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High-growth entrepreneurship in a developing country: Regional systems or stochastic process?

*Emprendimientos de alto crecimiento en un país en desarrollo: ¿sistemas
regionales o proceso estocástico?*

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Abstract

High-growth entrepreneurship represents a key socioeconomic phenomenon that is expected to spur aggregate levels of innovation and competitiveness. Since its impacts are mainly felt at the regional level, the concept of Regional Systems of Entrepreneurship becomes central to this debate. While several approaches have dealt with this issue in the context of developed economies, assessments of developing nations are still scarce. This research addresses this situation by investigating the determinants of entrepreneurial activity in Brazilian states. Econometric estimations and cluster analysis comprehend data from gazelle firms in Brazilian states throughout the period 2008-2014. Findings allow identifying the existence of relevant agglomeration diseconomies and an overall lack of connection between the knowledge infrastructure and entrepreneurial activity. These conditions suggest that Brazil has incipient Regional Systems of Entrepreneurship and that the geographic dynamics of entrepreneurial activity in this country is remarkably different from what has been observed in developed countries in general.

JEL code: L26, R58

Keywords: High growth entrepreneurship; Regional systems of entrepreneurship; Geography of innovation; Gazelles.

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Resumen

Los emprendimientos de alto crecimiento representan un fenómeno socioeconómico clave asociado al estímulo de niveles agregados de innovación y competitividad. Dado que sus impactos se sienten principalmente a nivel regional, el concepto de Sistemas Regionales de Emprendimiento se convierte en marco analítico fundamental para este debate. Si bien varios enfoques han abordado este tema en el contexto de países desarrollados, las evaluaciones de los países en desarrollo siguen siendo escasas. Esta investigación aborda esta situación a través de un análisis de los determinantes de la actividad empresarial en los estados brasileños. Las estimaciones econométricas y el análisis de conglomerados comprenden los datos de las empresas gacela en los estados brasileños durante el período 2008-2014. Los hallazgos permiten identificar la existencia de diseconomías de aglomeración relevantes y una falta general de conexión entre la infraestructura de conocimiento y la actividad empresarial. Estas condiciones sugieren que Brasil tiene incipientes sistemas regionales de emprendimiento y que la dinámica geográfica de la actividad empresarial en este país es notablemente diferente de lo que se ha observado en los países desarrollados en general.

Código JEL: L26, R58, O33

Palabras clave: Emprendimientos de alto crecimiento; Sistemas regionales de emprendimiento; Geografía de la innovación; Empresas Gacela.

Introduction

High-growth entrepreneurship (HGE) stands for a key socioeconomic phenomenon that spurs aggregate levels of innovation, competitiveness and economic development (Audretsch et al., 2006; Hébert & Link, 2006; Saxenian, 1994; Stam et al., 2009). For these reasons this group of entrepreneurs is seen differently from the population of self-employed individuals, and they represent a much rarer social phenomenon (Henrekson & Sanandaji, 2017; Hurst & Pugsley, 2011). Their impacts originate from entrepreneurial capabilities related to the translation of available knowledge into products and services, reducing inefficiencies in the markets where they operate (Braunerhjelm et al., 2010). Also, these new ventures generate substantial levels of multiplier effects for the environment in which they are embedded (Stangler & Bell-Masterson, 2015). Increasingly, these propositions find their way into policymaking processes, drawing attention to the dynamics of entrepreneurial quality (not just quantity) for development (Henrekson & Sanandaji, 2014; Stam, 2015).

Nonetheless, knowledge is susceptible to increasing returns to scale, which can be attributed to agglomeration economies and complex socioeconomic environments that promote a heterogeneous pattern of innovation distribution in space (Krugman, 1998). Hence, impacts of entrepreneurial¹ activity can be mainly felt at the regional level (Ács & Armington, 2004), putting concepts such as Regional Systems of Entrepreneurship (RSE) and Entrepreneurial Ecosystems as matters of rising interest for public policy (Borissenko & Boschma, 2016).

However, entrepreneurship has received scant attention as an aggregate phenomenon in the field of innovation systems (Ács et al., 2014). As a consequence, there is a lack of empirical understanding on the location determinants of high-growth entrepreneurship (Audretsch, 2012). This situation reduces the ability of policymakers to formulate well-guided initiatives that

¹ After the initial conceptual claims, the terms “high-growth entrepreneurship”, “HGE” and “entrepreneurship” are used interchangeably.

make efficient use of public resources. A particular gap of knowledge persists for developing economies, which end up relying on conclusions drawn from the context of leading innovation systems. The problem is that these countries seem to present marked differences in respect to the spatial dynamics of innovation systems found in developed economies (Calá et al., 2014; Crescenzi & Rodríguez-Pose, 2012; Fischer et al., 2018a).

In order to contribute to this body of knowledge, *this research addresses the socioeconomic determinants behind the formation of Regional Systems of Entrepreneurship in the context of a developing country* using detailed information relevant to the regional geography of high-growth entrepreneurship in Brazil for the period 2008-2014. Three econometric models are developed in order to understand the dynamics of HGE occurrence, density and specialization at the regional level. Two broad dimensions of Regional Systems of Entrepreneurship are assessed as potential determinants of entrepreneurial activity: regional markets and knowledge infrastructure. Moreover, a detailed cluster analysis was performed in order to identify commonalities among states included in the sample.

Results indicate signs of relevant agglomeration diseconomies in the Brazilian context. Market traits appear to have a very distinct behavior to what has been observed in developed countries. More importantly, the lack of significance in the Knowledge Infrastructure dimension suggests that Regional Systems of Entrepreneurship in Brazil are in an embryonic stage, with weak or non-existent relationships among key components of these sub-systems.

