ON THE GEOGRAPHIC DISTRIBUTION OF KNOWLEDGE-INTENSIVE ENTREPRENEURSHIP: AN EVALUATION OF THE STATE OF SÃO PAULO, BRAZIL

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ABSTRACT

History has shown that the distribution of knowledge-intensive entrepreneurship (KIE) is concentrated in space, a function of agglomeration economies and the existence of a multidimensional structure that fosters the location of entrepreneurial activity in certain areas more than in others. Understanding the determinants and dynamics of emergence of entrepreneurial ecosystems represents a fundamental aspect in defining and orienting public policies aiming at reinforcing existing structures; and/or facilitating the rise of latent systems. This is particularly true for developing economies. These nations are poorly addressed by economic literature in concerning the spatial dynamics of entrepreneurial and innovation systems. In this research we propose an exploratory evaluation of the geography of KIEs in the State of São Paulo, Brazil, with focus on the determinants of KIE density at the city-level using data for 1130 KIE projects from the PIPE Program (Fapesp) in 114 cities. Descriptive assessments pinpoint the case of São Carlos as a strong candidate for representing the most developed entrepreneurial ecosystem in this region. Moreover, through OLS and heteroskedascity-corrected estimations for multidimensional models we find preliminary indications concerning the existence of agglomeration diseconomies affecting the location of KIE density in the State of São Paulo.

1. INTRODUCTION

The emphasis during the last couple of decades on (knowledge-intensive) entrepreneurship[1]-driven policies in developed and emerging economies alike is a continuation of a long-standing interest in bridging technical knowledge and products and services (Arrow, 1962), as well as reducing temporal and spatial inefficiencies (Kirzner, 1997). This is so because innovation-driven entrepreneurship is often seen as the key engine of socio-economic change and growth (Schumpeter, 1934; Baumol, 1968; Beckman et al, 2012). Additionally, it is noteworthy that the focus of policymaking has somewhat shifted over the years from a "regulation-oriented" approach to the activity of large corporations, to a "nurture-based" rationale dedicated to fostering small businesses (Gilbert et al, 2004).

[1] Knowledge-intensive entrepreneurship or simply KIE.

Nonetheless, history has shown that the distribution of these activities is concentrated in space (Stam, 2009; Feldman, 2001; Dorfman, 1983), a function of agglomeration economies and the existence of a multidimensional structure that fosters the location of entrepreneurial activity in certain areas more than in others. Consequently, significant impacts on social welfare and wealth creation (Beckman et al, 2012; Hathaway, 2013) arising from entrepreneurial activity are mainly felt at the regional level (Ács & Armington, 2004; Fritsch, 2008). These spatial dynamics are bound to generate two core options for KIE-related policies (OECD, 2007): i) redistribution of economic activity towards laggard areas (based on the logic of economic convergence); or ii) promoting supply-side benefits that promote aggregate growth (which may lead to regional divergence).

Accordingly, understanding the determinants and dynamics of emergence of entrepreneurial ecosystems represents a fundamental aspect in defining and orienting public policies aiming at reinforcing existing structures; and/or facilitating the rise of latent systems. Although this seems like a straightforward conclusion, the socio-economic environment underlying these agglomerations is often poorly comprehended, generating misguided and inefficient allocation of public resources. This is particularly true for developing economies. These nations are poorly addressed by economic literature in what refers to spatial dynamics of economic and innovation systems. Moreover, they present marked differences in respect to the usual subjects of research in geography of KIE activity, i.e., developed countries (Crescenzi & Rodríguez-Pose, 2012), rendering the existing body of knowledge in this area only partially (at best) applicable to the context of laggard systems.

For instance, a recent report released by The World Bank (Lederman et al, 2014) on entrepreneurial activity in Latin America points out that entrepreneurial activity in these nations suffer from an endemic and severe innovation gap in comparison with developed economies[2], making a case for in-depth analyses on the surrounding environments in which entrepreneurship is embedded in this group of countries. In the case of Brazil, the economic leader in Latin America, regional demographic and economic asymmetries have been recognized by the government as a barrier for further dispersion of entrepreneurial activity outside metropolitan areas (Brasil, 2012). This feature of the Brazilian economic system is likely to hinder a proper evolution of its Regional Innovation Systems, generating increased levels of agglomeration diseconomies and hampering the geographical diffusion of socioeconomic benefits arising from knowledge-intensive entrepreneurship (KIE). In this regard, the Brazilian institutional environment for entrepreneurial activities presents considerable barriers *vis-à-vis* developed economies (OECD, 2008), hence deserving the construction of more robust knowledge on its idiosyncrasies.

In this research we propose an exploratory evaluation of the geography of KIEs in the State of São Paulo, Brazil, with focus on the determinants of KIE density at the city-level. We depart from existing literature to establish four core dimensions of interest, namely: *Urban Environment, Centrality/Peripherality, Infrastructural Conditions,* and *Economic Structure*. The rationale behind this assumption is that KIE is a systemic phenomenon integrated within innovation systems, and being affected by market, technological and institutional opportunities (Radosevic & Yoruk, 2013). The relevance of this assessment lies in the scant attention that entrepreneurship as an aggregate phenomenon has received in the field of innovation systems (Ács, Autio & Szerb, 2014).

[2] This is valid for new product introduction, managerial practices, R&D investments and patent activity (Lederman et al, 2014).

