CONFIGURATIONS OF KNOWLEDGE- INTENSIVE ENTREPRENEURIAL ECOSYSTEMS: AN ASSESSMENT OF THE STATE OF SAO PAULO, BRAZIL

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ABSTRACT

Knowledge-intensive entrepreneurship is unevenly distributed in geographical space, which is largely attributed to heterogeneous endowments in terms of knowledge, institutions, resources and demand. Nonetheless, specialized literature faces a lack of approaches dealing with the evolutionary dynamics of Entrepreneurial Ecosystems' components. Based on these foundations, we hypothesize that entrepreneurial ecosystems can assume different configurations, i.e., varying combinations of influential dimensions that can generate similar outcomes in terms of entrepreneurial intensity. In order to address this proposal we use Qualitative Comparative Analysis with fuzzy sets to assess city-level data from the State of São Paulo, Brazil. The analytical exercise focuses on five dimensions as causal conditions for the emergence of entrepreneurial ecosystems: Science & Technology, Human Capital, Market Dynamics, Business Dynamics and Infrastructure. Findings underscore the heterogeneous nature of entrepreneurial ecosystems. Nonetheless, a common core is perceived across different configurations, mainly involving the Science & Technology environment and the local Market Dynamics.

Keywords: entrepreneurial ecosystems; evolutionary economic geography; knowledge-intensive entrepreneurship; Brazil.

1. INTRODUCTION

Knowledge-intensive entrepreneurship (KIE) represents a socioeconomic phenomenon that drives economic competitiveness and innovative capabilities (Audretsch et al., 2006; Audretsch & Lehmann, 2005; Ács et al., 2008; Saxenian, 1994). Entrepreneurship has, however, received relatively little attention in studies related to innovation systems' approaches (Ács et al., 2014). The influence of context upon entrepreneurial activity is still often ignored in favor of a focus on individuals and firms (Borissenko & Boschma, 2016; Autio et al., 2014; Stam & Spigel, 2016). As a result, we are still some way off a thorough understanding on issues related to the emergence of new technology-based companies and its systemic determinants (Audretsch, 2012).

What is known is that KIE is unevenly distributed in geographical space, which is largely attributed to heterogeneous endowments in terms of knowledge, institutions, resources and demand (Stam, 2009; Feldman, 2014; Isaksen & Trippel, 2017). As a consequence we observe a spiky geography of economic activities (Florida, 2005; Rodríguez-Pose & Crescenzi, 2008). In addition, evidence suggests that the impacts of entrepreneurial activity can be mainly felt at the regional level (Ács & Armington, 2004), placing Entrepreneurial Ecosystems (EEs) as a key aspect of interest for researchers and policymakers in recent years (Malecki, 2011; Audretsch & Belitski, 2017; Borissenko & Boschma, 2016)¹.

These conditions pose fundamental challenges for analysts and policymakers, as one-size-fits-all initiatives and analytical models can be deemed inappropriate for most locations (Nicotra et al., 2017; Stam & Spigel, 2016). The economic mechanisms that shape evolutionary trends in entrepreneurship are not of a linear nature and they operate differently in distinct locations with varying socioeconomic backgrounds (Ács et al., 2017; Brown & Mason, 2017; Martin & Sunley, 2011; Audretsch, 2015; Boschma & Martin, 2010; Rosenthal & Strange, 2001). Even in the case of world-renowned ecosystems, success can be reached in fundamentally distinct manners – as Saxenian (1996) illustrated in a comparison between the Silicon Valley and Route 128.

Thus, a simplistic, mechanistic approach to entrepreneurial ecosystems – based on a linear input-output logic – is likely to ignore the context-specific traits of regions and their interplay (Feldman, 2001). The combination of these features is what drives the aggregate patterns of firm-level

¹ The very concept of entrepreneurial ecosystems encompasses a focus on innovation-driven entrepreneurship (Stam & Spigel, 2016).

competitiveness in EEs (Radosevic & Yoruk, 2013). Nonetheless, specialized literature faces a lack of approaches dealing with the evolutionary dynamics of EEs components (Mack & Mayer, 2016). Based on these foundations, we hypothesize that entrepreneurial ecosystems can assume different configurations, i.e., varying combinations of influential dimensions that can generate similar outcomes in terms of entrepreneurial intensity. This is a function of distinct evolutionary paths of each location. Accordingly, our research questions can be stated as follows: *Are there different configurations of vectors of interest that shape successful entrepreneurial ecosystems?*

Drawing from different strands of literature addressing the dynamics of business location we deal with a broad set of variables in order to identify the different foundational patterns behind ecosystems of entrepreneurship. For a concrete case we assess the State of São Paulo, Brazil. We assess KIE using data from PIPE projects, a program funded by FAPESP (the research funding agency of the State of São Paulo) that supports innovative initiatives in small enterprises (resembling in structure and objectives the Small Business Innovation Research - SBIR program in the United States). Our goal is to develop further knowledge on the evolutionary geography of innovation and entrepreneurship in the context of an advanced region in a developing country, acknowledging the substantial discrepancies that these countries present respective to developed economies when it comes to the geography of entrepreneurial activity (Crescenzi & Rodríguez-Pose, 2012). We expect our research to inform analysts and policymakers with a multidimensional view on the location drivers of start-ups in relatively laggard innovation systems – even though analytical insights can be useful for more advanced nations as well.