Regional systems of entrepreneurship in perspective

Recent efforts in the field of innovation management and economics has contributed substantially to the literature on the role of entrepreneurial activity within the realm of Regional Systems of Innovation (e.g. Ács et al., 2014; Ács et al., 2015; Szerb et al., 2015). This geographic scope of analysis offers an important contribution to nation-wide analysis, particularly for the case of large countries (Cooke et al., 1997). This is of special interest for the assessment of high-growth entrepreneurship. First, because the rate of high-impact entrepreneurial activity is influenced by structural and institutional factors (Henrekson & Sanandaji, 2017). Second, these dynamics rely on learning processes for innovation that are localized in space (Cooke et al., 1997), generating concentrated areas of entrepreneurship itself (Cooke, 2016; Feldman, 2001; Stam, 2009). As a result, HGE plays an active role in shaping long-term development paths, but these impacts are restricted to the region in which they operate (Duranton, 2007).

Thus, the concept of Regional Systems of Entrepreneurship² (RSEs) has risen to deal with the specific dynamics of entrepreneurial activity within innovation systems. This literature incorporates several conceptual aspects from the Regional Systems of Innovation literature, using dimensions of interest such as market structures, interactions, entrepreneurial culture, local presence of research institutions and universities, supportive services, and qualitative aspects of the available workforce (Fritsch, 2002; Iammarino, 2005; Isenberg, 2010; Qian et al., 2013; Saxenian, 1994; Stam, 2009; Stam, 2015).

It follows that the combination of these factors of interest is what drives the aggregate patterns of firm-level competitiveness in RSEs (Radosevic & Yoruk, 2013; Szerb et al., 2015). Because of its own nature, these systems involve multiple agents and the context in which they

² A closely related concept to that of Regional Systems of Entrepreneurship is that of Entrepreneurial Ecosystems (Isenberg, 2010).

are embedded, whereas their productivity is affected by the performance of its components (Ács et al., 2014; Szerb et al., 2015). However, when dealing with the reality of laggard innovation systems, we must bear in mind that entrepreneurs in these countries face contexts of scarce resources within their respective systemic environments (González-Pernía et al., 2015). For these reasons, drivers of entrepreneurial activity diverge along different stages of economic development, where developing countries do not present favorable settings for these activities to emerge (González-Pernía et al., 2015).

Based on these introductory concepts of Regional Systems of Entrepreneurship and its rationale we address two broad dimensions that cover the constructs of interest pointed out by literature: markets and knowledge infrastructure. Because of the scant literature with particular focus on the dynamics of HGE in developing countries, the literature review draws largely from concepts and empirical findings related to developed economies. We use these insights as guidelines for our analytical approach, and then discuss the limitations of the ‘developed world perspective’ for analyses dealing with nations that lag behind in terms of economic development.

Markets

A first issue related to regional market dynamics that we pay attention to concerns its (uneven) distribution in space. The regional dynamics of economic growth are usually related to the existence of agglomeration economies (Delgado et al., 2010). Puga (2010) summarizes the main arguments behind the benefits of agglomeration in three categories: i) a larger market facilitates sharing of local infrastructure, suppliers and labor pool; ii) better matching between firms and employees, demand and supply, and among business partners; and iii) more efficient learning processes between agents. Hence, regions that contain large metropolitan areas are expected to have a relative advantage in terms of innovative activity because of their capacity of providing access to markets, business and social networks, and ideas (Glaeser, 2011; Stam, 2009).

Correspondingly, regional economic agglomerations tend to generate higher rates of entrepreneurial activity (Audretsch & Fritsch, 1994; Li et al., 2016). Armington and Ács (2002) and Spilling (1996) use similar arguments to those of Puga (2010), arguing that these greater levels of new firm formation can be attributed to industrial density, larger populations and income levels. Giner et al. (2017) refer to these conditions as “locational advantages”. These dynamics create heterogeneous geographic distributions of high-tech entrepreneurship (Dorfman, 1983; Feldman, 2001). Nonetheless, the scant literature on Regional Systems of Entrepreneurship in developing countries has yielded contradictory outcomes, demonstrating weak significance of agglomeration economies for entrepreneurial activity (e.g. Calá et al., 2014; Fischer et al., 2018a).

A second market trait of interest – and closely related to the first one – concerns relative geographic position of Regional Systems of Entrepreneurship. In this regard, proximity to large economic centers seems to matter. Peripheral regions suffer from reduced capabilities in terms of business activity and innovation (Fritsch, 2002; Iammarino, 2005). We can relate this situation to lower levels of interconnectedness with key innovation networks and lack of exposure to knowledge spillovers from central areas (Crescenzi & Rodríguez-Pose, 2012). This perception seems to hold for start-up formation, where core-periphery structures have been identified (Spilling, 1996).

Another issue that deserves attention involves the dynamics of urbanization and localization economies. While the Marshallian argument defends the hypothesis of local specialization (urbanization economies) of industries, later work developed by Jacobs states that diversity in the productive structure is key for localized innovation (localization economies) (Beaudry & Schiffauerova, 2009). Empirical work concerning regional and urban systems of innovation in this respect provides mixed outcomes (Qian et al., 2013), even though positive effects in terms of entrepreneurship are more strongly connected to Jacobs' propositions (Beaudry & Schiffauerova, 2009; Li et al., 2016). This is a function of the evidence presenting that excessive industrial specialization can be detrimental to long-run growth (Antonelli et al., 2016; Beaudry & Schiffauerova, 2009; Stangler & Bell-Masterson, 2015). This can be attributed to the strategic relevance of complementary economic activities and the significant contributions they offer for start-ups (Cooke, 2016; Delgado et al., 2010; Glaeser & Kerr, 2009).

In a similar vein, some authors have put emphasis on “entrepreneurial support networks”, i.e., business agents that offer complementary services to the activity of entrepreneurial ventures (Bresnahan et al., 2001; Kenney & Patton, 2005). From these theoretical and empirical expositions it can be gathered that the existence of a complementary economic structure can exert desirable effects on regional entrepreneurial propensity. On the other hand, this relationship is not deterministic, as excessive dispersion may provide little contribution for aggregate innovative capabilities (Boschma et al., 2014).