Our core interest is to generate empirical knowledge on the geography of innovation-oriented entrepreneurship, addressing some of its determinants, thus outlining potential public policy implications. Further aspects in the scientific realm, particularly connected to the dynamics of KIE in Brazil and in developing countries in general are also in our agenda. The indicator we have applied as a proxy for KIE activity is represented by PIPE Program's grants, which are funded by Fapesp (the research funding agency of the State of São Paulo) and directed towards innovative initiatives in small enterprises. These data comprehend 1130 grants provided to entrepreneurs located in 114 cities in São Paulo. Our estimations of the relevance of entrepreneurial ecosystems' determinants rely on OLS and heteroskedasticity-corrected regressions.

The rest of this document is structured as follows: section 2 introduces some of the main theoretical and empirical landmarks found in literature concerning the geography of entrepreneurship. Section 3 presents the methodological steps of our analytical exercise. Section 4 contains the exploration of our dataset and econometric estimations of the determinants of KIE activity. Section 4 concludes with some relevant remarks, potential implications for KIE-related policymaking and avenues for future research.

2. LITERATURE REVIEW ON THE GEOGRAPHY OF ENTREPRENEURSHIP

The geography of knowledge-intensive entrepreneurship (KIE) shows that this activity is unevenly distributed across space, which can be primarily related to heterogeneous endowments in terms of knowledge, institutions, resources and demand (Stam, 2009). We can add to this a consistent and straightforward explanation for clustering processes of KIE: "*industries cluster because entrepreneurs find it difficult to leverage the social ties necessary to mobilize essential resources when they reside far from those resources*" (Stuart & Sorenson, 2003, p. 229). Duranton (2007) exposes the issue of geographical shifts in economic activity as a function of innovation and entrepreneurship (what he calls "small industry-level shocks"), bringing to light a much more evolutionary-oriented view of the geography of entrepreneurship (and its relevance to the long term development of regions). This introductory perspective highlights the important role of public policy in setting the stage for KIE to flourish, taking into account the multidimensionality of the driving forces of these phenomena.

However, more than considering absolute stocks of influential dimensions on entrepreneurial activity, it is fundamental to understand that the productivity of an entrepreneurial system is affected by the performance of any of its components (Ács, Autio & Szerb, 2014). In a similar vein, Radosevic and Yoruk (2013, p. 1016) propose that "*entrepreneurship activity is a social activity which is dependent on structural features of the economic system and on social processes and mechanisms*". These authors refer to the "entrepreneurial propensity" of innovation systems as their capacity to generate and exploit innovation-oriented opportunities (Radosevic & Yoruk, 2013).

The discussion contained in this section approaches a wide array of research subjects related to the location and spatial concentration of entrepreneurial and innovation-driven activity. As a starting point for further scrutiny of theoretical and empirical issues, we present Krugman's (1998) rationale on the dynamics of centripetal and centrifugal forces in economic geography (see Table 1).

Centripetal forces	Centrifugal forces
Market-size effects (linkages)	Immobile forces
Thick labor markets	Land rents
Pure external economies	Pure external diseconomies

Table 1. Forces affecting geographical concentration
Source: Krugman (1998).

These propositions represent the fundamental cornerstone of the New Economic Geography, and they are inherently related to several other analytical frameworks on the concentration of economic activity. On the one hand, centripetal forces stand for systemic characteristics that have positive impacts on geographical clustering, generating increasing returns to scale (*a la* endogenous growth theory). On the other hand, centrifugal forces represent a set of characteristics that act in the opposite direction, creating decreasing returns to scale (*a la* traditional neoclassical models).

The simultaneous existence of both of these forces spawns a dynamic equilibrium which we refer to as *gravitational balance*. A positive gravitational balance represents a situation of enduring concentration of economic activity, where centripetal forces prevail. A negative gravitational balance can be understood as the opposite situation, with dominant centrifugal forces[3]. As it will be further explored in this section, the sole issue of pure external economies/diseconomies is affected by a myriad of vectors involving a complex comprehension of how to facilitate the emergence of hubs of entrepreneurship.

The main problem is that the governmental role associated with the promotion of productive agglomerations (districts, clusters, entrepreneurial ecosystems, etc.) is usually directed towards direct support to specific locations (in a simplistic, linear fashion), while the most relevant indirect aspects (related to a wide range of infrastructure aspects, regulatory frameworks and institutional efficiency) are not properly addressed (Mazzarol, 2014; Lerner, 2009). Correspondingly, Freytag and Thurik (2007) stress the relevance of an "entrepreneurial environment" comprising issues related to economic regulations, administrative complexity, intellectual property rights, education, etc. In their view, these aspects represent the basic framework conditions which public policy can act upon. Audretsch et al (2006) refer to this as "entrepreneurship capital", understood as local-level institutions that foster entrepreneurial activity.

Hence, the shortsightedness from public policy ends up compromising the success of local productive systems even in the presence of deliberate initiatives to foster their development (Mason & Brown, 2013). As a consequence, it is of utmost importance to build further scientific knowledge on the drivers of KIE activity in space, enabling policymakers to conceive better-informed initiatives to promote the emergence of these new ventures. In order to develop the empirical structure of our analysis, the following subsection scrutinizes the core aspects related to the generation and concentration of entrepreneurial activity in space.

2.1 Location Determinants of (Knowledge-Intensive) Entrepreneurship

One first indicator that is expected to be related to entrepreneurial strengths is GDP per capita (Radosevic & Yoruk, 2013). This aspect of the economic condition of nations and regions functions as a proxy for the demand (purchase power) and the supply (labor and capital productivity) sides of productive systems. Moreover, it provides systemic

[3] Delgado, Porter and Stern (2010) use a similar conceptual rationale, where they identify situations of agglomeration (positive gravitational balance) and convergence (negative gravitational balance).

feedbacks that allow a continuous evolution of innovation systems over time. Also, wealthy economies are more prone to have available financial resources for reinvesting in new ventures (in a typical endogenous growth formulation). As it happens, credit availability is a fundamental feature of economic systems related to the upsurge of entrepreneurial activity (Ács, Autio & Szerb, 2014), a traditional Schumpeterian assumption.