After this introductory section, the rest of the article is structured as follows: Section 2 contains the conceptual background of our assessment, as well as the proposal of a workable analytical model for the case of the State of São Paulo. Section 3 debates the state of the literature and the need for a more flexible comprehension of entrepreneurial ecosystems' configurations. Section 4 presents the method and the data used in our approach. Section 5 presents empirical results, and Section 6 closes with concluding remarks, implications and avenues for future research.

2. KNOWLEDGE-INTENSIVE ENTREPRENEURIAL ECOSYSTEMS

Regions differ in their respective propensity to establish knowledge-intensive entrepreneurial activity (WEF, 2014). These patterns reinforce themselves throughout time because geographic proximity functions as a fundamental vector for knowledge exchange (Gilbert et al, 2004). In its turn, such interactions among agents largely define firms' innovative capabilities (Fagerberg et al., 2005). These conditions put significant emphasis in the comprehension of local-level context as a determinant for KIE emergence, moving the target beyond the sole understanding of firm-level capabilities (Mason & Brown, 2014; Ács et al., 2014; Audretsch & Belitski, 2017).

It is by acknowledging these features of the socioeconomic environment that the Entrepreneurial Ecosystems concept has gained ground in recent years. According to its original definition, EEs represent *'an interconnected group of actors in a local geographic community committed to sustainable development through the support and facilitation of new sustainable ventures'* (Cohen, 2006; p. 3). A somewhat similar conceptualization has been offered by Mason and Brown (2014; p. 5) when they refer to EEs as a *'set of interconnected entrepreneurial actors, entrepreneurial organizations, institutions and entrepreneurial processes which formally and informally coalesce to connect, mediate and govern the performance within the local entrepreneurial environment'*.

In sum, the underlying rationale of entrepreneurial ecosystems is focused on interactions between economic agents, tangible and intangible factors of production, and how these vectors translate into entrepreneurship within a given location (Ács et al., 2017; Nicotra et al., 2017; Mack & Mayer, 2016; Stam, 2015). Because of its (eco)systemic character, the productivity of these geographical units is

affected by the performance of any of their components (Ács et al., 2014). By productivity we understand what Radosevic and Yoruk (2013) call ‘entrepreneurial propensity’, i.e., the local capacity to generate and exploit innovation-oriented opportunities through the doings of entrepreneurs. In the same vein, Audretsch et al. (2006) make reference to ‘entrepreneurship capital’, understood as the capacity of local-level institutions fostering entrepreneurial activity.

Based on this literature, and with particular emphasis on the works of Isenberg (2010), and Mason and Brown (2014), we offer a workable model of the entrepreneurial ecosystem concept (Figure 1). Our adaptation follows the basic principles contained in existing frameworks. Some items are dropped because of the lack of available information to address this model empirically at the local-level (city-level) in the Brazilian context². In this regard, main shortcomings concern dimensions related to culture, venture capital and public policy – although the latter can be indirectly assessed through other elements. Next we address in further detail each of the five dimensions set out in the model.

Figure 1. Knowledge-Intensive Entrepreneurial Ecosystem

Source: Authors

2.1 Science and Technology

Amongst the factors related to entrepreneurial location in geographical space, access to a relevant knowledge base stands for a fundamental attribute of interest – even more so for the scrutiny of knowledge-intensive entrepreneurship (Nicotra et al., 2017; Boschma & Martin, 2010). Affluent

² Because of the highly local nature of entrepreneurial ecosystems, literature has recognized these units (cities) as the most adequate *locus* for empirical assessments (Bruns et al., 2017; Audretsch & Belitski, 2017)

technological environments tend to facilitate entrepreneurial activity at the local level (Nicotra et al., 2017). In the State of São Paulo, Brazil, city-level patenting activity has demonstrated a strong influence on the emergence of KIE activity (Fischer et al., 2017).

Universities and research institutes are strategic agents within these dynamics (Spigel, 2017; Stam & Spigel, 2016). These institutions not only contribute to knowledge generation, but they also shape local conditions related to educational attainments of the population, issues of vital importance for the emergence and success of new technology-based ventures (Isaksen & Trippel, 2017; Dorfman, 1983). Therefore, geographical proximity to research-oriented universities and research centers can be valuable source of knowledge for high-tech entrepreneurial activity (Stam, 2009).

