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Measuring Local Entrepreneurial Ecosystems: Insights from Portuguese Sub-Regions

Medição de Ecossistemas Empreendedores Locais: Perspectivas das Sub-Regiões Portuguesas

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Abstract

Over the years, Entrepreneurial Ecosystems (EEs) have gained significant attention from scholars and policymakers, becoming a pivotal framework for understanding entrepreneurship's importance in regional development dynamics. However, the existing literature presents several theoretical and empirical gaps, often neglecting the specificities of the local context. This paper aims to address this void by conducting a quantitative analysis of local EEs, using data from 25 Portuguese sub-regions. Drawing upon established EE theory, the study calculates the Portuguese Local EE Index, comprising 17 indicators and a Penalty for Bottleneck methodology. Correlation and regression analyses shed light on the relationships between local EEs and entrepreneurship outputs and socio-economic indicators. The findings also underscore the critical role of leadership, market demand, and access to financial capital as focal points for tailored policy interventions to address these local bottlenecks. Moreover, the study identifies urban-rural disparities, advocating for policies that bridge geographical divides and unlock the potential of rural entrepreneurship. Furthermore, significant variability is found within each region, highlighting the importance of adopting a local perspective when developing EEs. By advancing our understanding of local EE dynamics, this research contributes to a more nuanced discourse on entrepreneurship and informs evidence-based policymaking aimed at cultivating more vibrant and resilient entrepreneurial economies.

Keywords: entrepreneurial ecosystems; local development; resilience; entrepreneurship; regions; public policy.

JEL Codes: P25; R58; L26; L38

Resumo

Ao longo dos anos, os Ecossistemas Empreendedores (EEs) têm merecido grande atenção por parte de académicos e decisores políticos, tornando-se um importante modelo para a compreensão da importância do empreendedorismo nas dinâmicas de desenvolvimento regional. No entanto, a literatura existente apresenta várias lacunas frequentemente negligenciando as especificidades do contexto local. Este artigo pretende colmatar esta lacuna através de uma análise quantitativa a nível local, utilizando dados de 25 sub-regiões portuguesas. O estudo calcula o Índice Local EE Portugal, composto por 17 indicadores e uma metodologia de penalização por estrangulamento. As análises de correlação e regressão esclarecem as relações entre os EEs, a atividade empreendedora e indicadores socioeconómicos. Os resultados sublinham o papel da liderança, do mercado e do acesso a capital financeiro como pontos críticos a nível local e regional. Além disso, são identificadas disparidades urbano-rurais, defendendo-se políticas para superar as divisões geográficas e desbloquear o potencial do empreendedorismo rural. Por fim, é encontrada uma variabilidade significativa dentro de cada região, destacando a importância de adoptar uma perspectiva local ao desenvolver EEs. Ao avançar na compreensão das dinâmicas locais dos EEs, esta investigação contribui para um discurso mais sistematizado sobre o empreendedorismo, melhor informando a elaboração de políticas destinadas a promover economias locais empreendedoras, vibrantes e resilientes.

Palavras-Chave: ecossistemas empreendedores; desenvolvimento local; resiliência; empreendedorismo; regiões; políticas públicas.

Códigos Jel: P25; R58; L26; L38

INTRODUCTION

In the last decade, Entrepreneurial Ecosystems (EEs) have gained widespread attention from researchers and policymakers, resulting in a proliferation of studies in this field (Spigel, Kitagawa, and Mason 2020). However, despite the growing interest in EEs, empirical evidence, particularly using quantitative approaches, remains scarce (Leendertse, Schrijvers, and Stam 2021; Liguori et al. 2019). Many existing studies have focused on individual success cases, posing challenges in replicating findings across different regions or countries, and often lacking robust theoretical foundations or precise and comparable metrics (Nicotra et al. 2018).

Consequently, several scholars have emphasized the importance of securing a balance between quantitative and qualitative approaches to better understand the diverse contexts of EE (Spigel, Kitagawa, and Mason 2020). Recent efforts have seen the development of tools for measuring EEs through empirical quantitative analyses using primary or secondary data. Nonetheless, many of these studies tend to concentrate on specific case studies that may be difficult to extrapolate, or on the national (Radosevic and Yoruk 2013; Corrente et al. 2019) or regional levels (Leendertse, Schrijvers, and Stam 2021), overlooking the significant variation in entrepreneurial inputs and outputs within those regions or countries.

To address this gap, this study aims to examine EEs at the local level, acknowledging the substantial variability of local EEs across different regions and territories. It adopts the recommendations of various authors working on EEs (Liguori et al. 2019; Wurth, Stam, and Spigel 2021) and builds upon the framework proposed by Stam and van de Ven (2021). The framework encompasses ten elements and seventeen indicators to measure EE quality, along with four indicators to measure entrepreneurship outputs, and five indicators to assess local socio-economic development. Furthermore, it explores the interrelationships between these elements and develops an EE index using the Penalty for Bottleneck methodology. Moreover, potential associations between EE quality, entrepreneurship outputs, and local socio-economic development are verified. Additionally, we identify critical bottlenecks such as leadership, demand, and finance, offering actionable insights for policymakers to tailor interventions that bolster the overall quality of EEs.

