Location of entrepreneurial zones in Latin America: a spatial analysis

Localización de zonas emprendedores en América Latina: un análisis espacial

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Abstract: This study analyzes spatial patterns in the entrepreneurial intention of university students in Latin America. Studies on the entrepreneurial phenomenon have paid little attention to possible spatial associations, which might explain the dissimilar results reported by prior work. The analysis uses a sample of 70,337 university students drawn from the GUESSS survey. The results of the exploratory spatial model reveal significant spatial patterns in Costa Rica and Panama with a high entrepreneurial intention (hot spots). This study can serve as a basis for developing public policies to promote entrepreneurship and, when appropriate, propose articulated and coordinated strategic initiatives between countries located in the identified clusters (hot/cold spots).

Keywords: Entrepreneurship, entrepreneurial intention, spatial analysis, Moran Test, *hot/cold spots*, GUESSS survey

Resumen: El objetivo de este trabajo es de analizar los patrones espaciales de la intención emprendedora de los estudiantes universitarios en el continente americano. Los estudios sobre el fenómeno emprendedor han omitido la posible asociación espacial, lo cual podría explicar la inconsistencia de los resultados y conclusiones de investigaciones anteriores. Los datos se han obtenido de la Encuesta GUESSS y contienen una muestra inicial de 70,337 participantes. El Análisis Exploratorio de Datos Espaciales demuestra patrones espaciales en Costa Rica y Panamá con una alta intención emprendedora (*hot spots*). Este estudio puede servir de base para el desarrollo de políticas públicas que promuevan y apoyen el emprendimiento; y, cuando sea pertinente, proponer iniciativas estratégicas articuladas y coordinadas entre países basadas en la ubicación se estos en los clústers identificados (*hot/cold spots*).

Palabras clave: Emprendimiento, intención emprendedora, análisis espacial, Test de Moran, *hot/cold spots*, encuesta GUESSS

1. Introduction

The role that entrepreneurs play in the economic growth and social development of countries is widely recognized (Wennekers & Thurik, 1999), thus constituting one of the most relevant drivers of structural change in economies (Reynolds et al., 2002; von Graevenitz et al., 2010). This explains why the study of the entrepreneurial phenomenon has emerged as one of the most vital, dynamic, and relevant fields of research (Teixeira, 2011). Proof of this is the increase in specialized journals and papers published in this regard (Katz, 2003; Serrano-Bedía et al., 2016; Wiklund et al., 2011). One of the research lines receiving significant interest is based on entrepreneurial intentions (Liñán & Fayolle, 2015), primarily due to the predictive capacity of the models they rely on (Shapero & Sokol, 1982). According to intention-based theoretical approaches, business creation is a deliberate choice (Weiss et al., 2019). It is rarely initiated without prior desire on the part of the entrepreneur (Autio & Fu, 2015). Therefore, the intention to undertake is a precursor to actual business creation and, hence, a strong predictor.

Therefore, understanding the factors influencing entrepreneurial intentions is one of the key aspects within this line of literature (Bae et al., 2014; Liñán & Fayolle, 2015). According to the review conducted by Liñán and Fayolle (2015), there is a variety of studies examining the impact of personal and cognitive variables on the aspiration to start a business; however, the results have been diverse and contradictory (Lortie & Castogiovanni, 2015). For this reason, much of the research includes elements of the entrepreneurial ecosystem in their models when studying how the context in which entrepreneurs are located influences their business activity (e.g., creation, growth, etc.). However, independent country analyses still need to be completed as they do not consider potential linkages between countries or territories. It may be the case that the entrepreneurship rate of a country in question is the product of the performance of neighbouring territories and not only of internal conditions (Almeida et al., 2021; Hong et al., 2015). In this sense, one could argue that the entrepreneurial intention of each individual within a particular field is interconnected with the aspiration to undertake by other individuals in different locations (Anderson, 2012). That is the effect that an entrepreneurial person or company located in a neighbouring territory can have on an entrepreneurial activity located in a specific place (Plummer, 2010).