Apart from that, science-based entrepreneurship is significantly related to academic spin-offs (Di Gregorio & Shane, 2003), a situation that attributes key relevance to the local presence of preeminent universities. Etzkowitz (1998) puts the university and academic researchers as fundamental agents of innovation systems through knowledge transfer and entrepreneurial activities, an issue also raised by Guerrero et al. (2016). This helps explaining why high-tech clusters are often attached to university campus towns (Isaksen & Trippel, 2017). Fitjar and Rodríguez-Pose (2011) even make a case for regions that lack agglomeration economies (in the sense of large economic structures) but present high relative levels of innovative activity. These regions present a high tendency to create virtuous circles of innovative activity, even in the absence of other relevant drivers of entrepreneurial activity.

2.2 Human Capital

Chatterji et al. (2013) state that the key pillars clusters of entrepreneurship are essentially related to human capital. This is incorporated in the general education of the workforce and on the local supply of individuals with entrepreneurial orientation. This feature is widely recognized by literature, be it under the concepts of human capital (Isenberg, 2011; WEF, 2014), worker talent (Spigel, 2017), human resources (Nicotra et al., 2017) or talent pool (Stam & Spigel, 2016). Illustratively, the ratio of high-tech employment often predicts entrepreneurial activity in regions (Motoyama & Danley, 2012).

In fact, availability of highly skilled labor is a structural precondition for the creation of innovative entrepreneurial systems (Bresnahan et al, 2001). Also, although labor is theoretically considered as a mobile resource, entrepreneurial clusters are more likely to arise wherever professional talent is located or where it can be easily attracted (Dorfman, 1983). Accordingly, Audretsch and Feldman (1996) identified that the propensity to cluster is stronger in industries that rely heavily in new economic knowledge, thus depending to a large degree upon skilled labor. This proximity allows easier access for KIE companies to tap into available human capital and establish knowledge exchange practices with other agents (Storper, 1995).

In addition, entrepreneurial strengths are strongly related to income per capita of individuals (Radosevic & Yoruk, 2013; Stel et al., 2007). These conditions approximate not only the level of education and capabilities within the pool of individuals, but also the quality of life and overall level of development of regions, fundamental aspects in the location decision of knowledge-intensive entrepreneurs (Florida & Mellander, 2014).

2.3 Market Dynamics

The third dimension of interest in our EE model concerns the Market Dynamics of specific locations. The inclusion of this analytical vector follows one of the key traditions in the assessment of the geography of economic activity (Florida & Mellander, 2014). When it comes to entrepreneurial activity, large markets can offer increased levels of opportunities (Armington & Ács, 2002). Isenberg (2010) follows this rationale, including local markets as significant vectors in the formation of entrepreneurial ecosystems – a proposition that finds support in other influential documents on this

field of analysis (WEF, 2014). Correspondingly, evidence from developed countries suggest that opportunity-driven entrepreneurship tends to be more concentrated in large urban areas (Bosma & Sternberg, 2014). Also, the size of markets also feeds entrepreneurial endeavors from a different direction: the size of the population is a representation of the pool of potential entrepreneurs in a given location (Stuart & Sorenson, 2003).

Another issue that falls under our category of market dynamics concerns the economic conditions for available funding for knowledge-intensive entrepreneurs, an aspect that is ubiquitous in entrepreneurial ecosystems approaches (Isenberg, 2010). This is a function of the strategic relevance attributed to credit as a platform for start-ups to operate (Lerner, 2002; Feldman, 2001). Besides private flows of capital, governments can help correcting market failures in financing processes of these incipient ventures, based on the expectation that the introduction of these enterprises can result in substantial social and private gains for economic systems (Lerner, 2002). Considering the Brazilian context, this vector is particularly critical as SMEs in this country find it difficult to have access to funding mechanisms in Brazil due to scarce credit lines (Neto, et al., 2014; Ribeiro & Carvalho, 2008).

2.4 Business Dynamics

Complementarily to the idea of market dynamics we bring a perspective on the business environment -and its intrinsic dynamics - of cities as an influential component of entrepreneurial ecosystems. Here we introduce the importance of aspects related to the level of development of regional economic structures, as well as its attractiveness for investments from incumbent firms.