By depicting the complex dynamics of local EEs, this study contributes to the empirical evidence on EEs and offers policymakers valuable insights for promoting entrepreneurship and innovation as local development strategies.

This paper first discusses the theoretical background of EEs, presenting several examples of previous attempts to measure EEs at local and regional level. Following that, section 2 presents the methodology, research context and indicators and data sources used. Thirdly, it presents the main results regarding descriptive analysis, regression analysis and bottlenecks identified, being discussed and compared with other studies on the topic. Finally, the main conclusions are presented, discussing implications for policymaking, as well as the limitations of this study and further research suggestions.

1. ENTREPRENEURIAL ECOSYSTEMS

Entrepreneurship does not occur in a vacuum, as it flourishes within a supportive environment conducive to innovation and business development (Cowell, Lyon-Hill, and Tate 2018). Hence, the concept of the EE has emerged as a place-based perspective suitable for understanding entrepreneurship within broader geographical, temporal, and social contexts (Alvedalen and Boschma 2017). Building upon previous concepts such as innovation systems, clusters, industrial districts, and entrepreneurial support networks, the EE concept offers an integrative and distinct viewpoint on the complex and diverse interactions between actors and environmental elements shaping the entrepreneurial performance of a region or locality (Stam 2015).

Despite the exponential growth of research publications and policy papers on EE (Spigel, Kitagawa, and Mason 2020), the concept still lacks strong theoretical foundations and empirical support (Kansheba and Wald 2020; Alvedalen and Boschma 2017). These documents have identified four main research challenges in EE research: theoretical foundations and frameworks, dynamic and longitudinal perspectives, empirical work, and applicability to other contexts. Addressing these challenges is crucial for advancing EE research and informing effective policy interventions.

1.1. Local Entrepreneurial Ecosystems

Each EE is shaped by the combination of physical and formal elements, as well as the perceptions and relationships of the local actors (Muñoz et al. 2020). The unique socio-cultural environment, available resources, networks, and geographical conditions of a location shape the interactions between the stakeholders, ultimately impacting the success or failure of adopted policies and strategies (Mason and Brown 2014; Xu and Dobson 2019). Due to variations in location, the elements and contextual conditions of EE frameworks may vary and their interactions across different spatial levels can be (dis)aggregated, making it essential to adopt multi-actor, multi-level, and multi-scalar approaches (Wurth, Stam, and Spigel 2021). Therefore, a place-based perspective becomes imperative to comprehend how entrepreneurship influences a territory's development.

Nevertheless, research on EEs has predominantly focused on specific ecosystems rather than employing a multi-scalar approach (Wurth, Stam, and Spigel 2021). Most authors have concentrated their efforts on the national or regional level, due to the availability of national or regional statistics. Current EE models and policies often adopt a one-size-fits-all approach, which may not be suitable for every local ecosystem. However, it is important to recognize that each region encompasses multiple unique local ecosystems that may complement or compete with one another (Muñoz et al. 2020). Consequently, calls have been made for new conceptual and methodological approaches that capture the diversity of conditions and outcomes, recognizing the distinctiveness of each local EE (Muñoz et al. 2020; Freitas and Kitson 2018).

Comparative analyses of EEs, whether across different points in time or between different EEs, have become crucial in both EE research and policymaking (Corrente et al. 2019). Various tools, such as Global Entrepreneurship Monitor, World Bank indicators, World Economic Forum index, or the Organization for Economic Co-operation and Development (OECD) measures, have

been introduced in recent years to capture EE attributes (Liguori et al. 2019). However, most of these tools primarily focus on the national level, making it challenging to adapt them for regional or local analysis (Liguori et al. 2019). Despite these challenges, there are some studies and reports that analyse EEs at the regional and local level, awakening a growing interest among researchers and policymakers.

Early attempts to measure EE quality at the regional level include the 'Regional Entrepreneurship & Development Index (REDI)' (Szerb et al. 2017) and the 'Regional Ecosystem Scoreboard (RES)' (León et al. 2017), two European policy instruments that were developed to assess the entrepreneurial environment and development prospects within specific regions. More recently, Sternberg, von Bloh, and Coduras (2019) undertook measurements of EEs' quality at the regional level in two German and two Spanish NUTS-2 regions, drawing upon Stam's (2015) framework and using a survey to measure the perception of the people and organizations within these regions. Similarly, Liguori et al. (2019) employed an approach based on capturing entrepreneurs' perceptions of the ecosystem to measure EEs performance. On the other hand, Leendertse, Schrijvers, and Stam (2021) and Mikic, Horvatinovic, and Kovac (2020) used secondary data to measure EEs at the regional level in 273 European Regions (NUTS-2), also drawing upon Stam 2015 proposed elements.