However, the studies that incorporate the context start from the premise that the factors that affect entrepreneurial activity differ between territories (country, region, etc.), thus ignoring the "spatial dependency or autocorrelation" (Plummer, 2010). If the relationship is positive, one could assert the presence of a specific imitation leading to the emergence of clusters. Conversely, if it is negative, it implies a random pattern regarding entrepreneurial intention, resulting in its dispersion within space. Along these lines, Plummer (2010) shows that it is important to include spatial dependence in entrepreneurship research, a process of collective and network-based activities (Hong et al., 2015), to avoid inconclusive results. Furthermore, it recommends its consideration in studies on the topic.

To our knowledge, no studies on entrepreneurial intentions consider spatial dependence in their models. This fact can explain, in part, the existence of incomplete, inconsistent, or opposite results and conclusions (Plummer, 2010). Therefore, the objective of this work is twofold: on the one hand, to identify if there is spatial dependence on entrepreneurship within the American Region. On the other hand, if there is autocorrelation, locate the groups or clusters of high or low entrepreneurial intention (*hot/cold spots*, respectively).

To these ends, we utilized data from the GUESSS Survey (*Global University Entrepreneurial Spirit Students' Survey*), which, as a distinguishing feature from other alternatives, records the geolocation of the respondent. This enables the exploitation of information from a spatial perspective, something that, to the best of our knowledge, has not been undertaken with this dataset to date. On the other hand, we employed the Exploratory Spatial Data Analysis (ESDA) technique. This approach served the dual purpose of confirming the presence or absence of spatial dependence in the entrepreneurial intention of university students across countries within the American region. Additionally, in the event of spatial correlation, it aimed to discern whether high and low entrepreneurial intentions interacted among neighbouring territories.

Our study reveals the presence of spatial dependence in general and identifies spatial patterns concerning entrepreneurial intention among university students. Specifically, Colombia, Costa Rica, and Panama stand out as the countries where students exhibit the highest entrepreneurial intention, forming a distinct hotspot cluster.

The remainder of the paper is structured in the following way. Section 2 delves into the relationship between context and the business creation process. Furthermore, it elucidates the significance of factoring in spatial dependence in entrepreneurial studies. In Section 3, we describe the data used and the key variables. Section 4 reports and interprets the results. Section 5 provides conclusion implications for policymakers, discusses the study's limitations and offers suggestions for future research.

2. Theoretical framework: entrepreneurship, context, and spatial dependence

Much of the research has shown that the entrepreneurial dynamic does not arise in isolation but instead occurs in the economic and social context in which it is located (Autio et al., 2014; Bergmann et al., 2016). It is considered that the context, understood as the territorial space where the person or business activity is located, determines how entrepreneurs perceive opportunities and their subsequent step toward action (Audretsch & Fritsch, 1994; Dodd et al., 2013; Pijnenburg & Kholodilin, 2014).

The above implies that the differences in entrepreneurship rates can be explained by territorial characteristics, such as income level (Reynolds et al., 1995), industry structure of territories (Fritsch, 1997), the business climate in the area (Schutjens & Wever, 2000), unemployment rates (Armington & Acs, 2002) o cultural differences (Liñán et al., 2013; Lado-Sestayo et al., 2017).

Much of the research on differences in entrepreneurial creation has assumed, explicitly or implicitly, spatial heterogeneity (Audretsch, 2005). In this vein, Breitenecker et al. (2016) identified 52 published works addressing spatial heterogeneity in the entrepreneurial process. Therefore, these studies assume that the findings cannot be applied to other nations or regions.

However, territories do not behave as isolated units but rather interact through international trade, migratory movements, clusters with neighbouring regions, social and institutional networks, and spillover of knowledge and technology (Acs et al., 2013; Anokhin et al., 2021; Hong et al., 2015; Pijnenburg & Kholodilin, 2014). In recent decades, more literature has addressed the regional interdependencies of knowledge spillovers. In other words, the generation and accumulation of knowledge in one region can be propelled by spillovers from other regions, alluding to the existence of interregional spatial spillovers (Acs et al., 2009).