A fourth specificity of markets is associated to the level of development in a RSE and its endogenous relationship to local wealth and demand characteristics. In its turn, entrepreneurial capabilities can be related to levels of income (Radosevic & Yoruk, 2013), as this indicator functions as a proxy for purchasing power (market attractiveness) and productivity. Also, demand size is associated to positive incentives for entrepreneurial activity (Kangasharju, 2000).

Knowledge infrastructure

Knowledge is an essential part of Regional Systems of Entrepreneurship. As argued by Qian et al. (2013), it not only represents a key source for entrepreneurial opportunities, but it also feeds entrepreneurs with higher levels of absorptive capacity. When it comes to the knowledge infrastructure, a first aspect to be addressed concerns the provision of an educated workforce – a fundamental cornerstone of HGE (Béchar & Grégoire, 2005; Kuratko, 2005; Li et al., 2016). But this knowledge pool can also be translated into technological advancements, which affect the performance of new technology-based firms (Qian et al., 2013). Furthermore, local innovation potential can supply the Regional System of Entrepreneurship with valuable inputs, knowledge spillovers and learning effects (Puga, 2010).

Correspondingly, it is intuitive to refer to the impacts originated from the presence of academic institutions. Henrekson and Sanandaji (2017) highlight the importance of these agents in shaping educational conditions and knowledge production. They can act as support entities for the evolutionary processes of entrepreneurial ecosystems, functioning as sources of ideas, manpower, and entrepreneurs themselves (Dorfman, 1983; Etzkowitz, 1998). This helps explaining why regional presence of universities offers access to technical expertise for high impact entrepreneurial activity (Etzkowitz, 1998; Fini et al., 2011; Stam, 2009). Nonetheless, these effects appear to be restricted to eminent institutions (Di Gregorio & Shane, 2003).

Universities can also perform the role of poles of attraction for high skilled labor, thus leveraging the regional pool of potential high-growth entrepreneurs (Florida et al., 2012; Glaeser et al., 2010). This is relevant for RSEs, since availability of human capital is a fundamental condition for the creation of entrepreneurial hubs (Bresnahan et al., 2001; Dorfman, 1983; Okamuro & Kobayashi, 2006). Nonetheless, the role of academia in shaping entrepreneurial systems varies widely between nations at different stages of development (González-Pernía et al., 2015). Particularly, these contextual conditions seem to be much less supportive in poorer countries in terms of fostering entrepreneurial activity.

A complementary perspective is offered through the analysis of knowledge stock as an ingredient of innovative activities in regions. Antonelli et al. (2016) verify that patent data can supply a valuable indicator in predicting innovation throughout regions in Europe. This is because patents – and their representation of available knowledge – functions as an external source of available knowledge and localized specialization for firms and individuals (Antonelli & Colombelli, 2015). However, this connection is by means mechanistic. For instance, technological activity does not seem to be related to the generation of innovation-driven entrepreneurship in developing economies (González-Pernía et al., 2015).

General models

Reference models are developed as exploratory entrepreneurial propensity functions. This follows Radošević and Yoruk (2013) who propose that the “entrepreneurial propensity” of innovation systems signals their capacity to spawn innovation-driven opportunities. In other words, these authors see entrepreneurship as a resulting vector of contextual conditions. For the purpose of our research, we take high-growth new firms (‘gazelles’) as the object of analysis (see further details in section Data and Estimation Method). Thus, a simple model is introduced in Equation 1:

$$E_{it} = \alpha + E_{it-1} + \sum i M_{it}^{\alpha} + \sum i K_{it}^{\beta} + \varepsilon_{it} \quad (1)$$

Where E corresponds to total high-growth entrepreneurial activity. This outcome is defined according to the two broad dimensions explored in this article: Market (M) effects with elasticity α ; and Knowledge Infrastructure (K) effects with elasticity β . A lagged term of the dependent variable (E_{it-1}) is introduced to control for persistent patterns of entrepreneurship over time (Glaeser & Kerr, 2009; O’Shea et al., 2005). This structure represents the need to make each dimension operational via an adequate set of predictors (see section 4 for a description). α is the constant of the model. ε comprehends aspects that are not within the scope of our analytical framework and that may help shaping the dynamics of Regional Systems of Entrepreneurship (unobserved effects)³. Since the empirical part of this research deals with panel data, this error term comprehends both a unit-specific and a time-invariant component.

An additional assessment of entrepreneurial activity concerns the relative weight of HGE within the regional productive structure. This is an aspect of particular interest in the evaluation of entrepreneurial ecosystems (Ács et al., 2014). The second model is a simple derivation from Equation 1:

³ In this regard, the case of entrepreneurial culture is noteworthy (see Feldman, 2001; Isenberg, 2010; Lambooy & Boschma, 2001). This dimension lies beyond the scope of this research due to the lack of suitable indicators, particularly within the sub-national scope of Brazil.

$$\frac{E_{it}}{F_{it}} = \alpha + \left(\frac{E_{it-1}}{F_{it-1}}\right) + \sum i M_{it}^{\alpha} + \sum i K_{it}^{\beta} + \varepsilon_{it} \quad (2)$$

Where F_{it} represents the total number of firms in region “i”, period “t”. The remainder of the model is analogous to the structure depicted in Equation 1.

Lastly, we use a vector of “entrepreneurial specialization” as the dependent construct. In this alternative structure, the total number of entrepreneurial firms is substituted by the location quotient of high-growth entrepreneurship (E^*) in region “i”, period “t”. The quotient is given by:

$$E_{it}^* = \frac{\frac{E_{it}}{F_{it}}}{\frac{E_{Ct}}{F_{Ct}}} \quad (3)$$

E^* corresponds to high-growth entrepreneurial activity (HGE). F is a measure of total firms. Subscripts correspond to the regional level (“i”), country level (“C”) and specific periods in time (“t”). E^* weighs the relevance of HGE in any given region compared to the national profile. The third general model takes the following form:

$$E_{it}^* = \alpha + E_{it-1}^* + \sum i M_{it}^{\alpha} + \sum i K_{it}^{\beta} + \varepsilon_{it} \quad (3.1)$$

The use of the approaches as defined in Equations 1 (absolute numbers of HGE), 2 (entrepreneurial density) and 3.1 (entrepreneurial specialization) can offer a deeper understanding of the dynamics of Regional Systems of Entrepreneurship than either assessment by itself. As expressed in the literature review, each of the two dimensions approached by the general models presented in this section is composed by a set of operational variables. A specific parameter is assigned to each variable in the estimations that follow.