At the local level, studies are relatively scarce. Stam and van de Ven 2021 measured EEs at the provincial level in The Netherlands, while Iacobucci and Perugini 2021 and Perugini 2022 conducted similar analyses in Italy.

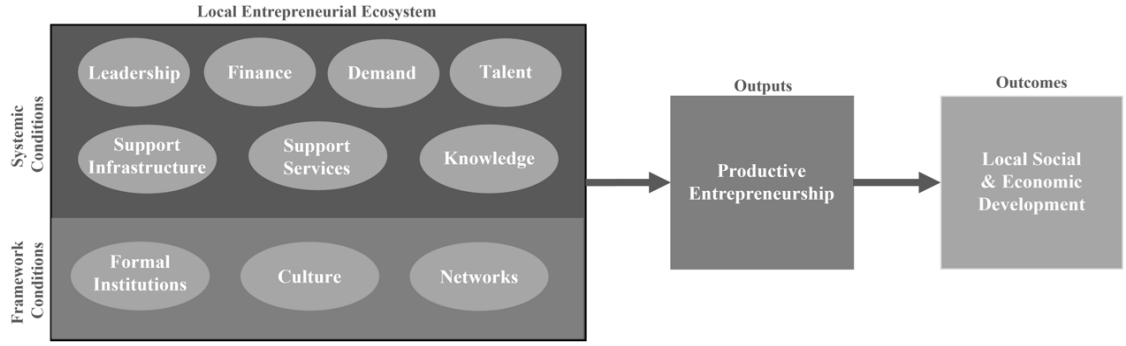
Despite the novelty of contributions, these approaches face challenges in scaling up and conducting longitudinal analyses due to data limitations (Liguori et al. 2019; Spigel, Kitagawa, and Mason 2020) or the unavailability of local-level data (Iacobucci and Perugini 2021). Thus, this study aims to contribute to EE research at the local level and respond to the call for further research "in other contexts, potentially revealing different relations between the entrepreneurial ecosystem and its outputs" (Stam and van de Ven 2021, 829).

2. METHODOLOGY

2.1. Research Framework

This study builds upon Stam and van de Ven 2021 framework, gathering insights from the empirical studies to EE at local and regional levels discussed in the previous section. The Local Entrepreneurial Ecosystem (LEE) comprises ten elements, categorized into three framework conditions (formal institutions; culture; and networks) and seven systemic conditions (leadership, finance, demand, talent, support infrastructure, support services, knowledge). These elements have been widely acknowledged in seminal works within the EE literature, capturing the fundamental conditions necessary for entrepreneurship to thrive in a given location (Isenberg 2010; Stam 2015). The framework considers productive entrepreneurship as the primary output of the LEE, and the local social and economic development as the principal outcome. A detailed description and discussion of each element are provided in the 'Indicators and Data Sources' section.

Figure 1 – Local Entrepreneurial Ecosystem Framework. Adapted from Stam and van de Ven 2021.



2.2. Research Context

Portugal is a European country with just over ten million inhabitants. The country is divided into seven regions (NUTS 2) and 25 sub-regions (NUTS-3), according to the European Union nomenclature (see Table 4)[1]. The Portuguese regions and sub-regions lack political autonomy (except for the Autonomous Region of Madeira and the Autonomous Region of Azores). While some boundaries are subject to political discussions, these spatial divisions were established based on shared historical and common characteristics among municipalities, and numerous institutions operate within these boundaries.

Regarding entrepreneurship and innovation (ecosystems), various studies suggest that Portugal has been increasing its national EE quality and entrepreneurship outputs in recent years (Singh and Ashraf 2020; Pita, Costa, and Moreira 2021; Almeida, Daniel, and Botelho 2023). This is supported by reports from the Global Entrepreneurship Monitor, indicating growth in entrepreneurial self-perceptions and activity in Portugal (GEM 2019).

At the regional level, Leendertse, Schrijvers, and Stam (2021) work on the European NUTS-2 regions showed that all Portuguese regions, except for the capital region (AM Lisboa), have EE index scores far below the European average. These disparities among Portuguese NUTS-2 regions are also reflected in innovation indicators, where *Norte*, *Centro* and *AM Lisboa* regions are considered Moderate Innovators, while the remaining regions (*Alentejo*, *Algarve*, *RA Açores* and *RA Madeira*) are considered Emerging Innovators (European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs 2021). At the local level, (Silva and Teixeira (2012) mapped the local political entrepreneurship confirming a positive impact in the creation of local businesses, and finding significant variation among different regions. More recently, Subtil et al. (2023) confirmed this important role of local governance in Portuguese LEEs development.