In line with the above, some empirical studies have suggested that geographic proximity positively impacts entrepreneurial and innovative activities in high-level industries and the manufacturing sector (Bailey, 2015; Cardamone, 2017). This significance of proximity for entrepreneurial activities implies that the regional innovative performance is subject to a region's location and contiguity with other regions, which can also be termed spatial dependence (Autant-Bernard, 2012). Hence, the existence of spatial dependence suggests that entrepreneurship in these areas is impacted not only by their own resources, but also by spatial interactions with neighboring regions (Plummer, 2010).

Once the premise of the entrepreneurial activities of 'neighbours' can have on the entrepreneurship of a particular focal point is accepted, the question arises of what is meant by 'neighbours'. Regarding this, empirical studies on spatial spillovers suggest a decrease in influence as the distance between the boundaries of two areas increases. This decrease ranges between 200 and 300 km (Bottazzi & Peri, 2003; Rodríguez-Pose & Crescenzi, 2008). In the specific case of West Germany, Bode (2004) also indicates that knowledge spillovers are subject to a marked decrease with distance, indicating high spatial

transaction costs. The reduction in the spillover effect can be explained by knowledge being generated through personal interactions to propagate (Bode, 2004; Bottazzi & Peri, 2003).

The findings of Furková (2018) also support the decrease in knowledge diffusion between regions with distance. According to the author, the spillover effect among European regions diminishes with each degree of proximity. This finding can be supported by the fact that the spatial concentration of companies with similar technologies in a region allows them to exchange knowledge. This knowledge diffusion decreases as proximity increases. Fossen and Martin (2018) also demonstrated, through a panel study of 402 German municipalities from 1996-2011, that interactions among startups decrease with geographical distance. The authors conclude that face-to-face communication is an important spillover or imitation concept element. They find that 41% of immediate responses to a temporary and local shock in a high-tech startup originate from regions within a distance of 100km from the origin of the shock.

Therefore, the creation of companies in a specific location can be infected by the business activity of its "neighbors" (Acs & Audretsch, 2005; Plummer & Acs, 2014). If this is the case, it is said that there is spatial dependence or spatial autocorrelation (Anselin, 1988). Thus, not addressing this relationship can cause inconsistent results obtained by applying classical statistical methods (e.g., Ordinary Least Squares) (Plummer, 2010).

Due to the above, empirical publications that deal with spatial dependence in their models have recently emerged, thus demonstrating the importance of including it. In this line, Lado-Sestayo et al. (2017) show spatial autocorrelation in Spanish ventures with a life of fewer than 42 months and that the effects of neighbouring cities are more significant than even the incidence on the rate of entrepreneurship generated in the same locality. Therefore, the authors recommend incorporating spatial techniques and spatial econometrics to avoid the biases arising from their omission. Likewise, Almeida et al. (2020) analyze self-employment rates in the United States and identify clusters of regions that are strongly infected by high business activity ("high-high" cluster) and territorial groups that are characterized by low entrepreneurial intensity ("low-low" cluster).

There is evidence that spatial autocorrelation is more likely to occur in the early stages of the entrepreneurial process (Plummer, 2010) since they depend more on environmental resources, such as knowledge and contact networks, among others (Cooper & Folta, 2000). For this reason, in this work, we focus on entrepreneurial intention (henceforth EI) as a precedent for the effective creation of companies (Weiss et al., 2019). Due to its predictive capacity, the study of EI is currently one of the research branches that is receiving the most attention in the specialized literature (Liñán & Fayolle, 2015). Because universities and research facilities are an important source of external knowledge (Acs et al., 2013) and play an important role as a breeding ground for future entrepreneurs, we focus on university students as the study's target population.