Firstly, literature recognizes the importance of adjacent firms as an important driver of local competitiveness (Stuart & Sorenson, 2003). This can take place through either Marshallian (specialization) or Jacobian (diversification) processes (Beaudry & Schiffauerova, 2009). In any case, positive externalities arise from local clustering of firms. This generates a critical mass of support activities for new companies (Isenberg, 2010; Isaksen & Trippel, 2017; Storper, 1995). Besides, these incumbent firms can also leverage the growth conditions for new firms (WEF, 2014), providing incentives for new business creation and contributions to start-up firms' survival (Delgado et al., 2010). Within this context, large firms play an important role in setting the stage for the emergence of knowledge-intensive new ventures (Brown & Mason, 2017). These large companies can leverage overall capabilities in clusters, particularly multinational corporations (Bresnahan et al, 2001), given their key role in the formation of innovation ecosystems (Guimón, 2009). Isaksen and Trippel (2016) refer to this situation as benefits related to thick and diversified regional innovation systems.

An additional item of interest in this analysis concerns the geographical reach of large markets (or core regions) and how the proximity to these economic hubs can exert effects in neighboring areas. This happens because large cities are not only a representation of an agglomeration of people, but they are also associated with the generation of innovative, science-based entrepreneurship (Duranton & Puga, 2002). In this regard, an 'efficiency gap' exists when comparing peripheral regions to those located close to large markets (Fritsch, 2002; Crescenzi & Rodríguez-Pose, 2012). This is why high-tech clusters of entrepreneurship are prone to be located in core regions (Isaksen & Trippel, 2017). This situation can be magnified in areas such as the State of São Paulo, provided the presence of a Megahub (WEF, 2018), i.e., an exceptional large city that functions as center for business services, venture capital and corporate demand.

2.5 Infrastructure

The third dimension in our model deals with the quality of infrastructure in cities. This is a platform upon which economic activity strongly relies. Infrastructure facilitates urban linkages, labor mobility and knowledge flows (Audretsch et al., 2015). Thus, its impacts as a determinant of formation of

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entrepreneurial ecosystems must be acknowledged (Spigel, 2017; Nicotra et al., 2017; Stuart & Sorenson, 2003). Also, infrastructural quality can mitigate ambiguous effects associated with large markets' agglomeration diseconomies (Audretsch & Belitski, 2017) and establish the intensification of relationships among individuals through higher urbanization levels, driving diversification of demand (Stam, 2009). It must be recognized, however, that these urbanization economies – while relevant for entrepreneurial activity – present a marginal contribution to EEs when compared business concentration (outlined in Section 2.2) (Rosenthal & Strange, 2001).

3. HETEROGENEOUS CONFIGURATIONS OF ENTREPRENEURIAL ECOSYSTEMS

Notwithstanding the agreement on the very basic definitions of entrepreneurial ecosystems, there are persistent controversies on causal links within its intrinsic dynamics (Borissenko & Boschma, 2016). After all, what dimensions of interest really matter for EEs? One of the main issues here concern the potential tautology involved with proposed models based on the reality of some highly preeminent cases (e.g. Feld, 2012; Saxenian, 1994). These expositions - although informative - are developed around an idea of relative stability in the configuration of influential attributes in EEs. On the other hand, researchers have increasingly criticized such formulations, as they lead to one-size-fits-all implications.

Even if the dimensions included in these models are highly inclusive, some of its attributes may be more dominant in some cases than in others (Spigel, 2017), relativizing the importance of EEs' components according to different contexts (Motoyama & Watkins, 2014). The central argument here is that economic mechanisms shaping evolutionary trends are not of a linear nature, and they operate differently in distinct locations as a function of their historical backgrounds (Boschma & Martin, 2010). This is why top-down policies to organize clusters of entrepreneurship can be deemed as ineffective (Bresnahan et al, 2001; Chatterji et al, 2013; Dorfman, 1983). Hence, mechanistic approaches to entrepreneurial clusters based on the linear input-output relationships are likely to ignore systemic and context-specific features of regions (Feldman, 2001).

This is the pillar of Evolutionary Economic Geography (EEG). EEG puts emphasis in historical processes related to the generation of knowledge bases and industries at the regional/local level, as well as interaction patterns among agents (Isaksen & Trippel, 2017). In dealing with the dynamics of entrepreneurial ecosystems, the evolutionary view pinpoints the relevance of pre-existing conditions and assets – such as research institutes and potential entrepreneurs - for ecosystems to emerge (Isaksen, 2016). Accordingly, new science-based firms can be understood as functions of the prior existence of scientific research undertaken by universities and research institutes in a given location (Feldman & Lendel, 2011).

What we want to add to this debate is a perspective that, because of distinct evolutionary paths, entrepreneurial ecosystems can achieve efficiency (or a successful level of 'entrepreneurial propensity') through different configurations. In other words, the relevance of EEs' dimensions are bounded by location-specific trajectories, thus altering the dynamics of interconnection among actors, institutions and organizations. This leads us to the following research hypothesis:

H₁. Because of idiosyncratic evolutionary paths, Entrepreneurial Ecosystems can present heterogeneous configurations in terms of relevant drivers without compromising their respective level of entrepreneurial propensity.