This study focuses on the 25 Portuguese sub-regions (NUTS 3) as the unit of analysis. This spatial level presents a compromise between the lower institutional level (municipality), which is too disaggregated due to the people and firms operating outside their municipality of origin, and the broader levels (regional and national) which do not allow to capture the high internal variability that significantly influences entrepreneurship and innovation (Iacobucci and Perugini 2021).

2.3. Indicators and Data Sources

In this section, we provide the definitions and operational measures for the EE elements, outputs and outcomes, used in the research framework outlined above. The selection of indicators was based on their relevance, analytical robustness, timeliness, and accessibility. The starting point for the selection was the empirical studies on EEs at the regional and local levels presented in section 1.1., as many authors have already tested and confirmed the significance of some indicators which ease the selection process. Afterwards, the initial pool of indicators was tailored to the availability of data within the Portuguese context and at the sub-regional level. The data collected range from 2015 to 2021, being mainly used that from 2018. The final set of indicators consisted in seventeen indicators to measure EE quality, four indicators to measure EE outputs, five indicators to measure EE outcomes, and one control variable. These indicators are summarised in Table 1.

2.3.1. Entrepreneurial Ecosystem Elements

Formal Institutions. The quality and efficiency of formal institutions are essential for entrepreneurship (Stam and van de Ven 2021). The institutional environment and regulatory framework for businesses, can boost or hinder entrepreneurs to further develop their ideas (León et al. 2017; Leendertse, Schrijvers, and Stam 2021). We use data from the Local Quality of Governance

[1] In this study, we followed NUTS-2013 classification. We acknowledge the recent redefinition in Portuguese regions with NUTS-2024, however since the data was collected prior to this new division, we use the previous classification.

Index of Portugal presented by Tavares et al. (2018). It measures the quality of governance of the 308 Portuguese Municipalities (NUTS 4), using 22 indicators divided into five dimensions: citizen voice and accountability; political stability; government effectiveness; market access and regulation; rule of law and prevention of corruption. The data was aggregated into 25 sub-regions (NUTS 3) using an average aggregation procedure. As this study focuses only on one country, country-level indicators such as the legal system, regulations or taxation or level of bureaucracy were not included.

Entrepreneurial Culture. It reflects the degree to which entrepreneurship is valued and facilitated in a society (Sternberg, von Bloh, and Coduras 2019), fostering or hindering (potential) entrepreneurs to develop their ideas (León et al. 2017). There are different types of methods and indicators to measure entrepreneurial culture (Credit, Mack, and Mayer 2018). We measure entrepreneurship culture indirectly with the prevalence of new firms, which indicates how 'common' it is to start a business in the sub-region. This is a common indicator used in other EE empirical studies (Mikic, Horvatinovic, and Kovac 2020).We also include a more qualitative indicator from the European Social Survey related to the population opinion on the 'importance to be innovative and have new ideas'. This indicator was already used in other EE empirical studies (Leendertse, Schrijvers, and Stam 2021).

Networks. This element covers the interactions among the different players in an ecosystem (Sternberg, von Bloh, and Coduras 2019), being measured by the percentage of businesses in a region that collaborate for innovation, based on data of the Community Innovation Survey (CIS). This indicator may not include other micro businesses or other non-business players of the ecosystem, as well as, not covering the nature and quality of the interactions among the local stakeholders. However, this was an indicator already used in other EE empirical analyses at the local and regional level as the best proxy to measure this element (Stam and van de Ven 2021; Leendertse, Schrijvers, and Stam 2021).

Support Infrastructure. Physical infrastructure, such as accessibility to roads, railroads and airports, as well as, digital infrastructure are essential to promote interactions between ecosystem players and ensure an adequate flow of resources (Mikic, Horvatinovic, and Kovac 2020; Leendertse, Schrijvers, and Stam 2021). We use three empirical indicators to measure the physical and digital context that enables the connection between EE stakeholders. Two of the indicators are related to the transportation infrastructure regarding road (Dijkstra, Poelman, and Ackermans 2019) and rail accessibility (Cruz et al. 2021). Other indicators regarding passenger flights, for example, were not considered given the lower spatial level of the analysis. The third indicator is related to the digital infrastructure and is measured by the percentage of the population with access to the internet. Other relevant indicators such as broadband accessibility were not available at the sub-regional level.

Demand. It is measured using two indicators: one related to potential market demand, measured by the number of inhabitants; and other the related to the population's capacity to purchase goods and services, measured by the purchasing power per capita. This element is the most complex to measure, since in todays's globalised world companies, especially for high-growth firms, are most likely to serve markets outside their spatial boundaries.

Leadership. The importance of lead actors in fostering a healthy EE has been well-established (Porras-Paez and Schmutzler 2019). One indicator used to measure leadership is the prevalence of innovation project leaders within a sub-region, as determined by data from the Horizon 2020 projects database. This metric has been employed in previous empirical analyses on EE (Leendertse, Schrijvers, and Stam 2021).