3. Methodology

The population under study is university students. The interest in studying their entrepreneurial intentions is because the creative talent inherent in young people is crucial for the development of high-impact ventures since they are generally based on knowledge and technology (Audretsch, 2014; Lakovleva et al., 2011; Trivedi, 2016). The information on the georeferenced data and the entrepreneurial intention (variable object of analysis) has been obtained from the GUESSS project. In the 2018 edition, 70,337 students from 11 countries of the American continent participated (see table 1)[1]. EI was measured following Liñán and Chen (2009) since it is the most used literature.

1 The GUESSS project is the largest international observatory that studies the entrepreneurial intentions of university students in different countries. For more information, the following website can be consulted: www.guesssurvey.org.

Table 1: Sample used

Country	N° Universities	Students
Argentine	26	2,691
Brazil	143	20,623
Chile	30	7,704
Colombia	65	18,695
Costa Rica	85	7,359
Ecuador	8	3,702
El Salvador	11	641
Mexico	53	5,173
Panama	4	3,564
Peru	1	121
United States	2	64
Total	428	70,337

Before proceeding with the data analysis, responses in very remote areas, such as Asia, where there was little concentration, were first eliminated. They are students from American universities who were in those locations when the responses were collected. On the other hand, a characteristic of the records must be addressed to analyze the data from a spatial perspective. The surveys are collected by storing the geolocation of the response. By exploring the data, we found geographical points from where several responses are sent, so we have duplicate location records. That is, groups of students from the same university campus responded to the survey. So, to build the study sample, it was decided to calculate the average of the response variables for each location, finding a total of 2,947 locations from which the responses were received.

The ESDA is used to achieve this study's objectives. It can be defined as the statistical study of the phenomena that occur in space (Anselin, 1992, 1996, 1999). The ESDA should be the first step in any entrepreneurship study involving georeferenced data since it allows for exploring global patterns among spatial data (Plummer, 2010). The three stages that the ESDA has developed are (i) *Maps of atypical observations* (Anselin et al., 2007), through which extreme observations are identified. To do this, a cartogram is a technique that focuses attention on the magnitude of the variable under study instead of the area of the spatial unit (Anselin et al., 2007). (ii) *The global spatial autocorrelation*, a global measure of clustering, is measured by the random location null hypothesis test. The most widely used test for this purpose is *Moran's Global I* (Anselin, 1996), which is a correlation statistic that incorporates the "territory" through the matrix of spatial weights, known as *W* (Anselin, 1992). (III) *Local spatial autocorrelation (LISA)*. This statistic makes it possible to identify the clusters or *outliers*' locations and test local spatial patterns. The formal expression of *Local Moran's I* for each geographic unit i is (Anselin, 1995):

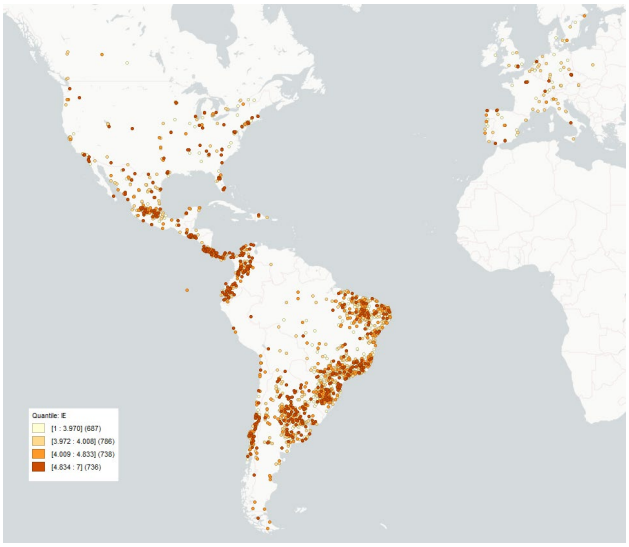
$$I_i = \frac{\sum_j w_{ij} z_i z_j}{\sum_i z_i^2}$$

A positive *I* value indicates a spatial clustering of similar values (high or low). In contrast, a negative value indicates a spatial clustering of different values between a region and its neighbours.