On a different realm, Glaeser (2007) identifies demographic traits (such as age and education levels) as an important driver of entrepreneurial behavior in cities[4]. Similar propositions are made by Stuart & Sorenson (2003), who use population size as a proxy for the pool of potential entrepreneurs, and for available infrastructure for new companies (Stuart & Sorenson, 2003). In its turn, higher levels of urbanization are likely to promote more intense relationships among individuals, and it is also expected to drive up diversification of consumer demand (Stam, 2009). Additionally, urbanization economies are important for firm-level activities, but they have marginal effects on productivity in a comparison with localization economies[5] (Rosenthal & Strange, 2001; Stuart & Sorenson, 2003). Also, localization economies represented by the presence of a complementary economic structure seem to generate strong incentives for new business creation and contributions to start-up firms' survival (Delgado, Porter & Stern, 2010; Glaeser & Kerr, 2009). This is likely to promote the necessary feedback for positive reinforcement of agglomerations over time.

Under a more geographic-oriented perspective, several authors have addressed the existing dynamics behind physical distances. Usually, large distances to political and economic centers of power functions as an indicator of peripheral regions (Iammarino 2005), where periphery is commonly associated with laggard innovation systems. For example, Fritsch (2002) finds evidence supporting the existence of an efficiency gap of innovative activity in peripheral regions in a comparison with "central" regions, indicating the existence of agglomeration economies. Also, geographically peripheral regions have difficulties to translate innovation into regional growth due to reduced levels of interconnectedness with innovation networks located elsewhere and low exposure to knowledge spillovers from central areas (Crescenzi & Rodríguez-Pose, 2012). Gilbert et al (2004) present analogous findings, suggesting that geographical proximity is fundamental for knowledge transmission, thus having an important impact on the emergence of knowledge-intensive entrepreneurial activity.

Nonetheless, there is an extensive body of literature which asserts that geographical proximity *per se* is not a determinant of network formation (see, for instance, Boschma & Martin, 2010), thus not necessarily leading to the desired innovation outcomes. For this reason, the OECD (2007) stresses the importance of entrepreneurial policies tackling issues related to business networking and technology transfer strategies. Furthermore, it must be reminded that this literature is widely oriented towards the socioeconomic environment of developed countries and their respective regions. In this context, there is scant evidence on possible predominance of a negative gravitational balance, i.e., the occurrence of strong external diseconomies. We wonder to what extent these dynamics hold true for less developed locations.

In terms of physical and knowledge infrastructure, geographical proximity to research-oriented universities and research centers is often seen as a valuable source of expertise for high-tech entrepreneurial activity (Stam, 2009; Etzkowitz, 1998; Dorfman, 1983). Also, the presence of science parks stands for a core support mechanisms for

[4] Glaeser and Kerr (2009) find a limited role of demographics on manufacturing entrepreneurship.
[5] Urbanization economies are related to economies of scale arising from city size. Localization economies are those economies of scale arising from spatial concentration of industries (Rosenthal & Strange, 2001).

start-ups (Fini et al, 2011; Feldman, 2001). Thereupon, regions which are better endowed in terms of physical and human capital, universities and research centers are more prone to create virtuous circles of innovative activity (Fitjar & Rodríguez-Pose, 2011). Notwithstanding, these aspects are not uncontroversial. Motoyama and Danley (2012), for example, while highlighting the key role played by a highly skilled labor force, also find little contribution arising from the presence of research-oriented universities, R&D investment, patents, and venture capital firms[6]. Similar results are reported by Motoyama and Wiens (2015), also pinpointing the ineffectiveness of business incubators as a tool in the process of entrepreneurial promotion.

The following section presents the methodological procedures of our research, including our analytical proposal based on the theoretical and empirical features exposed in this literature review.

3. METHODOLOGICAL PROCEDURES

Our empirical exercise is based primarily on data from the PIPE/FAPESP program (Innovative Research in Small Enterprises, managed by the São Paulo Research Foundation), an initiative that grants subsidies for entrepreneurial projects presenting high levels of knowledge-intensity and innovative potential. The program was created in 1997 and it was strongly inspired by the Small Business Innovation Research (SBIR) program in the USA. It comprises KIE projects within a two-stage structure[7]: the first phase is focused on researching the feasibility of proposals (up to 6 months); the second phase supports the technical and productive development of proposals (up to 24 months).

Though we acknowledge that this dataset potentially represents a small fraction of the KIE scenario in the State of São Paulo, it is also true that it offers an interesting source of "certified" knowledge-intensive entrepreneurs for 1130 knowledge-intensive proposals, as a result of the technical body of experts involved in the appreciation of submitted proposals. This makes possible to work with high-quality micro-level data, instead of resorting to the analysis of knowledge-intensive sectors (and all of its internal heterogeneities).

Although the dataset was originally composed of 1196 proposals, 66 of them represented projects in different stages of support by FAPESP[8]. Hence, we have scanned the dataset and kept only projects with different technological goals. Around a third of the total number of projects belonged to entrepreneurs with more than one project inscribed in the PIPE Program. Nonetheless, as our interest lies within the scope of entrepreneurial *activity* (not entrepreneurial individuals or firms), we kept in the dataset all observations that consisted in different potential contributions to economic systems.