Finance. The access to various sources of debt and equity, both formal and informal, is an essential requirement for the growth and sustainability of new ventures (Miles and Morrison 2020). To measure finance, this study employed three indicators, where one pertained to venture capital and was measured by the number of investors registered in the sub-region on the Crunchbase platform; and the other two indicators were based on investment in innovation and entrepreneurship through European funds databases over an eight-year period.

Talent. It is related to the availability of qualified human capital, crucial to the existing and potential companies' growth. It is measured by the percentage of the population with higher

education. Other indicators related to skills and training commonly used in this element were not available at the local level.

Knowledge. Investments in new knowledge are an important source of entrepreneurial opportunities. The indicator used for the knowledge element is the amount invested in R&D (by public and private organizations) as share of the GDP. This is a widely used indicator to measure the knowledge production in a given region.

Support Services. The presence of business services can substantially lower the barriers to new value creation (Stam and van de Ven 2021). Besides the existence of incubators and science parks which support the local EE (Sternberg, von Bloh, and Coduras 2019), we include the percentage of support services firms on the total number of businesses in the sub-region, and the number of technological infrastructures per 1000 inhabitants.

2.3.2 Outputs

We measured productive entrepreneurship using three indicators – the number of firms registered on the Crunchbase platform, the number of new medium-high technology firms, and the number of high-growth firms. These indicators represent the best proxy to productive entrepreneurship, being commonly used in other EE studies (Stam and van de Ven 2021; Leendertse, Schrijvers, and Stam 2021; Mikic, Horvatinovic, and Kovac 2020). Additionally, a fourth indicator related to the survival rate of new firms, to understand if the LEE is related to higher or lower survival of new firms.

2.3.3 Outcomes

The main outcome of the LEE is the local social and economic development of the territory. This is measured using five indicators. One relates to economic development – GDP per capita; two related with social development – the population change in the last ten years and the quality of life of the region; and two related to the resistance to crises – measured by changes in the unemployment rate change and the GDP per capita change during the first year of the pandemic. Regarding this last indicator, we consider the first year of the pandemic as the period during the shock, coinciding with the peak of unemployment of the country, following Iacobucci and Perugini (2021) work which measure resilience by looking at the variations of GDP or employment at local level: during the shock (resistance) and soon after it (recovery).

2.3.4 Control Variable

The degree of urbanisation classifies the Local Administrative Units (LAUs) in Europe into three types of areas (cities, towns and suburbs, and rural areas), based on the share of the local population living in urban clusters and urban centres (Eurostat 2022). This indicator was used in this study as a control variable to understand how the EE index performs across urban and rural areas.

Table 1 - Description of the indicators used for each element.

	Element	Empirical Indicators	Year	Data Source
Framework Conditions	Formal Institutions	Local Quality of Governance Index	2018	(Tavares et al. 2018)
	Entrepreneurial Culture	Enterprises Born Rate per 1000 inhabitants (15-64 years)	2015-2018	(Statistics Portugal 2022)
		Importance to be innovative and have new ideas	2008-2018	European Social Survey (ESS)
	Networks	% of companies that cooperated with other companies or organisations	2018	Community Innovation Survey (CIS)
Systemic Conditions	Support Infrastructure	Geographical accessibility by road	2018	(Dijkstra, Poelman, and Ackermans 2019)
		Geographical accessibility by railway	2018	(Cruz et al. 2021)
		% of Population's Access to Broadband	2018	(Statistics Portugal 2022)
	Demand	Number of inhabitants	2018	(Statistics Portugal 2022)
		Purchasing Power per capita	2017	(Statistics Portugal 2022)
	Leadership	Number of H2020 Coordinators per 1000 inhabitants (15-64 years)	2014-2018	CORDIS Database
	Finance	Number of Investors per 1000 inhabitants (15-64 years)	2021	Crunchbase
		Investment in Innovation Projects per capita (15-64 years)	2010-2018	Portuguese National Innovation Agency (ANI)
		Public Investment through European Funds in Entrepreneurship and Innovation (per capita)	2010-2018	Portugal 2020
	Talent	% of higher-educated in adult population	2021	(Statistics Portugal 2022)
	Knowledge	Share of research and development (R&D) expenditure in GDP	2018	(Statistics Portugal 2022)
	Support Services	Number of Technological Infrastructures per 1000 inhabitants (15-64 years)	2018	Portuguese National Innovation Agency (ANI)
		% Support Services Firms on total business	2018	(Statistics Portugal 2022)
Outputs	Productive Entrepreneurship	Crunchbase firms per 1000 inhabitants (15-64 years)	2017-2018	Crunchbase
		Number of New Medium and High Technology Firms per 1000 inhabitants (15-64 years)	2019	(Statistics Portugal 2022)
		Number of High-growth enterprises per 1000 inhabitants (15-64 years)	2018	(Eurostat 2022)
		Firms Survival Rate (2 years)	2019	(Statistics Portugal 2022)
Outcomes	Local Social and Economic Development	Population Change	2011-2021	(Statistics Portugal 2022)
		GDP per capita	2019	(Statistics Portugal 2022)
		Territorial Quality of Life Index	2018	(Sessa et al. 2020)
		Unemployment rate change during the first year of the pandemic	2019-2020	(IEFP 2022)
		GDP per capita change during the first year of the pandemic	2019-2020	(Statistics Portugal 2022)
Control Variable	Degree of Urbanisation	Percentage of Cities, Towns and Suburb Areas in the region	2021	(Eurostat 2022)