Recent literature has dedicated some efforts in a similar direction. Brown and Mason (2017) develop a simplified taxonomy of entrepreneurial ecosystems, based on illustrative cases of

‘embryonic’ and ‘scale-up’ locations. By testing this hypothesis, our goal is to empirically refine these introductory propositions and provide a more nuanced view on the variegated combinations of characteristics that can form a functional EE.

4. METHODOLOGICAL APPROACH

The basic source of information concerns data for knowledge-intensive entrepreneurship in the State of São Paulo, Brazil. The grants of the PIPE program are used as a proxy for KIE activity. This program is funded by the Research Foundation of the State of São Paulo (FAPESP) to support innovative initiatives in small enterprises. The program has similar structure and objectives to the Small Business Innovation Research (SBIR) program in the United States. The full dataset includes 1130 grants located in 114 cities across the state allocated during the period 1998-2014. We selected data from 298 cities in the State of São Paulo in order to run comparative models and account for differences in configurations between cities that have received project grants from those that have not received them. This information is supplemented with data on the urban environment, infrastructure, market conditions, and distance from the major economic hub for all the examined cities in the state.

To address our research questions we use Fuzzy-Set Qualitative Comparative Analysis (fsQCA). QCA is a method used to identify configurations or ‘recipes’ of causal conditions associated with different outcomes. It follows the ‘equifinality principle’, meaning that multiple paths or solutions can lead to the same outcome (Ragin, 2000). Different from statistical regression analysis, QCA also follows principle of causal complexity, that is, instead of looking at the effect of independent variables into a dependent variable, it accounts for the combination of causal measures to a specific outcome within a property space.

4.1 Model and Unit of Analysis

Following the literature review contained in Section 2 of our article and graphically represented in our analytical model (Figure 1), as well as respecting a parsimony principle for fsQCA solutions, the socioeconomic dimensions included in our assessment are described in Table 1. Most variables represent averages of city-level characteristics as proxies of the prevailing economic conditions in the examined cities. This procedure avoids problems related to year-to-year variations, while also controlling for the time span during which projects have started (1998-2014).

Table 1. Variable Description and Sources

Variables	Definition	Source
Outcome		
KIE PROJECTS	Number of projects granted to a given municipality.	PIPE/FAPESP
Conditions		
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
PATENTS	Patents and Utility Models. Sum of patents and utility models per capita assigned to a city/region in a given year.	Brazilian Patent Office (INPI)
HDI-M	Average municipal Human Development Index 1991, 2000, 2010.	São Paulo Statistics Office (SEADE)
KIJOBS	Average weight of selected knowledge-intensive jobs (STEM activities) in cities’ total labor force, 2001-2014.	General Register of Employment (CAGED)
POPULATION	Average population aged 25-54 1993-2014.	São Paulo Statistics Office (SEADE)
GDP	Mean GDP 1999-2012 (constant 2012 Reais).	São Paulo Statistics Office (SEADE)
CRED	Average credit operations per capita 1993-2013 (constant 2014 Reais)	São Paulo Statistics Office (SEADE)
BUSCONC	Average weight (%) of total city-level businesses in the State’s total, 2008-2011.	Brazilian Institute of Statistics (IBGE)
MNE-I	Announced investments from multinational enterprises in selected Knowledge-Intensive Activities at the city/- level in the State of São Paulo. It includes expansion and greenfield	São Paulo Statistics Office (SEADE)

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	investments. Data represents the average investment for the 2002-2014 period in millions of USD.	
PROXCAP	Road distance in km from the state capital and economic center, São Paulo.	Google Maps
ENERGY	Average percentage of households connected to the electrical grid, 2000 and 2010	São Paulo Statistics Office (SEADE)
URB	Average percentage of urban territory 1992-2014.	São Paulo Statistics Office (SEADE)

4.2 Calibration procedures

Qualitative Comparative Analysis works using the principle of set-theoretic ‘membership’ using fuzzy-sets. In order to conduct the analysis, variables must be calibrated into the fuzzy sets by defining thresholds (Ragin, 2007). In order to calibrate the fuzzy-sets, we used quartiles (see Appendix 1). The only exception for this rule was the causal condition RESUNI which was a binary variable indicating the presence or absence of a major Research University in the city. For the PROXCAP, quartiles were obtained by using only the cities that have displayed the outcome. For the Outcome variable, a rather flexible threshold was used in order to generate enough diversity in our sample and avoid skewness of the data. Our sample had a total of 298 cities where 114 of these cities had received grants. We chose to set our threshold at 1 in order to include in the set-membership of the innovation ecosystems any city with 3 or more grants.