Data and estimation method

Data for the estimation of the general models focus on regional units of the Brazilian economy represented by 26 states and the Federal District observed throughout the period 2008-2014⁴. The adoption of state-level analysis for Regional Systems of Entrepreneurship has been conceptually proposed in Qian et al. (2013), and empirically tested for the case of European regions (Ács et al., 2015; Szerb et al., 2015). We fundamentally address simultaneous effects from the Market and Knowledge Infrastructure dimensions. We follow the basic analytical structure of Qian et al. (2013), not neglecting the issues that this approach might involve. Nonetheless, there is a lack of clarity in terms of the adequate lags for the set of variables.

The operational definition of high-growth entrepreneurship is given by gazelles. This subset of high-growth firms consists in those companies with 10 or more employees (in t-3) that achieved an average employment growth of at least 20%/year from t-3 to t⁵. What approximates gazelles to the classification of entrepreneurial firms is the fact that they are up to 8 years old. These companies are recognized by the literature on entrepreneurship as adequate proxies for “Schumpeterian entrepreneurship”, altering technological regimes and replacing incumbents (e.g. Bos & Stam, 2014; Fritsch & Schroeter, 2009; Henrekson & Sanandaji, 2017). Nonetheless,

⁴ Latest data available at the time the research was carried out.

⁵ According to the definition used by the Brazilian Office of Statistics.

we recognize that it is an imperfect definition of innovation-driven entrepreneurship. First, it neglects companies that have less than 10 employees, potentially disregarding technology start-ups that are not labor-intensive. Second, the focus on employment growth may not comprehend companies that are scaling up in terms of revenue without increases in the workforce. Third, it might include non-innovative firms that achieved rapid growth due to aspects other than introducing structural changes to the markets in which they operate. Thus, although gazelles stand for a useful indicator of innovative, high-growth entrepreneurship, the factors cited above encompass some caveats that should be taken into account when analyzing empirical results.

The complete group of analytical variables is depicted in Table 1. The Market dimension comprehends six vectors: GDP, Population Density, Regional Specialization, KIBS, MNEs and Trade Openness. These variables are related to the aspects of interest highlighted in the literature review and they largely represent indicators of interest found in previous empirical research (e.g. Ács & Armington, 2004; Ács et al., 2014; Andersson & Koster, 2011; Bresnahan et al., 2001; Qian et al., 2013; Stangler & Bell-Masterson, 2015). Specifically, GDP and Population Density also serve the function of controlling for economic and population sizes of Brazilian states.

The Knowledge Infrastructure dimension is represented by five variables: Patents, Human Capital, Universities, Infrastructure⁶ and Gross Expenditures in R&D. We take the variable Patents as a measure of knowledge stock, more than of innovative potential, which explains the interest in patent deposits rather than in grants. The use of national-level data is justified by the fact that Brazil has a low propensity of generating international patents. This can be problematic for the very small numbers involved in the state-level analysis (including a substantial amount of zeros), particularly for the North, Northeast and Mid-West regions. Human Capital is approximated by tertiary enrollment per thousand inhabitants. Our measure of universities accounts for faculty per thousand inhabitants (as in Qian et al., 2013). These indicators are also derived from our literature review and a set of empirical investigations (e.g. Colombo & Grilli, 2005; Fini et al., 2011; Qian et al., 2013; Rosenthal & Strange, 2001; Spilling, 1996).

⁶ Following Hymel (2009), we introduce a vector of physical infrastructure.

Table 1.
Analytical variables

Dimension	Variable	Definition	Source
Dependent	Gazelles(total)	Total number of gazelles.	
	Gazelles(density)	Share of gazelle firms among the population of firms.	
Market	Location Quotient (Gazelles)	Location quotient of gazelle firms.	Brazilian Office of Statistics
	GDP	State-level Gross Domestic Product in thousands (local currency).	
	Population Density	Population (thousand inhabitants) per squared kilometer.	
	Regional Specialization	Herfindahl-Hirschman Index of economic activity (NACE 2-digit Rev.2).	
	KIBS	Share of selected Knowledge-Intensive Business Services ⁷ among the population of firms.	Brazilian Ministry of Labor
	MNEs	Share of wholly-owned foreign subsidiaries among the population of firms.	
	Trade Openness	Exports plus Imports as a share of the regional GDP.	Brazilian Ministry of Industry and Trade/Brazilian Office of Statistics
	Patents	Domestic patent deposits (invention and utility models) per capita.	Brazilian Patent Office
Knowledge Infrastructure	Human Capital	Individuals enrolled in tertiary education per thousand inhabitants.	Brazilian Ministry of Education
	Universities	Faculty in Higher Education Institutions per thousand inhabitants.	
	Infrastructure	Share of highways rated as “excellent” and “good”.	Brazilian Transport Confederation
	GERD	Gross Expenditures in R&D as a share of regional GDP.	Brazilian Ministry of Science, Technology and Innovation

Estimations are carried out via Fixed-Effects (FE) models for panel data with heteroscedasticity and autocorrelation-consistent standard errors (HAC). The use of FE models is warranted by statistical merit (Hausman tests⁸). Also, the use of fixed-effects models allows addressing the data while providing consistent estimates of time-constant omitted variables on dependent vectors (Wooldrige, 2000). This is a desirable feature when assessing state-level data, as fixed-effects approaches exclude potential issues concerning non-observable characteristics

⁷ Real estate, hardware and software consultancy, data processing and computer related activities, R&D, legal services, accounting, financial services, engineering, advertising and business activities.