Operationally, data are mainly oriented towards the geographic location of ventures. We have also gathered complementary information on economic conditions of firms' locations (see table 2 for the set of variables used in empirical analyses) as indicators of the socioeconomic environment in which these new ventures are embedded. These

[6] It must be noticed that these authors do not focus on KIE firms, but rather on high-growth companies. Hence, one may consider that there is a sample bias (related to high firm-level heterogeneity) in their analysis.

[7] Projects are neither obliged to follow each stage in a linear manner, nor to stay connected to the PIPE program after finishing a given stage (regardless of it being successful or not).

[8] It was not within our interest in this exploratory approach to assess differential results between distinct stages of development of KIE. Rather, our focus lies exclusively on knowledge-intensive projects, regardless of their phase of development.

variables function as proxies for the evaluation of the determinants of entrepreneurial activity within the scope of our sample.

From this we attempt to build a descriptive analysis of the KIE geographical structure within São Paulo, through standard procedures, such as location Gini and explanatory explorations of socioeconomic data. We have also explored the distribution of projects per 100 thousand inhabitants in order to have a control for population size[9] (highly skewed in absolute terms towards the Metropolitan Region of São Paulo). We finish this descriptive assessment by applying log-likelihood clusters to the population of PIPE projects, aiming at generating some further knowledge on the distribution of KIE activity in the State of São Paulo. In order to achieve more robust insights from the dataset, we also undertake an assessment of the population of PIPE projects from an econometric perspective. For this purpose, we have developed three exploratory models.

Code	Definition	Source
PROJECTS	Number of projects granted to a given municipality.	PIPE/FAPESP
PROJP100	Number of projects per 100 thousand inhabitants aged 25-54 (see variable POP).	PIPE/FAPESP and SEADE
GDPPC	Average GDP per capita 1999-2012 (constant 2012 Reais).	SEADE
CRED	Average credit operations per capita 1993-2013 (constant 2014 Reais)	SEADE
INFRA	Average municipal investments in infrastructure 1993-2011 (constant 2014 Reais)	SEADE
POP	Average population aged 25-54 1993-2014.	SEADE
DENS	Average demographic density (inhab./km2) 1993-2014.	SEADE
HDI	Average municipal Human Development Index 1991, 2000, 2010.	SEADE
URB	Average percentage of urban territory 1992-2014	SEADE
RESUNI	Existence of at least one major research-oriented university or university campus with focus on STEM in the city. Dummy variable.	Brazilian Ministry of Education
DISTCAP	Distance in km from the state capital and economic center, São Paulo. The distance is calculated in "road distance" from Google maps.	Google Maps
TECHPARK	Presence of a relevant technological park within the city boundaries.	Development Office of the State of São Paulo
TECHACT	Patent activity (National Office) per 100.000 inhabitants 2002-2005. This variable contains data for microrregions, thus being extended for municipalities included in each of these larger locations.	FAPESP
BUSCONC	Average participation (%) of total businesses in the state's total 2008-2011.	IBGE
LABCONC	Average participation (%) of the labor force in the state's total 2008-2011.	IBGE

Table 2. Analytical variables.

The rationale for choosing this specific set of indicators comes from a wide range of theoretical and empirical sources previously outlined in our literature review. Most variables represent averages of city-level behavior over different periods of time. This is an unfortunate issue arising from data availability constraints, but the idea is to offer a

[9] In this case, only the cohort of people aged 25-54 was considered (for this group includes the main target population for KIE activity). In a similar vein, Glaeser (2007) focuses on the cohort comprehending people aged 25 and 65.

"smoother" representation of the conditions of municipal economic contexts. This procedure avoids problems related to year-to-year variations, while also controlling for the time span during which projects have started (1998-2014). Besides variables that are directly related to our literature review (see subsection 2.1) we have also included variables that control for municipal-level HDI as a proxy for institutional quality (Alonso & Garcimartín, 2011), and technological activity at the micro-regional level.

The exploration of the abovementioned indicators follows a simple exploratory entrepreneurial propensity function[10], assessing a set of entrepreneurial systems' location determinants (for further information on the components of the model, see Stel, Storey & Thurik, 2007; Glaeser, 2007; Radosevic & Yoruk, 2013; Fritsch, 2002; Stam, 2009; Ács, Autio & Szerb, 2014; Fini et al, 2011). The fundamental structure of this assessment is outlined in Model 1 below.

$$\boldsymbol{Y = AZ^{\alpha}}$$

Model 1

Where **Y** represents the KIE activity, **A** is a measure of overall efficiency of unaccounted predictors (error term), and **Z** (with elasticity **α)** stands for a representative vector of the following dimensions:

$$\boldsymbol{Z^{\alpha} = X^{\beta}C^{\gamma}I^{\delta}S^{\varepsilon}}$$

Model 1.1

Where **Z** is defined by four influential dimensions, namely: i) *Urban Environment* (**X** with elasticity β); ii) *Centrality/Peripherality* (**C** with elasticity γ); iii) *Infrastructural Conditions* (**I** with elasticity δ); and iv) *Economic Structure* (**S** with elasticity ε). These dimensions represent mere constructs of elements already analyzed by dedicated literature. It is not within the scope of this research to restrain these broad vectors of entrepreneurial patterns in space, but rather to use them as guidance for empirical estimations. Because of the sample size, and in order to estimate parsimonious model specifications, we have ran regressions according to three different functional forms of model 1 classified by their analytical dimensions. The measure of *Centrality/Peripherality* (i.e. DISTCAP) was kept across models as a control for potential latent agglomeration externalities arising from proximity to the economic center represented by the city of São Paulo. The functional forms of regressions are outlined below.