We used the following set-membership threshold for our outcome variable:

- Above 10 projects (full membership)
- Between 4 to 10 projects (more-in-than-out)
- Between 2 to 4 (more-out-than-in)
- Below 2 (full non-membership)

4.3 Analysis of Necessary Conditions

As indicated by Ragin (2000), we ran two sets of analysis: the first one verify if any of our causal conditions could be considered necessary for the Outcome. Conditions are considered necessary when they represent the superset of the outcome, i.e., when the set membership values for the outcome Y are lower than the set membership for a given causal condition (Ragin, 2006). Necessary conditions are verified by using the following formulas for Consistency and Coverage.

$$\text{Consistency: } \Sigma\{\min(X_i, Y_i)\} / \Sigma(Y_i) \quad \text{equation (1)}$$

$$\text{Coverage } (Y_i \leq X_i): \Sigma\{\min(X_i, Y_i)\} / \Sigma(X_i) \quad \text{equation (2)}$$

According to Ragin (2008, p. 44), “consistency addresses the degree to which instances of the outcome agree in displaying the causal condition to be necessary, while coverage assesses the degree to which instances of the condition are paired with instances of the outcome”. Coverage indicates the relevance or importance of a set-theoretic connection. However, necessary conditions are more important the ‘more sufficient’ they are (Goertz, 2006). This can be verified as the coverage of the conditions (X) decreases in relation to the outcome (Y).

The second test involves the analyses of sufficiency to identify the combinations of conditions that that are in accordance with the presence of KIE activity, thus forming knowledge-intensive entrepreneurial ecosystems. Fuzzy-sets are converted into crisp-sets with value of 1 or 0 if the set membership scores on fuzzy-sets falls above or below the 0.5. This generates a truth table with the property space of different combinations or configurations of conditions that lead to the outcome³. We analyzed the truth table correlating the membership scores of different conditions with intensity of entrepreneurial activity to identify different configurations associated with entrepreneurial ecosystems.

³ The complete truth table is available from the authors upon request.

In this article we present results for the Complex Solution, which provides a general description of different sufficient causal paths that can be observed in cases where the outcome is present.

5. RESULTS

Table 3 and Figure 2 show the causal paths for the complex solution (CS) obtained in our analysis, consisting of four paths. The overall consistency of the solution indicated that 85% of cases displaying the outcome have been captured by the solution paths. As it can be observed, RESUNI, PATENTS, HDIM, POP, BUSCONC, GDP and CRED are present in all paths. These conditions seem to be a shared base for the most relevant EEs. However, differences arise when we focus on the following variables: KIJOBS, PROXCAP, MNE, ENERGY and URB. These results signal the existence of variegated structures in entrepreneurial ecosystems, even though they fundamentally rely on a common core of drivers.

The first path of the complex solution, besides the common conditions, adds KIJOBS, ~PROXCAP, URB and ~ENERGY to its configuration. This particular profile of entrepreneurial ecosystems demonstrate high presence of knowledge-intensive jobs, are distant from the main regional economic hub (city of São Paulo), with high levels of urban population and with deficient infrastructure (as indicated by the relatively low per capita consumption of energy). Path 1 seemingly stands for a typical configuration of peripheral entrepreneurial ecosystems. The emblematic case of this group is São Carlos, a small/medium-sized city, far from the State capital, with a strong academic environment and thriving conditions for KIE activity (Fischer et al., 2018). In its turn, the city of Araras presents a very low membership in the outcome, a situation that can be understood as an ‘error’ as per its inclusion in Path 1. This city has received only 1 KIE project grant over 20 years. Nonetheless, this case could deserve some attention as it matches the high membership score in all causal conditions within the group.

Table 3. Sufficient combination of conditions for high KIE activity (Complex Solution)

Path	Recipe	raw	unique	consistency
		coverage	coverage	
1	RESUNI*PATENTS*HDIM*KIJOBS*POP*GDP*CRED*BUSCONC*~PROXCAP*URB*~ENERGY	0.20	0.10	0.82
2	RESUNI*PATENTS*HDIM*KIJOBS*POP*GDP*CRED*BUSCONC*~MNE*~PROXCAP*ENERGY	0.09	0.03	0.77
3	RESUNI*PATENTS*HDIM*KIJOBS*POP*GDP*CRED*BUSCONC*MNE*PROXCAP*URB	0.21	0.14	0.88
4	RESUNI*PATENTS*HDIM*~KIJOBS*POP*GDP*CRED*BUSCONC*~MNE*PROXCAP*URB*~ENERGY	0.05	0.01	0.91
		Solution coverage	0.39	
		Solution consistency	0.85	

The second path of the complex solution is slightly different from the first with the addition of one variables (Energy) and the absence of another (MNE). Similar to the first path, it has a high presence of knowledge-intensive jobs, far from the main economic hub, urbanized and with high infrastructure, but with low levels of investments from multinational companies. However, differently from Path 1, this group includes a regional economic center, the city of Ribeirão Preto. In any case, this seems to represent an alternative configuration of entrepreneurial ecosystems located outside the geographic reach of the city of São Paulo, consisting of an additional profile of peripheral EE.