⁸ The Hausman test is the standard test to differentiate the quality of fixed-effects vs. random effects models for panel data based on statistical merit.

related for instance to cultural and institutional differences across regions. The HAC estimation adds consistency to this analysis by diminishing auto-correlation biases in the assessment of panel data. In addition, robustness tests are undertaken with the exclusion of the states of São Paulo and Rio de Janeiro. We do so in order to identify if the presence of two metropolitan areas with international reach, as well as the two most important economies of the country, may bias econometric findings. We apply natural logs to analytical variables so statistical relationships can be interpreted as elasticities.

Additionally, aiming at delving deeper into the sample structure, we performed cluster analysis. This allows identifying commonalities among analyzed Brazilian federal units. In other words, this analysis was undertaken with the goal of identifying general patterns of high-growth entrepreneurship in the sample under scrutiny. Cluster analysis offers a helpful tool to complement the econometric estimations by allowing to develop a taxonomy of observations based on similarities and differences of Brazilian states in terms of the activity of gazelle firms (Hair et al., 2006).

Cluster membership was calculated using the mean values for the entire period (2008-2014) for variables Gazelles (density) and Location Quotient (Gazelles)⁹. A combination of hierarchical and non-hierarchical techniques was applied, following recommendations from Aldenderfer and Blashfield (1984) and Hair et al. (2006). According to these authors, this approach aims at compensating for weaknesses of each individual technique, providing robustness to analyses. First, the hierarchical approach is used to generate a complete set of solutions, establish which of these solutions are applicable to the dataset, characterize clusters' centroids and identify outliers. Subsequently, the non-hierarchical method is applied without taking account outliers, using the centroids from the hierarchical method as seed points.

Accordingly, hierarchical clusters were built using Ward's method and squared Euclidian distances. This procedure produces groups with similar sizes. Based on percentage variations of heterogeneity measures within clusters, two, three or four valid solutions were obtained. In any of these solutions, one of the clusters was formed by one observation (State of Amazonas). Vis-à-vis the identification of this outlier, we opted for its exclusion from this part of the analysis, returning two or three clusters as possible solutions. Next, K-means cluster analysis, a non-hierarchical procedure (Hair et al., 2006), was used. Two and three clusters solutions were tested, and the two-cluster structure returned as the most robust. In this solution, variables used for cluster construction, as well as representative variables of dimensions Market and Knowledge Infrastructure, presented the most consistent results in terms of difference in means. Tests for these differences (Mann-Whitney's U) were applied to check for clusters' robustness. The small sample size (26 observations) justifies the use of non-parametric tests for assessing differences between groups.

Results

Descriptive statistics of the analytical variables in their original structure can be found in Table 2. A preliminary observation of the sample highlights the strong heterogeneity in terms of regional entrepreneurship in the country for absolute numbers, density and specialization.

⁹ This procedure (using variable means) is used in order to address central trends in states' data without incurring in issues associated with yearly variations associated with panel data, while also keeping a workable number of observations for each resulting group.

Marked differences can also be noted for economic size (GDP), Population Density, Trade Openness, Patent activity (per capita), Human Capital, Universities, Infrastructure and GERD. These socioeconomic traits are an example of the strong regional asymmetries found in the Brazilian economy.

Table 2.
Descriptive statistics

Variable	Mean	Min.	Max	Within Std. Dev.	Between Std. Dev.
Gazelles (Total)	823.53	29	7118	111.67	1260.2
Gazelles (Density)	.009	.005	.022	.001	.002
Location Quotient (Gazelles)	1.115	.680	2.273	.119	.240
GDP	\$162,070,000.00	\$ 4,841,900.00	\$ 1,858,200,000.00	\$ 69,274,000.00	\$ 281,980,000.00
Population Density	.070	.001	.495	.004	.109
Regional Specialization	.220	.174	.298	.006	.032
KIBS	.092	.057	.141	.005	.016
MNEs	.0002	.0000	.0009	.0001	.0001
Trade Openness	.039	.001	.224	.009	.040
Patents	.023	.000	.104	.004	.024
Human Capital	28.945	11.117	64.834	2.971	8.975
Universities	1.793	0.593	3.362	.120	.531
Infrastructure	.466	.000	.868	.090	.181
GERD	.004	.0001	.0412	.0014	.0074

Note: Descriptive statistics are provided for data in their original structures.

An additional point to be made concerns the sectoral distribution of the gazelle firms in Brazil. Although a detailed classification cannot be achieved – considering the restraints of available data – it is relevant to perceive a strong concentration in the Services sector (38.74% of firms). The Manufacturing sector follows with a participation of 16.14%, while Administrative Activities and Complementary Services stand for 8.85% of the sample. From this data we can notice a significant weight of high-growth new ventures in customer and business-oriented economic sectors within the Brazilian economy, a feature that goes along the lines of the deindustrialization argument in this country (Jenkins, 2015).

Econometric estimations

Results for the econometric estimations are presented in Table 3. The lagged term of the dependent variable is statistically significant for the total number of Gazelles and for Gazelles' density, although only slightly for the latter case (significant at 10%). Hence, for the second and third models, persistence of the dependent variable over time does not seem to be remarkably present. For the Market construct, most outcomes for individual variables are contrary to previous expectations drawn from the literature dedicated to developed economies. GDP seems to serve better as a control for economic size than as an indication of stronger entrepreneurial ecosystems. Its results are only significant for predicting the total number of gazelles, but they are not related to HGE density and specialization.

In its turn, Population Density exerts significant and strong negative impacts on all measures of high-growth entrepreneurship. Even though this finding is in conflict with the dominant literature (Glaeser, 2011; Stam, 2009), it provides a hint in favor of recent developments that deal with developing nations (Calá et al., 2014; Fischer et al., 2018a). What has been noticed for the environment of less advanced socioeconomic systems is that regional agglomerations can suffer from decreasing levels of quality of life, social cohesion and industrial competitiveness.