Source: Own.

2.4. Index Construction

Building a composite index is a multifaceted endeavour that involves various stages, including theory selection, indicator identification, normalization, weighting, and aggregation procedures (OECD 2008).

In this study, the EE index was developed based on the ten elements proposed in the theoretical framework (Figure 1) and employing the Penalty for Bottleneck (PFB) methodology proposed by Acs, Rappai, and Szerb 2011. The PFB approach assumes that the performance of the ecosystem depends on the weakest element (bottleneck), that is, the bottleneck has a negative effect on the other elements, and hence on the whole ecosystem. Therefore, targeting and improving the weakest element through tailor-made policies has a magnifying effect on the overall index. This methodology differs from the most commonly applied methods of index construction, e.g. arithmetic average or sum, which assume perfect substitutability of the elements, potentially leading to misinterpretations and implications (Acs, Rappai, and Szerb 2011).

The first step involved normalizing the indicators since those were initially expressed in different statistical units. Normalization is necessary to ensure comparability among indicators and is a prerequisite for data aggregation (Mazziotta and Pareto 2013). A Min-Max normalization was used, following the equation (1):

$$0 \leq z_{re} = \left(\frac{x_{re} - x_{min,e}}{x_{max,e} - x_{min,e}}\right) \leq 1 \qquad (1)$$

where r = 1, 2, … 25 (number of sub-regions)

z_{re} is the normalized value for a particular element (e) for a sub-region (r)

x_{re} is the observed value of a particular element (e) for a sub-region (r)

$x_{min,e}$ is the minimum value of a particular element (e)

$x_{max,e}$ is the maximum value of a particular element (e)

The second step involved calculating the PFB-adjusted values for each sub-region. The values for each element were determined using equation (2) proposed by Acs, Rappai, and Szerb (2011):

$$z_{re}^{(p)} = z_{min,r} + \ln\,(1 + z_{re} - z_{min,r}) \qquad (2)$$

$z_{re}^{(p)}$ is the PFB-adjusted value for a particular element (e) for a sub-region (r)

z_{re} is the normalized value for a particular element (e) for a sub-region (r)

$Z_{min,\,r}$ is the value of lowest element for a particular sub-region (r)

The final step involved calculating the EE index with the PFB-adjusted values. A simple arithmetic average was used to aggregate the ten elements. Equal weighting was applied to each dimension, indicating that all ten elements were considered equally important and received the same weight in the final index. This procedure is widely used in composite indicators when there is limited knowledge about the strength and nature of relationships among the dimensions of the conceptual framework (OECD 2008). Moreover, other authors also applied this procedure when measuring EEs at the regional or local level (Stam and van de Ven 2021; Leendertse, Schrijvers, and Stam 2021). The resulting values were rescaled to a 0-100 scale by multiplying the index by 100 for easier visualization of the results.

To ensure the reliability of the computed index, several robustness and sensitivity tests were conducted. These tests included applying different normalization methods (log normalization, z-score normalization), employing different aggregation methods (additive, multiplicative, and logarithm), and conducting variable removal tests by calculating the index with only nine dimensions using a one-at-a-time variable removal methodology. The data analysis was performed using SPSS Statistics software and R Programming software to carry out the necessary computations.

3. RESULTS AND DISCUSSION

3.1. Descriptive Statistics

Table 2 presents the normalized means, minimum and maximum values, and standard deviations of the ten EE elements, the overall EE Index calculated according to the PFB methodology, along with its outputs and outcomes across the 25 Portuguese sub-regions. The EE Index is later discussed in the next section.

Even in a small country like Portugal, there is a significant variation in the values of the EE elements, as well in most of the outputs and outcomes. This regional heterogeneity confirms the need to analyse EEs at the local level, in order to understand better their dynamics and to design more effective policies.

Table 2 - Descriptive Statistics (EE elements after normalization)..