$$lnPROJP100_i = \kappa + \beta_1 lnDENS_i + \beta_2 URB_i + \beta 3HDI_i + \gamma lnDISTCAP_i + \chi \quad (1)$$

$$lnPROJP100_i = \kappa + \rho_1 RESUNI_i + \rho_2 TECHPARK_i + \rho_3 lnINFRA_i + \rho_4 lnCRED_i + \gamma lnDISTCAP_i + \chi \quad (2)$$

$$lnPROJP100_i = \kappa + \varepsilon_1 BUSCONC_i + \varepsilon_2 LABCONC_i + \varepsilon_3 lnGDPPC_i + \varepsilon_4 lnTECHACTi + \gamma lnDISTCAP_i + \chi \quad (3)$$

Where the density of knowledge-intensive entrepreneurship (PROJP100[11]) in municipality "i" is a proxy for $\boldsymbol{\vartheta}$ and, according to previous definitions, a function of

[10] Radosevic and Yoruk (2013, p.1016) define entrepreneurial propensity as "*its* [Innovation Systems'] *capacity to generate and explore entrepreneurial opportunities in order to create new knowledge-intensive enterprises, new technologies (innovations) and new knowledge*".

[11] In this case, the dependent construct is PROJP100 so we can deal with the excessive number of repetitions in predicted values (for PROJECTS, for example, over 50 municipalities had only 1 project

Urban Environments (estimated by DENS, URB and HDI), *Infrastructural Conditions* (RESUNI, TECHPARK, INFRA and CRED), and the *Economic Structure* (BUSCONC, LABCONC, GDPPC and TECHACT). *Centrality/Peripherality* of a given location (DISTCAP[12]) is kept constant across models. κ is the constant in the model and χ is the error term in each estimation. We have taken natural logs for continuous variables, except those represented by percentage variations (URB, HDI, BUSCONC and LABCONC; RESUNI and TECHNPARK are dummy variables). Empirical applications of these 3 equations consisted in OLS regressions. Robustness tests were applied via heteroskedasticity-corrected estimations. Results of empirical analyses are presented in the next section.

4. RESULTS

We begin our analysis of the PIPE dataset by examining the concentration of projects throughout the territory of the State of São Paulo. The location Gini, though imperfect, offers a measure of geographic dispersion/concentration of industrial activities. Audretsch and Feldman (1996) also use spatial Gini as a measure of industrial concentration and find that innovative activity is more concentrated than overall production. Rosenthal and Strange (2001) and Ellison and Glaeser (1997) criticize the use of spatial Gini as this indicator might be an indicator of industrial structure rather than actual industrial concentration (as it would happen in a sector largely dominated by few large companies). We do not feel that this is an issue when dealing with KIE because of the inherent characteristics of these activities and the usual difficulty of classifying breakthrough activities within standard industrial classifications. As it can be gathered from Figure 1, the level of spatial concentration of KIE in the area under scrutiny is rather high (.809). Some further remarks on this characteristic of the dataset are explored below.

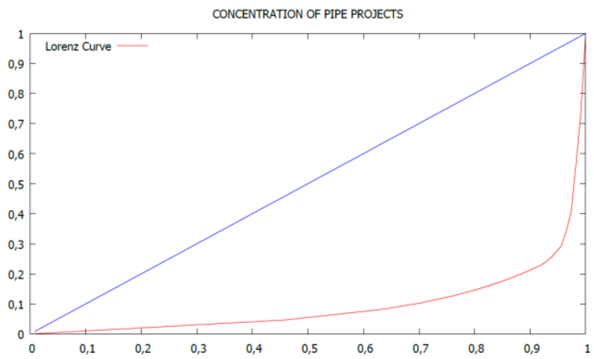


Figure 1. Concentration of PIPE Projects throughout the existence of the program (1998-2014).

Note: The Location Gini Index (city-level) for the population of projects is 0.809 (N=114). The Lorenz Curve is represented in red.

Table 3 builds a clearer picture of the distribution structure of KIE activity, putting emphasis on the importance of São Paulo, Campinas, São Carlos, São José dos Campos and Ribeirão Preto as main generators of innovation-driven entrepreneurship. What is interesting to notice is that, unlike the other main KIE cities, São Carlos does not rank

approved for PIPE support). Also, the analysis of entrepreneurial activity normalized by population size is a usual indicator of entrepreneurial density (Ács, Autio & Szerb, 2014).

[12] This variable is expected to have a negative sign. The remaining predictors are expected to be positive.

amongst the top ten largest economies at the state-level, coming only in the 35th position (as per 2012)[13]. As it will be subsequently highlighted, this particular location seems to stand for a very interesting case for closer examination, as it potentially represents a main regional entrepreneurial ecosystem.

City	Number of Projects	Total%	Cumulative%
São Paulo	298	26,35%	26,35%
Campinas	197	17,42%	43,77%
São Carlos	177	15,65%	59,42%
São José dos Campos	72	6,37%	65,78%
Ribeirão Preto	55	4,86%	70,65%
Remaining Cities (109)	332	29,27%	100%

Table 3. City-level distribution of PIPE projects in the State of São Paulo.

Table 4, in its turn, offers a geographical aggregation of PIPE projects' occurrence, considering data for administrative regions. Our intention in this case is to gather information on potential wider areas of influence from the main municipalities of our assessment (those presented in Table 3). Confirming our expectations, the concentration of projects around these locations increases from a total of 70.65% (main cities only) to nearly 91% of the population of KIE activity. A better grasp on the spatial patterns of this distribution can be gathered from Heatmap 1 which underscores the relevance of the “São Paulo-Ribeirão Preto axis”, going from East to North (in an approximate distance of 318 km). In this map we can also notice a high level of spatial correlation in the incidence of absolute numbers of PIPE projects. There is a clear core (red) around the metropolitan area of São Paulo, with an adjacent yellow zone with relatively high levels of KIE activity. A green periphery is contiguous to this yellow zone, while the remaining regions of the state show little to none KIE activity in absolute terms. Notwithstanding, and as expressed in the next analyses, we cannot rule out a strong relationship between this phenomenon and the concentration of state-level population.