4. Results

The *GeoDA* software, designed to explore and analyze geospatial data (Anselin et al., 2006), has been used to conduct the analyses described in the previous section. A first exploration of the results has been carried out using the spatial representation of the EI. Figure 1 shows the geographic distribution of the EI of all the students in the sample divided into four quartiles. The darker colours indicate locations where the EI is higher, such as Brazil, Argentina, Chile, Colombia, Panama, and Costa Rica[2]. The lighter colour indicates a lower EI, as would be the case in Ecuador and El Salvador. However, through this distribution of entrepreneurial intention, it is impossible to identify locations exhibiting significantly higher entrepreneurial intention than the rest of the areas analyzed. To address this, we turn to spatial analysis techniques.

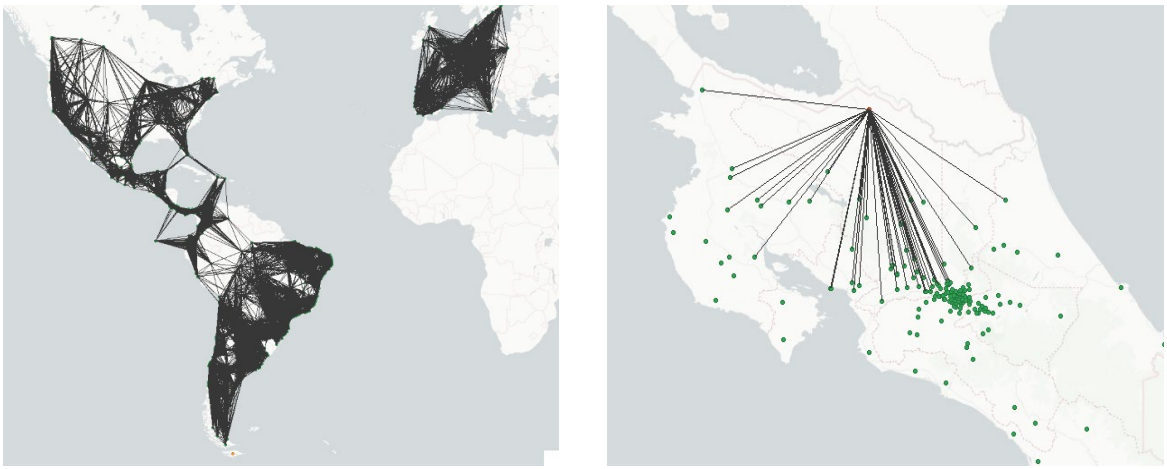
Figure 1: Geographic distribution of EI



First, to statistically analyze spatial dependence in the EI, different weight matrices were estimated to observe the relationship structure generated by the selection of different values of *k* for the k-nearest *neighbour method*. From its graphic representation, as shown in the examples in Figure 2, the existing dependency association between the previously assumed geolocations can be appreciated. Figure 2 displays the relationships established with the k-nearest neighbour matrix when k=50. The left subfigure shows all the generated interconnections, whereas the right figure exhibits the example of one specific region.