	N	Minimum	Maximum	Mean	Std. Deviation
Formal Institutions	25	0	.698	.510	.165
Entrepreneurial Culture	25	.304	.627	.430	.097
Networks	25	0	.852	.206	.206
Physical Infrastructure	25	.093	.779	.180	.180
Demand	25	.001	.852	.168	.168
Leadership	25	0	.825	.221	.221
Finance	25	.026	.638	.158	.158
Talent	25	0	.852	.178	.178
Knowledge	25	0	.825	.237	.237
Support Services	25	.130	.702	.141	.141
EE Index	25	20.57	72.88	40.08	13.43
CB	25	0	.292	.048	.060
MHTECH	25	.193	1.31	.437	.233
HGROW	25	.332	1.59	.841	.336
SURV	25	.438	.602	.525	.040
POP	25	-.115	.037	-.050	.043
GDP	25	14468	29291	20157.84	3082.56
QOL	25	.364	.557	.456	.048
RES_1	25	-.036	.608	.212	.152
RES_2	25	-.191	-.015	-.062	.040

Source: Own

3.2. Elements Correlation and Reliability

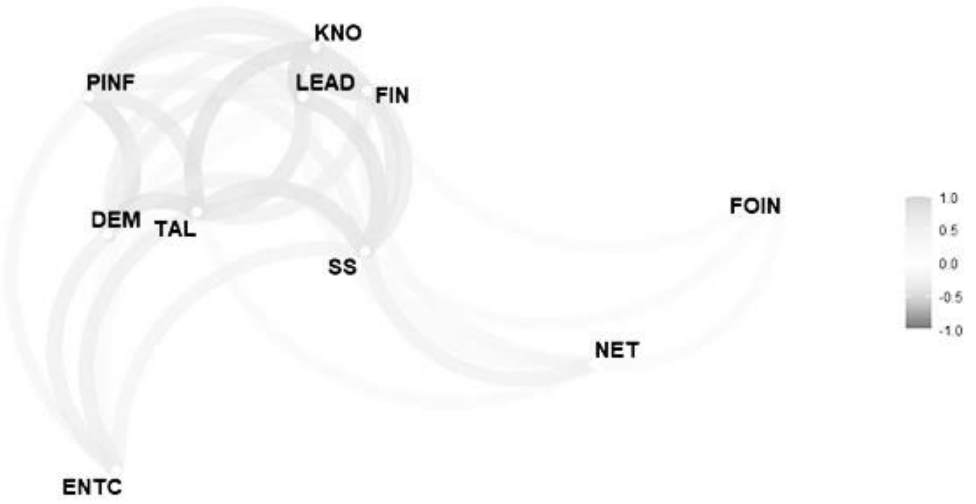
Figure 2 shows the correlation network between the ten elements, with a minimum correlation of .30. The figure shows that the seven systemic conditions are highly correlated with each other

and most often correlated to other elements. This confirms the systemic nature of EE where the elements are mutually interdependent and co-evolve (Stam and van de Ven 2021). On the other hand, the framework conditions (formal institutions, entrepreneurial culture and networks) are poorly correlated with each other and with the other elements. This may be explained by the nature of the indicators which may not capture these dimensions at sub-regional. In the case of Formal Institutions, it is not significantly correlated with any other element. The nature of the local/regional formal institutions in Portugal may explain this result, since Portugal does not have regional or sub-regional government bodies, and the indicator used was a quality of government index made to Local Administrative Units (Municipalities). Besides, this was also reported in other studies where *Formal Institutions* or *Entrepreneurial Culture* were poorly or negatively connected to the other EE elements (Stam and van de Ven 2021).

To build the EE index, we not only perform the correlation analysis but also a principal component analysis (PCA) to uncover the dimensions underlying the ten elements. The PCA highlighted two dimensions, one covering all the systemic conditions and another covering the three framework conditions. Besides, a reliability analysis performed on the ten elements showed strong scale reliability with a Cronbach's Alpha higher than 0.895.

Despite some issues regarding the framework conditions, given the higher correlations among the systemic conditions and higher scale reliability, the systemic nature of the EE is verified and the construction of a compositive index is possible to better analyse and discuss the EE in each region.

Figure 2 – Correlation Network of the EE elements (2018). Minimum Correlation = .30.



Source: Authors using R Programming software.