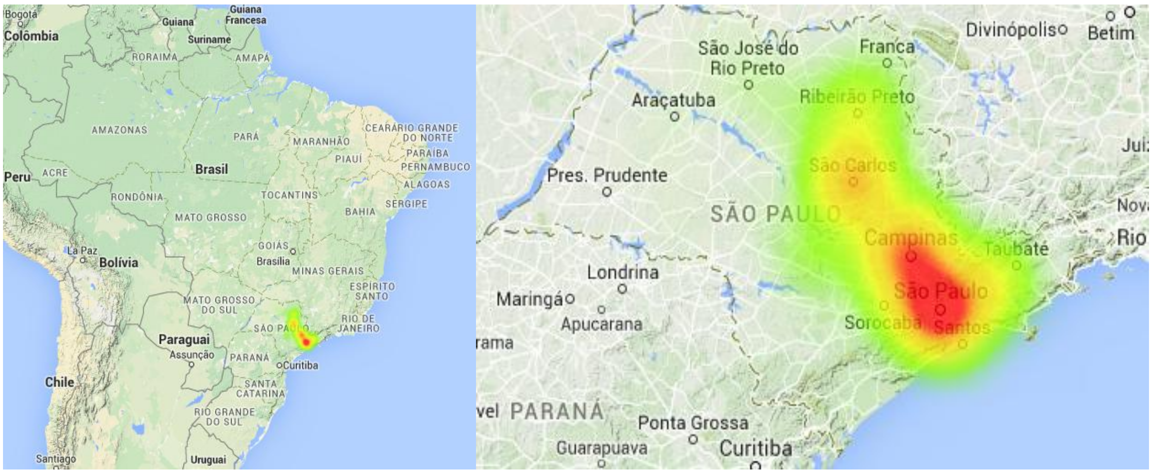
Administrative Region	Number of Projects	Total%	Cumulative%
São Paulo	389	34,42%	34,42%
Campinas	311	27,52%	61,95%
Central (São Carlos)	186	16,46%	78,41%
São José dos Campos	73	6,46%	84,87%
Ribeirão Preto	69	6,11%	90,97%
Remaining Regions (11)	102	9,03%	100,00%

Table 4. Regional-level (according to Administrative Regions classification) distribution of PIPE projects in the State of São Paulo.

Once we control for population size, São Carlos (city-level) is the only location that maintains a leading position in our ranks, offering support to our previously stated hypothesis that this municipality may represent an interesting case for future studies on the nature of its entrepreneurial ecosystem. In fact, it has the highest number of projects per 100 thousand inhabitants (199,43), followed by Holambra (152,78) and Rafard

[13] According to the absolute city-level GDP.

(112,73)[14]. It should be noticed, however, that among the top 10 cities with the highest scores in this item, only São Carlos and Campinas have over 50 thousand inhabitants[15] within the 25-54 years-old cohort, thus being less prone to suffer from excessive sensitiveness from a small number of KIE initiatives.



Heatmap 1. Distribution of PIPE projects 1998-2014.

Note: The heatmap on the left contextualizes the location of São in Brazil. The map on the right focuses on this particular state of the federation. The color-scale range from light green to red, where the latter indicates higher concentrations of absolute numbers of PIPE projects (mainly around the São Paulo-Campinas axis). Due to scale patterns, regions with minor participation in PIPE projects are not identified in this map.

		N	% of Combined	% of Total	Centroid	Main Examples
Cluster	***KIE-intensive***	3	2,63%	2,63%	154,98	São Carlos
	Moderate presence of KIE	10	8,77%	8,77%	51,24	Campinas
	Spasmodic presence of KIE	101	88,60%	88,60%	7,39	São José dos Campos, São Paulo, Ribeirão Preto
Total		114	100,00%	100,00%		

Table 5. Cluster analysis (log-likelihood distances) based on the number of projects per 100 thousand inhabitants (age cohorts 25-54) - variable PROJP100 (centroids).

The next step in our analysis consists in using PROJP100, i.e., number of projects controlled by population, as a classification variable for log-likelihood distances in a cluster assessment. We have predefined the number of clusters to 3 groups in order to develop an introductory taxonomy of KIE activity according to each municipality. These results are presented in Table 5 and basically correspond to concerns raised by The World Bank (Lederman et al, 2014) as per the innovation intensity of entrepreneurship in Latin American Countries. In this regard, most locations are classified as having only spasmodic levels of KIE, being its incidence highly concentrated in space (although we are now looking at number of projects weighed by population). Even cities (São José dos Campos, São Paulo and Ribeirão Preto) that

[14] São Carlos is located in the Central Administrative Region. Both Holambra and Rafard are located in the Campinas Administrative Region.
[15] São Carlos had an average population in the 25-54 years-old cohort (1993-2014) of 88,752 inhabitants. In its turn, the number for Campinas is 451,106.

concentrate a high absolute number of projects perform poorly in this assessment, suggesting a lack of capabilities to become true entrepreneurial ecosystems.

The last step in this exploratory assessment of KIE activity in the State of São Paulo (as per data from PIPE projects) consists in the estimations of equations 1-3. Results from OLS estimations can be found in Table 6 and the outcomes from heteroskedasticity-corrected estimations are presented in Table 7.