Concerning the variables related to the complementary economic structure, expectations derived from developed countries are also challenged. One would expect Regional Specialization to have a positive and significant influence on entrepreneurial activity if Jacobs' localization economies were in place – or the opposite situation to identify the presence of Marshallian economies. From the lack of significance of this variable, neither the Marshallian nor the Jacobian hypothesis can be confirmed. Multinational companies are negatively related to a thriving entrepreneurial ecosystem, which can be linked to the relatively low levels of absorptive capacity in the country under scrutiny. In this case, positive externalities arising from the presence of FDI are hampered and they may damage indigenous productive systems (Fischer & Queiroz, 2016). More puzzling is the negative behavior of KIBS in the first and second models. This is an issue that deserves further attention in future assessments, but it can be related to the identification of agglomeration diseconomies – as a complement to conclusions drawn from Population Density.

The last vector of the Market dimension concerns openness to trade. This indicator is positively related to the emergence of Gazelles (total and density). This is an aspect of interest for the Brazilian case, provided this country has a low level of trade as a share of GDP – possibly hurting aggregate levels of entrepreneurship.

For the case of the Knowledge Infrastructure dimension, patents per capita are consistently associated to more active Regional Systems of Entrepreneurship, but the remaining variables do not perform the expected roles. What is more interesting is that the density of universities in states wield lower levels of entrepreneurial activity. If we combine the analysis of this variable with our proxy for Human Capital, one can notice the absolute lack of integration between the academic environment and the generation of entrepreneurship in Brazil, a finding that is in line with the propositions of González-Pernía et al. (2015). A possible explanation resides on the strong institutional heterogeneity in terms of academic entrepreneurial propensity observed in universities (Di Gregorio & Shane, 2003), an aspect that is not captured in the specification of our variables. Moreover, these results may be a reflex of existing inequalities in technological, scientific, and innovative activities at the regional level in Brazil, particularly within the academic context (Albuquerque, 2003; Suzigan et al., 2011).

Table 3.
Fixed-Effects estimations (HAC)

Dimension	Predictor	Equation 1 LnGazelles (Total)	Equation 2 LnGazelles (Density)	Equation 3.1 LnLocation Quotient (Gazelles)
Market	const.	-6.074***[2.147]	-10.574***[2.193]	-7.295***[2.474]
	Dependent variable (t-1)	.256***[.092]	.197* [.098]	.124[.098]
	LnGDP	.291**[.112]	.028[.113]	.109[.125]
	LnPopulation Density	-1.125***[.382]	-1.350***[.373]	-1.105***[.332]
	LnRegional Specialization	.393[.688]	.049[.629]	-.273[.673]
	LnKIBS	-.662**[.308]	-.738**[.324]	-.419[.347]
	LnMNEs	-.046***[.017]	-.042**[.016]	.001[.015]
Knowledge Infrastructure	LnTrade Openness	.083*[.043]	.073*[.041]	.037[.047]
	LnPatents	.112***[.033]	.107***[.030]	.076***[.026]
	LnHuman Capital	.386[.247]	.199[.266]	.233[.271]
	LnUniversities	-.582***[.180]	-.538***[.177]	-.378*[.192]
	LnInfrastructure	.049[.048]	.031[.051]	.014[.050]
	LnGERD	.007[.015]	.006[.014]	-.005[.013]
	Valid N	145	145	145
	LSDV R sq.	.995	.880	.890
	Within R sq.	.485	.413	.173
	Std. Errors in brackets	*sig. at 10%; **sig. at 5%; ***sig. at 1%		

Regional involvement in R&D has no significant impacts on HGE activity, even though one might consider that its impacts may be of an indirect order via generation of knowledge stocks (patents, for instance). The proxy for physical infrastructure also does not seem to be an adequate predictor of entrepreneurial ecosystems.

Observations resist to robustness tests with the exclusion of the states of São Paulo and Rio de Janeiro (Table 4) – combined, these two federal units account for 30% of the population and over 40% of national GDP. Also, they contain the most important metropolitan areas in the country (together their capitals form a world level-megalopolis). As per our empirical evaluation, they do not seem to bias the outcomes of econometric estimations, and the observations of Market and Knowledge Infrastructure dimensions hold for our sub-sample of regions.

Table 4.

Robustness tests for Fixed-Effects estimations (HAC): exclusion of the states of São Paulo and Rio de Janeiro

Dimension	Predictor	Equation 1 LnGazelles (Total)	Equation 2 LnGazelles (Density)	Equation 3.1 LnLocation Quotient (Gazelles)
		W/O Rio de Janeiro and São Paulo	W/O Rio de Janeiro and São Paulo	W/O Rio de Janeiro and São Paulo
Market	const.	-5.617**[2.468]	-10.037***[2.384]	-5.783**[2.323]
	Dependent variable (t-1)	.246**[.096]	.183*[.101]	.093[.099]
	LnGDP	.254*[.126]	-.018[.127]	.030[.126]
	LnPopulation Density	-1.062**[.402]	-1.285***[.392]	-.970***[.344]
	LnRegional Specialization	.300[.708]	-.047[.651]	-.358[.712]
	LnKIBS	-.633*[.312]	-.709**[.327]	-.354[.354]
	LnMNEs	-.043**[.017]	-.039**[.016]	.002[.015]
	LnTrade Openness	.081*[.044]	.072*[.042]	.040[.047]
Knowledge Infrastructure	LnPatents	.109***[.032]	.104***[.030]	.073**[.026]
	LnHuman Capital	.427[.256]	.245[.272]	.308[.274]
	LnUniversities	-.562***[.185]	-.514***[.181]	-.335[.197]
	LnInfrastructure	.047[.049]	.029[.052]	.010[.051]
	LnGERD	.008[.015]	.007[.014]	-.003[.013]
Valid N		133	133	133
LSDV R sq.		.993	.878	.889
Within R sq.		.469	.406	.164
Std. Errors in brackets		*sig. at 10%; **sig. at 5%; ***sig. at 1%		

Cluster analysis

In order to further explore the dataset and offer a more robust picture of the phenomenon under evaluation, the next step of this assessment consists of a cluster analysis. This approach returned two clusters. The first one (Cluster 1) with 14 states, and the second (Cluster 2) with 12 states (Table 5). Mean values for variables used for cluster formation – Gazelles (density) and Location Quotient (Gazelles) – are presented in Table 6 along with figures related to Market and Knowledge Infrastructure dimensions. Besides, results based on non-parametric tests for difference of means in independent samples (Mann-Whitney U) are provided.