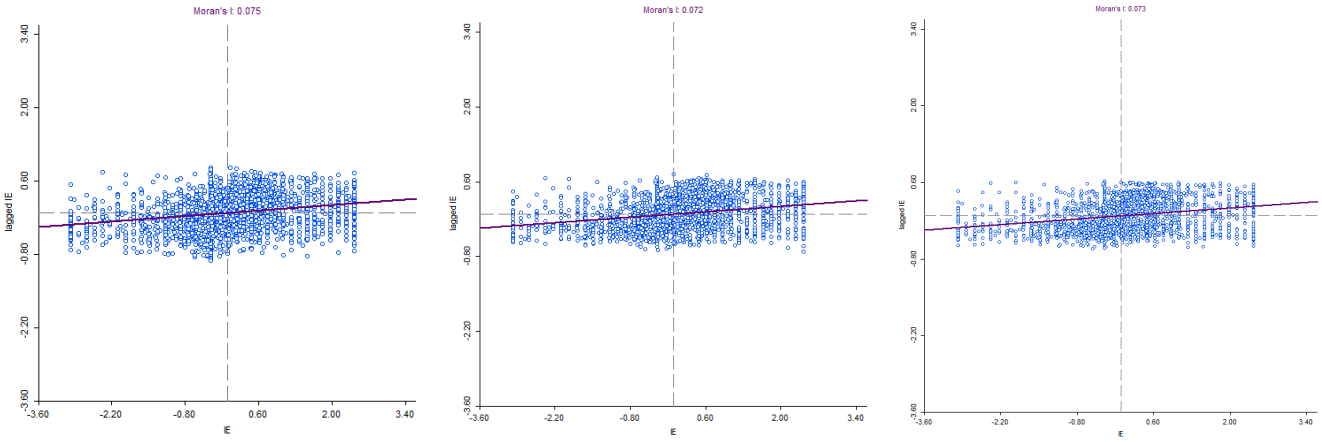
2 The countries' order is alphabetical and unrelated to the magnitude of the EI.

Figure 2: Dependency relationship between geolocations



Once this process was carried out, the *Moran Global I was estimated with different weight matrices*. That allows us to discover the existence or not of spatial structure. Figure 3 shows the result for weight matrices with k=25, k=50, and k=75 nearest neighbours, respectively.

Figure 3: Global Moran Index for weight matrices with k=25, k=50 and k=75

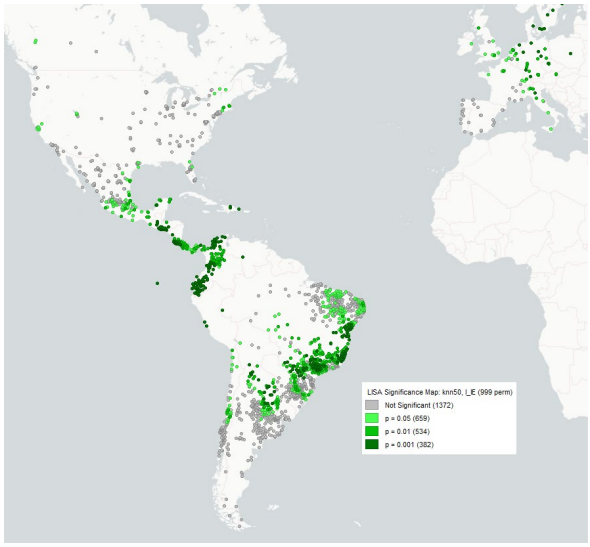


Moran's global test results, with a parameter of approximately 0.075, suggest a positive and significant spatial autocorrelation. This significant and positive result indicates that, in general terms, the entrepreneurial intention has a spatial pattern, where nearby locations in space also resemble each other in EI. However, the magnitude of Moran's I statistic is not very large, which might suggest that although this pattern exists overall, there could be geographic areas with greater similarity than others, thus justifying conducting a local analysis of spatial dependence.

The Local Moran *I* test (LISA) is performed to analyse the spatial autocorrelation of the students' entrepreneurial intention. Additionally, the local Geary test (Anselin, 1995) has been assessed as a robustness measure, yielding similar results. The results of the test's significance are shown in Figure 4 and indicate that more than 50% of the geolocations show

spatial dependence on their surroundings regarding entrepreneurial intention. That is, the test shows evidence that the EI in one location is correlated with the EI level of its neighbours. Geolocations where this occurs are depicted in green, with intensity increasing proportionally to the significance of spatial autocorrelation. Likewise, the tendency to cluster EI between locations is evident.