	Equation I	Equation II	Equation II.a	Equation III
const.	3.799*** [1.406]	-.484 [1.428]	-.584 [1.441]	-1.728 [2.219]
LnDISTCAP	-.096 [.059]	.129** [.057]	.116** [.057]	.331*** [.123]
LnDENS	-.435*** [.083]	-	-	-
URB	.127 [1.275]	-	-	-
HDI	1.423 [2.423]	-	-	-
RESUNI	-	-.017 [.329]	.326 [.269]	-
TECHPARK	-	.746* [.421]	-	-
LnINFRA	-	.608*** [.200]	.587*** [.202]	-
LnCRED	-	-.192 [.116]	-.156 [.116]	-
LnGDPPC	-	-	-	.177 [.216]
BUSCONC	-	-	-	49.295 [63.977]
LABCONC	-	-	-	-43.405 [73.151]
LnTECHACT	-	-	-	.089 [.138]
R^2	.285	.129	.103	.070
Valid N	114	114	114	114
Std. Errors in brackets	*sig. at 10%; **sig. at 5%; ***sig. at 1%			

Table 6. Results of OLS estimations

The first column indicates results for the *Urban Environment* dimension (also controlling for the *Centrality/Peripherality* dimension, as it happens for all equations). This model presents the highest level of predictive power in our empirical exercise (yet the R^2 is only moderate at .285) in OLS estimations, though this picture changes once we account for the presence of heteroskedasticity in residuals. Albeit the predictive power of models is substantially increased in this latter approach, we must highlight that individual variables' behaviors suffer only minor changes. At any rate, there is a predominance of effects related to *Urban Environment* and *Infrastrucutral Conditions* dimensions.

Interestingly, the variable DENS presents a significant and negative influence upon the dependent construct (density of KIE activity). This exploratory finding is in contradiction with expectations that population density in cities drives the formation of networks, the flow of ideas, and ultimately higher levels of innovation-related output (see Glaeser, 2011). Nonetheless, these assertion are usually based on the study of developed countries' metropolitan areas, thus inherently controlling for several agglomeration diseconomies that are fundamentally ubiquitous in the major urban centers in less developed nations. We can add to this the rising of housing costs in these densely populated areas of the region under scrutiny. This is true not only for living standards in São Paulo's main cities, but also for location rents related to business activities. We can hypothesize that these centrifugal forces represent additional financial risks for entrepreneurial activity.

In this case, some other features of our estimations point towards the existence of a negative gravitational balance in the State of São Paulo in terms of the density of KIE activity[16]. For instance, DISTCAP, whenever significant, possesses a positive sign, indicating that separation from the capital is actually beneficial for KIE density (in OLS estimations). In fact, when controlling for the *Urban Environment* dimension, DISTCAP is weakly negative (though significant at 10%) in the heteroskedasticity-corrected estimations. In a similar vein, the absence of significance in LABCONC and BUSCONC (as proxies for localization economies) also indicates that KIE activity in São Paulo faces detrimental effects from agglomeration diseconomies.

For the estimation of the *Infrastructural Conditions* equation, we have adopted an alternative specification because of high levels of collinearity between RESUNI and TECHPARKS (as it happens that several technological parks in the State of São Paulo are attached to universities). In any case, somewhat surprisingly, research university's campuses are not significant predictors of KIE density, while TECHPARKS are weakly related to our dependent variable in OLS estimations (this does not remain valid for heteroskedasticity-corrected approaches). In its turn, overall investments in infrastructure (per capita), however, represent an extremely important vector for entrepreneurial ventures in our sample. This finding can also be related to the importance of city management as a way of lowering agglomeration diseconomies and building a socioeconomic environment that is conducive to innovative endeavors.

Somewhat surprisingly, our functional definition of the *Economic Structure* dimension does not render any statistically significant insights. Further explorations and alternative compositions of this particular subset of variables are needed in order to have a better grasp on the impacts of the economic system upon KIE activity.

[16] As previously outlined, absolute numbers of PIPE projects are highly skewed towards larger municipalities.

	Equation I	Equation II	Equation II.a	Equation III
const.	4.348*** [1.303]	-2.624*** [.891]	-2.452** [.949]	-1.783 [1.876]
LnDISTCAP	-.078* [.044]	.325*** [.075]	.304*** [.079]	.473*** [.127]
LnDENS	-.406*** [.079]	-	-	-
URB	-.592 [1.277]	-	-	-
HDI	1.178 [2.198]	-	-	-
RESUNI	-	-.220 [.344]	.232 [.359]	-
TECHPARK	-	.671 [.601]	-	-
LnINFRA	-	.641*** [.040]	.643*** [.047]	-
LnCRED	-	-.070 [.087]	-.082 [.107]	-
LnGDPPC	-	-	-	.105 [.192]
BUSCONC	-	-	-	91.290 [66.256]
LABCONC	-	-	-	-85.204 [75.817]
LnTECHACT	-	-	-	.137 [.106]
R^2	.333	.716	.637	.131
Valid N	114	114	114	114
Std. Errors in brackets	*sig. at 10%; **sig. at 5%; ***sig. at 1%			

Table 7. Results of heteroskedasticity-corrected estimations

5. DISCUSSION

Results of our analytical exercise have highlighted the spatial heterogeneity of KIE activity in the State of São Paulo, underscoring the absolute weight of economic centers as strong generators of innovation-driven entrepreneurial activity. As it stands now, the absolute distribution of KIE projects in the State of São Paulo is largely oriented towards supply-side, transactional benefits that may generate aggregate growth, but which lead to increasing regional absolute divergence. As outlined in econometric estimations with KIE density as the dependent variable, the efficiency of such public policy rationale is likely to provide decreasing returns to governmental investments. This is in sharp contrast with the basic motivation for cluster policies (Chatterji et al, 2013), i.e., the existence of positive externalities amongst agents.