The third path of the CS is of high importance given its raw and unique coverage. Besides the common core of EE variables perceived in our sample, this group comprehends cities that are close to the main economic hub and with significant amounts of MNE investment. Also, high levels of urban population are noticed, in line with the agglomeration economies’ hypothesis rationale. Path 3 stands for a clear representation of a ‘core’ entrepreneurial ecosystem. The key cities in this group are São Paulo, Campinas and São José dos Campos. Added to this group are São Bernardo do Campo and Santo André. While these two cities alone do not seem to fit the model because of their low outcome

in terms of KIE projects, all causal conditions match the ones for the more robust ecosystems in this group. These two cities are industrial districts located within the metropolitan area of São Paulo.

Lastly, Path 4 is composed of one city alone: Santos. This path presents a peculiar configuration, one with the absence of positive influences from KIJOBS, MNE investments and lack of infrastructure. This can be related to local specificities that are not captured by our analysis. For instance, even though the human development index (HDIM) has a positive influence in all of the four paths, it should be noticed that Santos stands above the rest of cities with KIE activity in the State of São Paulo (0.840). Also, being a coastal city, it offers a wide range of amenities that might attract entrepreneurs⁴. In addition, Santos is located close to the city of São Paulo (72 km), facilitating the connection between new ventures and the support system available in the core region. For this reason, Path 4 can be understood as an ‘adjacent’ EE.

Figure 2. Configurational Paths of Knowledge Intensive Innovation Ecosystems

Conditions	Path 1	Path 2	Path 3	Path 4
Science and Technology				
Research Universities	●	●	●	●
Patents	•	•	•	•
Human Capital				
Human Development	•	•	•	•
Knowledge-Intensive Jobs	●	●	●	○
Market Dynamics				
Population	•	•	•	•
GDP	•	•	•	•
Credit	●	●	●	●
Business Dynamics				
Business Concentration	○	○	•	•
Proximity to Economic Hub	○	○	●	●
Multinational Investment	•	•	•	•
Infrastructure				
Energy	•	•	•	•
Urbanization	•	•	•	•
Cities	Araraquara (0.51,0.88) Araras (0.57,0.01), Botucatu (0.64,1), Jaboticabal (0.72,0.73), Rio Claro (0.54,0.82), São Carlos (0.55,1), São José do Rio Preto (0.62,0.62), Piracicaba (0.57,1),	Pirassununga (0.64,0.62), Ribeirão Preto (0.64,1)	Campinas (0.88,1), Santo André (0.66,0.18) São Bernardo do Campo (0.91,0.73), São José dos Campos (0.9,1), São Paulo (0.94,1), Sorocaba (0.81,0.98),	Santos (0.58,0.73)

Note: ● = core causal contributing condition (present); ○ = core causal contributing condition (absent); • = contribution causal conditions (present); ◦ = contribution causal conditions (absent)

Figure 3 presents the geographic distribution of these configurations. The blue marks show the cities that were selected through the construction of the truth table (Table 3) above the 0.76 consistency threshold. The green marks present relatively important innovation ecosystems that fell below the consistency threshold of 0.76. These are cities that do not present research universities, but have received a significant number of KIE projects. These cities are Mogi das Cruzes, Barueri, Jundiaí, Paulínia and Indaiatuba. While they do not have research universities, they are geographically located inside of a technological corridor near to cities that do have. Thus, we are calling these cities as ‘satellite’ EEs as they gravitate close to important technological centers.

⁴ Unfortunately we could not collect comprehensive data to test for this dimension. On the importance of amenities for entrepreneurial activity, see Florida (2003).

Figure 3. Mapping KI-Entrepreneurial Ecosystems in the State of SP

Source: Authors (based on research data)

6. CONCLUDING REMARKS

Our empirical assessment highlights the existence of heterogeneous configurations in entrepreneurial ecosystems in the State of São Paulo, Brazil, confirming our research hypothesis. However, a common core of features arise. This provides novel empirical findings that support expectations set by arguments contained in evolutionary economic geography arguments (Borissenko & Boschma, 2016; Boschma & Martin, 2010). Also, it highlights a hierarchy of attributes (Spigel, 2017) and a key role played by the knowledge context as a precondition for EEs to prosper (Feldman & Lendel, 2011).