Figure 4: Local Moran Test



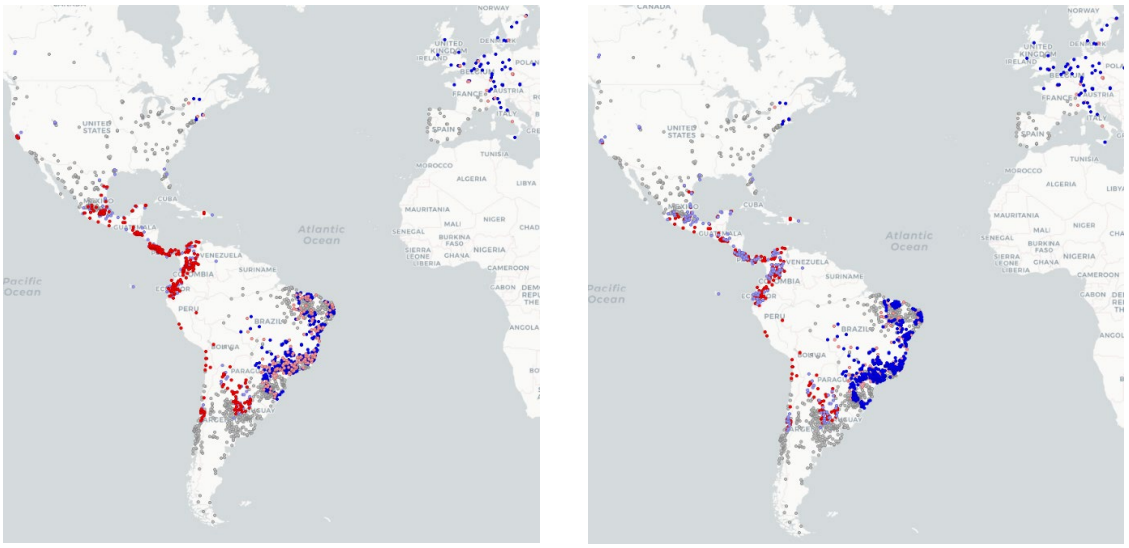
Depending on the characteristics of each geolocation dependent on its surroundings, it is possible to observe clusters with different profiles, among which are:

- *Hot Spots (red colour)*: locations with high EI influenced by neighbouring locations also with high entrepreneurial intention.
- *Cold Spots (blue colour)*: locations of low IE influenced by neighbouring locations with low entrepreneurial intention.
- Non-significant locations *(grey colour)*: locations where the Local Moran I test is no-significant. That is, it is not correlated with its neighbours.

The results of the analysis are shown in Figure 5. In subfigure (a), the *hot spots* are highlighted in red; in subfigure (b), the *cold spots are highlighted in blue*.

Figure 5: Analysis *Hot/Cold Spot*

(a) (b)



As can be seen, the *hot spots* (red colour) are primarily present in Colombia, Costa Rica, and Panama. This implies that these countries exhibit higher Entrepreneurial Intentions (EI) and are surrounded by locations with high EI. Proximity can facilitate contact among students from different territories, fostering contagion or imitation in the desire to undertake entrepreneurial endeavours. Sorenson (2018) notes that relationships often develop among individuals who live closer to each other. According to the author, this might be because the opportunities to meet people are greater in people's daily lives, and the cost of maintaining these interactions is lower when there is proximity. On the other hand, individuals tend to maintain relationships with others similar to themselves, such as in educational levels. Therefore, university students are expected to interact among themselves, promoting the exchange of attitudes and knowledge regarding entrepreneurship.

On the other hand, *cold spots* (subfigure b) occur mainly in Brazil. That is to say, this country shows a lower Environmental Impact (EI) and is surrounded by locations with low EI.

These results show essential differences in the students' entrepreneurial intention, showing that the location is essential for increasing entrepreneurial intention. The findings make it possible to identify those places where there is a context favourable to entrepreneurial intention and those places where there is a context of low entrepreneurial intention.

5. Conclusions

5.1. Concluding remarks

The study on EI has become a line of research of growing interest. Most studies have focused on understanding the factors that influence the desire to undertake, such as the individual characteristics of university students, the characteristics of the social context, and the relationships in which they are embedded, as well as the entrepreneurial education they receive at the university, among other factors. However, these investigations have overlooked analysing the influence of "space" in the entrepreneurial process. Therefore, our work contributes to understanding EI considering spatial dependence in

research. In line with Plummer (2010), this consideration should be made even though "the theoretical framework is not explicitly geographic" (p. 2).

