component analysis

Principal components/correlation				Number of obs=63 Number of comp=3 Trace =3 Rho = 1,00	
Component	Eigenvalue	Difference	Proportion	Cumulative	
Comp1	1,351	0,264	0,450		0,450
Comp2	1,087	0,524	0,362		0,813
Comp3	0,563	.	0,188		1,000

Principal components(eigenvectors)					
variable	Comp1	Comp2	Comp3	Unexplained	
sup	0,462	0,717	0,522		0
idade	0,481	-0,697	0,531		0
tecn	0,745	0,006	-0,667		0

BIOGRAPHY

ARAÚJO, V. Dimensão local da inovação no Brasil: determinantes e efeitos de proximidade. Tese de doutorado apresentada à Engenharia de Produção - USP, 2013.

ACS, Z.J. and AUDRETSCH, D.B. Innovation in large and small firms: an empirical analysis. The American Economic Review, pages 678–690, 1988.

ANSELIN, L; VARGA, A; ACS, Z. Local geographic spillovers between university research and high technology innovations. Journal of Urban Economics, v. 42, n. 3, p. 422-448, 1997.

AUDRETSCH, D.B and FELDMAN, M.P. R&D spillovers and the geography of innovation and production. The American Economic Review, 86(3):630–640, 1996.

AUDRETSCH, D.B. Agglomeration and the location of economic activity. Oxford Review of Economic Policy, 14(2):18–29, 1998.

BRESCHI, S.; LISSONI, F. Knowledge spillovers and local innovation systems: a critical survey. Industrial and corporate change, 10(4):975, 2001.

CABRER-BORRÁS, B., SERRANO-DOMINGO, G., Innovation and R&D spillover effects in Spanish regions: A spatial approach. Research Policy, v. 36, p. 1357-1371, jun 2007.

CARLINO, G. A.; CHATTERJEE, S. & HUNT, R. M. Urban density and the rate of invention. Journal of Urban Economics 61, 389–419, 2007.

CRESCENZI, R.; RODRÍGUEZ-POSE, A. & STORPER, M. The territorial dynamics of innovation: a Europe-United States comparative analysis. Journal of Economic Geography 7, p. 673-709. Oxford University Press, 2007.

FELDMAN, M. P AND AUDRETSCH, D.B.. Innovation in cities: Science-based diversity, specialization and localized competition. European Economic Review, 43(2):409–429, 1999.

FUJITA, M., KRUGMAN, P., VENABLES, A.. The Spatial Economy: Cities, Regions, and International Trade. MIT Press, Cambridge, 1999.

GERTLER, M.S. Tacit knowledge in production systems: how important is geography. The Economic Geography of Innovation, pages 87–111, 2007.

GLEASER, E; KALLAL, H; SCHEINKMAN, J and SHLEIFER, A. Growth in cities. Journal of Political Economy, 100(6), 1992

GONÇALVES, E.; ALMEIDA, E. S. Innovation and Spatial Knowledge Spillovers: Evidence from Brazilian Patent Data. Regional Studies, v. 43, p. 513–528, mai. 2009

GONÇALVES, E.; FAJARDO B. A. G. A influência da proximidade Tecnológica e geográfica sobre a Inovação regional no Brasil. Rev. Econ. Contemp., Rio de Janeiro, v. 15, n. 1, p. 112-142, 2011.

GRILICHES, Z. Issues in assessing the contribution of research and development to productivity growth. Bell Journal of Economics, v. 10, p. 92-116, 1979.

JACOBS, J. The Economies of Cities. Random House, New York, 1969.

JAFFE, A. B. Real effects of academic research, American Economic Review 79(5): 957-970, 1989.

JAFFE, A.B., TRAJTENBERG, M.AND HENDERSON, R.. Geographic localization of knowledge spillovers as evidenced by patent citations. the Quarterly journal of Economics, 108(3): 577, 1993.

MARSHALL, A. Principles in Economics, Macmillan, London, 1920.

MONTENEGRO, R. L. G.; BETARELLI JR, A. A. Análise e Investigação dos Fatores Determinantes da Inovação nos Municípios de São Paulo. Revista da Associação Brasileira de Estudos Regionais e Urbanos, 2, 2, 2009

MONTENEGRO, R. L., GONÇALVES, E. & ALMEIDA, E. Dinâmica Espacial e Temporal da Inovação no Estado de São Paulo: Uma Análise das Externalidades de Diversificação e Especialização. Estudos Econômicos 41(4), 2011.

MORENO, R., PACI, R; USAI, S. Spatial spillovers and innovation activity in European regions. Environment and Planning A, volume 37, pages 1793 – 1812, 2005a.

______. Geographical and sectoral clusters of innovation in Europe. Ann Reg Sci 39:715–739, 2005b.

NELSON, R.R. AND. WINTER, S. (1982) an evolutionary theory of economic change.

PACI, R; USAI, S. Externalities, knowledge spillovers and the spatial distribution of innovation. GeoJournal 49: 381–390, 1999.

STORPER, M. AND VENABLES, A.J.. Buzz: face-to-face contact and the urban economy. Journal of economic geography, 4(4):351, 2004.

SUZIGAN, W.; ALBUQUERQUE, E.; GARCIA, R.; RAPINI, M. University and industry linkages in Brazil: some preliminary and descriptive results. Seoul Journal of Economics, v. 22, p. 591-611, 2009.