Further examinations have showed the emergence of São Carlos as a potential case for a true entrepreneurial ecosystem in the territory under scrutiny. We believe that this introductory approach warrants more in-depth investigations of the underlying structure of KIE emergence in this particular location. If not to replicate it elsewhere, then to foster its strengths with dedicated entrepreneurship-oriented policies, particularly those that recognize weaknesses related to the sole use of transactional support (a rather linear way of addressing KIE). We believe that the effectiveness of entrepreneurship policy is highly dependent also on the creation of knowledge networks and in the construction of a multidimensional socioeconomic environment, not only in the application of public funds as a substitute to private venture capital.

This observation is in line with the view that the governmental role associated with the promotion of productive agglomerations (districts, clusters, entrepreneurial ecosystems, etc.) is usually directed towards direct support to specific locations, while the most relevant indirect aspects (related to a wide range of infrastructure aspects, regulatory frameworks and institutional efficiency) are not properly addressed (Mazzarol, 2014; Lerner, 2009). This shortsightedness from public policy compromises the success of local productive systems even in the presence of deliberate initiatives to foster particular places (Mason & Brown, 2013). Hence, the government role in fostering entrepreneurial ecosystems must be one of facilitating (not leading or controlling) the preexistent local strengths and capabilities, respecting cultural and institutional contexts, heterogeneity of firms and technologies, and designing regulatory reforms that can foster individual initiatives (Isenberg, 2010; Uyarra, 2010; Lambooy & Boschma, 2001). The entrepreneurial activity is fundamentally a systemic phenomenon and its analysis under a linear way of thinking - neglecting contextual conditions - is bound to offer biased insights (Ács, Autio & Szerb, 2014). This perception also poses implications for the need of coordination of entrepreneurship-oriented policies and the remaining framework for sustaining contextual dimensions.

Concerning results of our econometric models, some key aspects for further investigation in more refined versions of estimations (concerning the functional form of the model and the specification of variables) deserve attention. Firstly, it comes as a surprising result that there is a lack of significance of (research-oriented) university presence. We can hypothesize that this outcome may be related to: i) the fact that the Brazilian Innovation Law[17] is relatively recent (2004) and it does not encompass all of the projects in the population (projects starting dates range from 1998-2014); and/or ii) the perception that Brazilian universities (and scholars) often lack "entrepreneurial instincts", staying away from market-oriented initiatives (as recently demonstrated by Andrade and Campos, 2014). Although this perception can be extended to other developing countries, Di Gregorio and Shane (2003) already exposed that the capacity of universities generating high-tech start-ups varies considerably across different institutions (Di Gregorio & Shane, 2003). Nonetheless, we highlight the that these are only tentative explanations for this particular finding, and that further assessments are needed to provide more conclusive views on the role of research-oriented universities within the realm of spatial dynamics related to entrepreneurial activity[18].

In its turn, the negative contribution of population density can represent a valuable insight on the geographical analysis of KIE in developing countries, also deserving

[17] In broad terms, this law regulates knowledge and technology transfer from public universities and public research institutes to the market environment.

[18] We cannot rule out, for example, that universities' reach go beyond the arbitrary boundaries of municipalities. Also, the impact of university centers in smaller cities is likely to have higher per capita impacts than on large urban areas.

more attention in forthcoming stages of this ongoing research. Although the case for urban density is usually associated with interpersonal proximity and generation of spontaneous informal networks which generate innovative potential, the spatial structure of developing regions may present distinct features that affect this balance. In this regard we propose that subsequent developments of our econometric model integrate the speculative hypothesis that excessive concentration of people in Brazil (or Latin America in general) around urban centers may generate high levels of agglomeration diseconomies. This could hamper efficient flows of knowledge, which would incidentally affect KIE potential. This perception also receives support from the behavior of variables related to distance from the state capital (city of São Paulo), the quality of city-level infrastructure and the lack of significance found in the geographical concentration of companies and labor.

Furthermore, our preliminary results allow an inquiry into entrepreneurship-oriented policies. Mainly, our sample provides suggestive information on the inadequacy of transactional approaches to entrepreneurship that cover relatively large areas, as already exposed. Such linear forms of assessing innovation policy are likely to be economically inefficient, whereas relational, systemic, forms of connecting agents within areas of a denser entrepreneurial activity can provide more satisfactory socioeconomic outcomes. In this regard, governmental strategies towards regional development must take into account that peripheral locations often lack the fundamental "critical masses" (concerning venture capital, human capital, preexistent entrepreneurship, infrastructure, among others) to become high-tech poles, a feature that can hardly be tackled by funding isolated KIEs. Notwithstanding, in the presence of strong negative gravitational balances (as seems to be the case in the State of São Paulo), the choice for convergence-friendly initiatives may provide higher levels of aggregate benefits. If this is the case, then the dichotomy proposed by OECD (2007) between aggregate growth or convergence may not apply to the context of developing countries with largely overwhelmed urban centers.

Limitations of this exploratory approach are mainly related to the specification of econometric models and their respective analytical variables. Further explorations of the sample and alternative specifications of indicators must be tested in future approaches in order to validate our findings. For example, “softer” variables related to the quality of life of particular locations could be included in regressions. Also, we must remind the reader that the sample composition is highly skewed towards a very specific region within the State of São Paulo. In this case, as most municipalities are endowed with small numbers of KIE projects and also with small populations, potential distortions and spurious statistical relationships may arise. Unfortunately, structured, comparable observations of KIE are often unavailable. For these reasons, our empirical results should be regarded as suggestive, rather than conclusive, remarks.

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