Table 5.
Cluster Membership

Cluster 1	Cluster 2
Acre	Alagoas
Amapá	Bahia
Ceará	Espírito Santo
Distrito Federal	Goiás
Maranhão	Mato Grosso do Sul
Mato Grosso	Minas Gerais
Pará	Paraná
Paraíba	Piauí
Pernambuco	Rio Grande do Sul
Rio de Janeiro	Rondônia
Rio Grande do Norte	Santa Catarina
Roraima	São Paulo
Sergipe	
Tocantins	

Table 6.
Clusters descriptive statistics

Variable	Cluster	Cluster Mean	Cluster Std. Dev.	Sig.
Gazelles (Density)	1	.011	.001	.000***
	2	.008	.001	
Location Quotient (Gazelles)	1	1.235	.107	.000***
	2	.914	.098	
GDP	1	\$88833619.520	\$130213641.870	.046**
	2	\$255386419.726	\$388272923.022	
Population Density	1	.090	.144	.595
	2	.053	.050	
Regional Specialization	1	.228	.034	.193
	2	.211	.030	
KIBS	1	.091	.020	.252
	2	.095	.013	
MNEs	1	.000	.000	.980
	2	.000	.000	
Trade Openness	1	.023	.026	.023**
	2	.048	.029	
Patents	1	.013	.013	.023**
	2	.036	.030	
Human Capital	1	29.118	11.709	.742
	2	28.404	5.148	
Universities	1	1.744	.638	.595
	2	1.881	.406	
Infrastructure	1	.416	.181	.053*
	2	.557	.118	
GERD	1	.003	.003	.462
	2	.007	.011	

*sig. at 10%; **sig. at 5%; ***sig. at 1%.

Cluster 1 consists mainly of states located in the North and Northeast regions of Brazil, while Cluster 2 presents a predominance of Southern and Southeastern states. Cluster 1 is significantly differentiated from Cluster 2 as it comprises locations with higher relative weights of entrepreneurial activity within the economic system. However, and in line with the econometric approach, dissimilarities are somewhat marginal.

Values are significantly different only for variables GDP and Trade Openness (Market dimension), and Patents and Infrastructure (Knowledge Infrastructure). Surprisingly, these univariate analyses render outcomes that are inconsistent with the underlying rationale of Regional Systems of Entrepreneurship: The Cluster with the least entrepreneurial activity actually presents an overall economic condition that surmounts those of states classified in Cluster 1.

This appraisal of the sample under scrutiny, together with the evaluation of models' outcomes, supplies indications that the argument in favor of the existence of entrepreneurial systems in Brazil is shaky. Hence, our empirical analysis provides evidence that questions the validity of the Regional Systems of Entrepreneurship concepts for the Brazilian context. Rather, it seems that states in this country present a stochastic character in terms of HGE. This is supported by the lack of apparent integration between drivers and outcome variables for high-growth entrepreneurship, a key feature behind the systemic logic.

Why do the wealthier states (which concentrate approximately 70% of the Brazilian GDP) are relatively less involved in high-impact entrepreneurship than peripheral regions? Why do variables that have been perceived as consistent determinants of entrepreneurship perform poorly in predicting the concentration of gazelles? We address these issues in further detail in the next section.

Discussion

Our empirical analysis has been organized around two broad dimensions: Markets and Knowledge Infrastructure. Based on the application of econometric models and cluster analysis for Brazilian states, some startling findings have come to our attention. First, most variables in the Markets dimension have an opposite effect on the measures of RSEs than expected. Hints of agglomeration diseconomies can be perceived, confirming recent results obtained for entrepreneurial activity in Brazil at the city level (Fischer et al., 2018a). On the one hand, this might indicate a prevalence of regional convergence in respect to high-growth entrepreneurship. If it is so, then this can be a step towards the reduction of regional economic asymmetries that hamper development in peripheral regions (Andersson & Koster, 2011).

On the other hand, these findings may be representative of socioeconomic barriers to the formation of entrepreneurial hubs, and the consequent rise of a critical mass of innovation-driven new ventures. This is the most likely explanation for the sample under analysis and it may cast serious doubts on the use of the term Regional Systems of Entrepreneurship for the evaluation of developing countries – as the aggregate presence of systems' components does not correspond necessarily to functional systems. To substantiate this proposition some further arguments are necessary. First, our empirical evidence on the influence of the Knowledge Infrastructure is weak and concentrated on one (imperfect) measure of knowledge stock. This is not enough information to warrant that a true system of entrepreneurship is at work, where a stronger interplay among the variables of interest would be expected. Connecting this finding

to the scarce levels of innovation-driven entrepreneurship in Latin America (Ács & Amorós, 2008; Lederman et al., 2014), we may assert that Brazil has – at best - immature RSEs.

For instance, an endemic problem with the institutional and regulatory environment for entrepreneurial activity in Brazil may be behind the lack of systemic evidence for gazelles in this country, following the positive association between regulatory environments and high-impact entrepreneurship observed by Henrekson and Sanandaji (2017). This building block of systems of entrepreneurship may actually hinder systemic dimensions to function effectively. Illustratively, data from the Doing Business Report from the World Bank¹⁰ underscore some of these barriers. Even compared to other Latin American countries, Brazil performs poorly in terms of starting a business (28th position among 32 nations), tax compliance (30th) and international trade (30th). In this regard, the regulatory framework still represents a substantial barrier for the evolution of an entrepreneurial culture in Brazil respective to knowledge-intensive new firms (Arruda et al., 2015).