Our research has revealed the presence of spatial patterns in the Entrepreneurial Intensity (EI) among university students across countries in the Americas. This suggests that the EI of students in one location may be impacted by that of their neighbors. We have specifically identified Colombia, Costa Rica, and Panama as countries with high EI, located in areas surrounded by students with high EI. These countries constitute the *hot spot* regions.

5.2. Policy implications

The results of this study show that entrepreneurship, in its initial phase, is not randomly distributed in America but instead follows a pattern of spatial dependence. In this sense, it is essential to consider this type of autocorrelation in designing public policies to promote and support business activities. At the level of development of joint policies between countries in the Americas in general, this study can serve as a stimulus for rethinking strategic initiatives since these may depend on whether the units under analysis (students, entrepreneurs, startups, etc.) are found in clusters or *hot or cold spot* clusters. For example, university students from Costa Rica and Panama have been shown to have high EI. Therefore, institutional programs could be designed in those countries that achieve effective business creation by students, which can lead to high-impact business activities necessary for the region. On the other hand, for low EI countries, activities that motivate students to undertake could be implemented. In this line, the Central American Integration System (SICA), through the Regional Center for the Promotion of MSMEs (CENPROMYPE), builds the Regional Strategy for the Promotion of Entrepreneurship in Central America and the Dominican Republic (SICA *Entrepreneurship Strategy*) as a critical tool in the economic integration of the SICA Region.

In addition, the results show the existence of geographical patterns of entrepreneurship independent of the borders of the countries, which reinforces the justification for the coordination of policies between countries that support and favour interactions between these places.

In short, this work shows that entrepreneurial activity depends on the characteristics of the territories where they are located and those contexts that are considered "neighboring". Therefore, there is a need to consider the spatial interaction of the observations in designing a regional strategy aimed at modulating entrepreneurship and innovation. In this sense, implementing a standard, articulated, and coordinated strategy is facilitated through a more efficient allocation of resources and efforts based on the cluster (*hot/cold spot*) where business activities are located.

5.3. Limitations and future research

Our work is not free from limitations, which can potentially serve as pathways for future research.

Firstly, the nature of the survey provides us with the respondents' location. This limits our analysis when multiple students complete the survey from the same location (for example, when completing the survey during a class at a specific university). This requires us to summarize (average) the responses given from each location, which may alter the statistical and spatial characteristics of the data. However, as Bian and Butler (1999) point out, aggregating the data through weighted means helps predict behavior better than other aggregation methods, such as those based on the median or central-pixel.

Second, we have worked with cross-sectional data. Thus, we have not been able to fully capture the dynamics of EI in a way that allows exploration of whether the hot spot clusters and cold spots persist over time or tend to change. Therefore, in future research, it would be beneficial to include both the spatial and temporal aspects.

Third, our research has focused exclusively on analyzing the EI variable, without taking into account any causal relationships. Therefore, it would be beneficial for future studies to examine attitudes toward entrepreneurship, subjective norms, and perceived control (Ajzen, 2002) or other variables (Turker & Selcuk, 2009) as dependent variables in order to determine the extent to which these variables influence the dissemination of EI among students in nearby regions.

Finally, his research can serve as a basis for other studies to delve into the specific variables on which clustering occurs. In addition, this methodology and other spatial economics techniques can be applied to already established companies, thus obtaining a broader picture of the entrepreneurial process. Future research could explore the justifications for differences between countries and regions. They understand why some areas show greater entrepreneurial intention than others could be relevant. This work provides general information on the distribution of entrepreneurial choice in students from 11 American countries. Bearing that most policies for promoting entrepreneurship are carried out at the national or local level, these future works can emphasize country-specific analyses of the determining characteristics of entrepreneurial intention. However, as the results show, the detected spillovers must be considered, which seems to point to the existence of determining geographical patterns.

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