In this regard, a first dimension of interest concerns Science & Technology. The existence of preeminent research universities and strong technological activity are key drivers of knowledge-intensive entrepreneurship, as they leverage local stocks of knowledge capital. Local market dynamics (represented by economic size – GDP and population - and credit availability) exerts consistent impacts on cities' propensity to generate KIE activity. The validity of these two dimensions indicate a balance between market and technological forces in the nature of entrepreneurial ecosystems, pinpointing its multifaceted character (Isenberg, 2010; Mason & Brown, 2014).

The remaining dimensions also presented contributions to the production of relatively successful EEs. This is the case for human development conditions (partially representing the Human Capital dimension) and business concentration (Business Dynamics). For the case of business concentration, this finding provides support for the hypothesis of localization economies, as per the relevant contributions coming from a complementary productive structure (Isaksen & Trippel, 2017; Delgado et al., 2010). On the other hand, such perspective is not necessarily valid for the specific case of multinational companies – as our related indicator is not part of the common core in EEs' configurations. In this regard, it is important to take into account the distinct patterns of knowledge flows established by these firms within the context of developing countries when compared to advanced nations (Girma, 2005). Surprisingly, the Infrastructure dimension provides contributions rather shaky contributions – in some cases it is positively related to KIE activity, while in others it seems to exert negative impacts. This may be due to the operational variables applied.

Another remarkable result concerns the heterogeneity of influence attributed to the variable PROXCAP. Our results clearly indicate that both core and peripheral regions are capable of establishing prosperous levels of entrepreneurial activity, contrary to propositions stating a loss of

Organizadores:

Realizadores:

innovative capability in areas located outside the reach of economic centers (Fritsch, 2002; Crescenzi & Rodríguez-Pose, 2012). Provided that KIE is associated to increased levels of economic competitiveness, this situation may stand for a long term process of economic convergence, alleviating agglomeration diseconomies involved with exceptionally large metropolitan areas in laggard economies (Henderson, 2002).

The main message arising from our empirical findings is that entrepreneurial ecosystems are diverse in their configurations, and that comprehensive models may fail to address locations' idiosyncrasies. In its turn, this conceptual misfit is likely to lead to inadequate, one-size-fits-all policies and interventions – as it has been the case in several places worldwide, as expressed by the widespread 'next Silicon Valley' speech. By ignoring the local context, these top-down initiatives from policymakers to steer the development of clusters are usually unsuccessful (Martin & Sunley, 2003). Instead, emphasis should be put in policymakers understanding local/regional idiosyncrasies in terms of innovation and entrepreneurial dynamics (Isaksen & Trippel, 2017). The government role in fostering entrepreneurial ecosystems must be one of facilitating (not leading) 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).

Notwithstanding, while these are fundamental preconditions for adequate policies to emerge, our results also pinpoint the existence of necessary circumstances for KIE to thrive. This may be unfortunate news for several locations, as many of the influential drivers take a long time to mature and they are outside the reach of direct interference of policymakers. This is the case for most of the indicators that are part of the EEs common core in our analysis. Perhaps more challenging than that is the fact that several of these indicators can be taken as endogenous respective to knowledge-intensive entrepreneurship.

We expect our research to contribute to the debate on the evolutionary character of entrepreneurial ecosystems. Further testing of the propositions contained in this article, along with the use of different variables and dimensions, could provide more in-depth insights into this inquiry. Also, analyzing evidence from countries and regions in different stages of development is desirable, as some traits identified in our sample shall not hold in other contexts. Such appraisals are needed in order to overcome limitations to our methodological approach, mostly concerning the sample of knowledge-intensive entrepreneurs (based solely on data from one specific funding program) and the parameters used to identify successful cases of entrepreneurial ecosystems. This discussion based on empirical evidence is of utmost relevance for advancing the quality of entrepreneurial policymaking and maximize benefits that may emerge from these new ventures.

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Appendix

Quartiles used to calibrate fuzzy sets

	PATENTS	HDI-M	KIJOBS	POPTOTAL	GDP	BUSCONC	PROXCAP	MNE-I	CRED	URB	ENERGY
Valid	298	299	299	299	299	297	114	65	284	299	299
Missing	0	0	0	0	0	2	0	234	15	0	1
25	0.0769	0.6120	0.000117	8,481.41	110.93	0.000212	70.78	0.564	1,039.56	0.7936	0.99245
50	0.5384	0.6420	0.000307	29,270.18	475.38	0.000749	143.50	3.0434	2,165.19	0.9007	0.99635
75	3.3846	0.6743	0.000528	78,658.00	1,523.41	0.001895	315.75	28.1608	3,524.51	0.9603	0.9983