Alongside these lines, improvements in the overall institutional environment is likely to represent a facilitator for fostering high-growth entrepreneurship in Latin American countries (Aparicio et al., 2016). Furthermore, we notice a need for socioeconomic environments that articulate entrepreneurs with innovative capabilities (Amorós et al., 2012; Lederman et al., 2014). This is an aspect that is strongly connected with the need for policies that tackle challenges associated with the provision of higher levels of human capital, infrastructure, enhanced competition and improvements in regulatory frameworks.

Of course, these structural pillars, while of paramount importance, cannot fully explain why Regional Systems of Entrepreneurship in Brazil are dysfunctional. Some further arguments on the economic background of this country and its Latin American context are required to articulate our empirical findings with prior evidence. For instance, Russell (2004) addresses the lack of an entrepreneurial culture based on risk propensity – an intrinsic feature of high-growth, innovation-driven new ventures – as a relevant moderator that helps understanding the entrepreneurial dynamics in Latin America. Complementarily, the very notion of systems of entrepreneurship relies heavily in credit availability as a core determinant of opportunity-driven entrepreneurship (Aparicio et al., 2016), an activity that is intensely associated with risk tolerance. As an outcome of cultural barriers – and monetary policies that have historically kept interest rates at high levels - nascent entrepreneurs in Brazil have difficult access to credit (Neto et al., 2014).

From a different perspective, it is noteworthy that the Brazilian innovation system relies heavily on universities as generators of knowledge and hubs of skilled personnel. Nonetheless, connections between academia and markets via mechanisms of technology transfer (such as spin offs) are still in infant stages, following regulatory changes in the last decades (Fischer et al., 2018b). This situation seems to end up compromising the capacity of systems' components to effectively promote academics' propensity to engage in entrepreneurial activity (Alves et al., 2017).

Such fundamental aspects of entrepreneurial activity can render initiatives targeted at fostering systemic connections highly unfruitful. Accordingly, we highlight the importance of structural reforms involving the business environment and educational infrastructure to establish thriving entrepreneurial systems in catching-up economies (an argument also found in Brixiová & Égert, 2017).

¹⁰ Further details can be found at < <http://www.doingbusiness.org/rankings> >.

In the absence of such conditions, we might expect that necessity-driven entrepreneurship is predominant due to reduced incentives for those individuals focused on innovation-oriented new firms. In its turn, more developed markets, with stronger incumbents could partially explain the findings of our analysis. Following a similar logic, less developed regional markets could set the stage for necessity-driven entrepreneurs to prosper. Even without innovative content, these firms can be classified as gazelles and bias statistical evidence¹¹. Alternatively, findings for Chile (Felzenstein et al., 2012) state that even though economic conditions are worse for peripheral regions, opportunity perception is actually higher than in core areas. As a result, intensity of entrepreneurial activity is relatively homogeneous across areas at different stages of development within the country. Perhaps we are noticing a similar pattern in Brazilian states.

Conclusions

This article has addressed the determinants of Regional Systems of Entrepreneurship in the context of a developing country taking into account the case of gazelle firms. This stands as an issue of particular interest for the productive structure, since high-growth entrepreneurship can have pervasive effects in the overall competitiveness of Latin American countries (Amorós et al., 2012). Our empirical assessment emphasizes the need for further studies in this field by supplying evidence that is in conflict with the regional dynamics observed in advanced economies. Accordingly, applying policy rationales drawn from the experience of advanced nations may render initiatives in catching-up countries ineffective. For instance, the governmental role associated with the promotion of entrepreneurial ecosystems is often directed towards direct support to specific locations. However, several aspects related to a wide range of infrastructure, regulatory frameworks and institutional efficiency are not properly addressed (Chatterji et al., 2014).

Implications are clear. While Brazilian states might have the necessary components to structure their respective systems of entrepreneurship, these dimensions do not seem to work in consonance with each other. As a result, there is a lack of effectiveness in the regional coordination of high-growth entrepreneurship drivers. Hence, we pinpoint that building functional systems of entrepreneurship is a challenge that goes beyond subsidies allocated to new ventures. Unfortunately, successful anecdotal evidence is sometimes used by policymakers to claim otherwise. Such perspective is likely to perpetuate meager levels of innovation-driven entrepreneurship, harming the odds of gearing the country away from middle-income traps.

It is important to notice that our results and discussion do not go without limitations. Mainly, our research comprehends only companies with 10 or more employees (in t-3) that achieved an average employment growth of at least 20%/year from t-3 to t¹². Hence, our analyses miss out on data from firms with less than 10 employees, potentially disregarding technology start-ups that are not labor-intensive. Besides, the definition of gazelles might include non-innovative firms that achieved rapid growth due to aspects other than introducing structural changes to the markets in which they operate, thus potentially not representing perfectly the dynamics of the desirable knowledge-intensive entrepreneurship that is often mentioned in academics and policymakers' discourse.

¹¹ If this is so, then the utility of gazelles as a proxy for "Schumpeterian entrepreneurship" may be reduced for the context of developing countries.

¹² According to the definition used by the Brazilian Office of Statistics.

Further investigations are needed to validate these propositions - not only in the Brazilian context, but in other developing countries as well. High-growth entrepreneurship can be an important source of economic development and technological upgrading, thus making a case of interest. Alternative constructions of econometric models, use of different variables and time lags, are fundamental to verify if these conclusions stand. One key aspect of concern here is related to in-depth evaluation of sectoral specificities in gazelles, particularly taking into account knowledge intensity levels across industries. Also, different geographic scopes should be assessed, since federative units often display strong internal heterogeneities. From this perspective, perhaps systems of entrepreneurship in an immature innovation system present highly localized patterns which demand a closer look on micro-regions and even within cities.

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