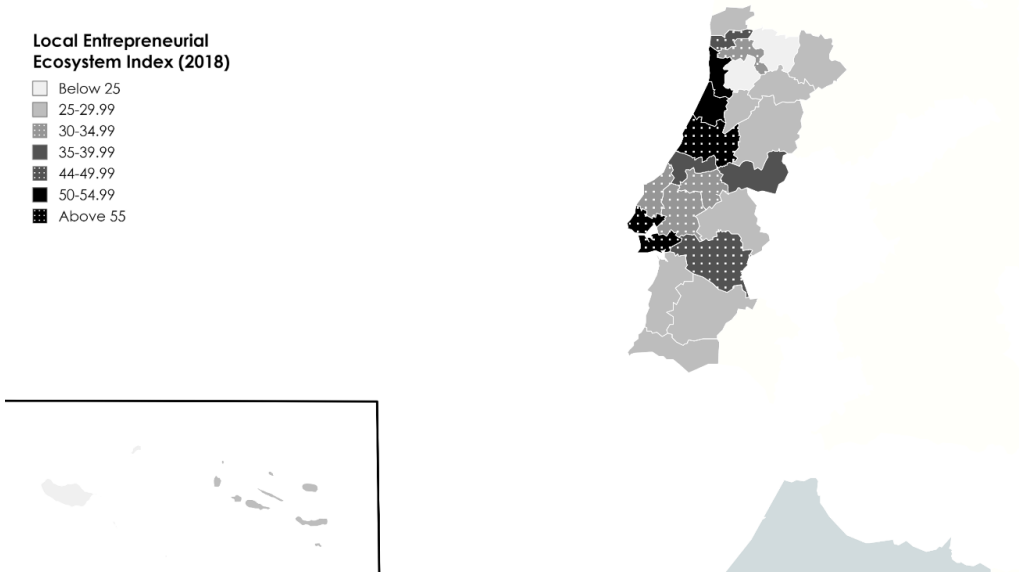
3.3 The Local Entrepreneurial Ecosystem Index in Portugal

The EE index was constructed according to the procedures described in the methodology section, using a Min-Max normalisation of the indicators, and a Penalty for Bottleneck aggregation procedure. Besides, several robustness tests were conducted. These tests did not substantially change the ranking order of the NUTS-3 regions, especially regarding the top and bottom regions which remain the same (see the Supplementary Material provided by the authors).

The geographical pattern of the EE index by sub-region is shown in Figure 3, with a distribution divided into seven categories. The darker areas, associated with above-average values of the index, are mainly located in the coastal areas of Portugal. The lighter areas, associated with lower values of the index are mainly located in the inland areas of Portugal and on the islands, following other studies on entrepreneurship in Portugal (da Silva and Teixeira 2012; Tibério and Teixeira 2018). The map also confirms the high intra-region variability of the local EE index. A clear case

is the Norte Region (NUTS-2), which encompasses two sub-regions with the highest EE scores (AM Porto and Cávado) and two of the lowest EE scores (Alto-Tâmega and Tâmega e Sousa). This supports the importance of analysing EEs at a more disaggregated territorial level (Iacobucci and Perugini 2021).

Figure 3 - Local Entrepreneurial Index of Portuguese NUTS-3 Regions (2018).



Source: Authors.

3.4 Urban-Rural Comparison

In comparing the EE index across different types of regions, we introduced the Degree of Urbanisation as a control variable. Our analysis revealed a clear pattern: regions with a higher percentage of urban areas exhibited higher EE Index values. This indicates that cities and intermediate regions generally possess stronger EEs, while rural and remote regions tend to have weaker ecosystems, particularly in terms of support infrastructure, demand, and availability of talent.

These rural-urban disparities regarding EE quality and its elements align with findings from prior research (Liedtke, Asghari, and Spengler 2021). These differences can be attributed to various factors, such as the agglomeration effects in urban areas, with a higher concentration of businesses, networks, and resources that foster entrepreneurship. On the other hand, rural areas face unique challenges, such as limited access to resources, a smaller customer base, and reduced connectivity. It is important to note that there are exceptions among rural areas that host regional capitals or significant higher education institutions, such as Alentejo Central with the University of Évora, following recent studies which argue the important role of higher education institutions in rural EE (Asmit et al. 2024; Lyons, Miller, and Mann 2017).

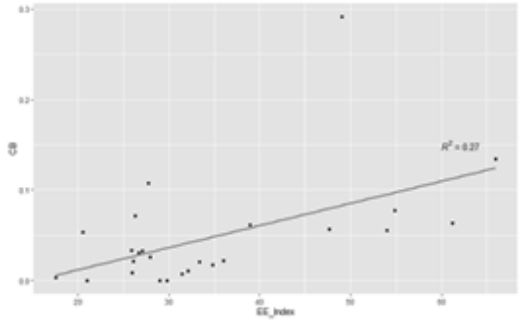
Efforts to bridge the urban-rural divide should focus on leveraging the specific strengths of rural areas, such as their natural resources, cultural heritage, and local networks (Almeida and Daniel 2022). By nurturing entrepreneurship in both urban and rural contexts, policymakers can foster balanced regional development and unlock the full potential of their respective EEs.

3.5 EE Index, Outputs and Outcomes

When exploring the correlations between the EE index and the output and outcome indicators, we observed several noteworthy relationships. The EE index is positively correlated with two outputs, the number of Crunchbase firms and medium-high technology firms, and two outcomes, population change and GDP per capita. Conversely, it is negatively correlated with firm survival rate, a finding that requires further clarification.

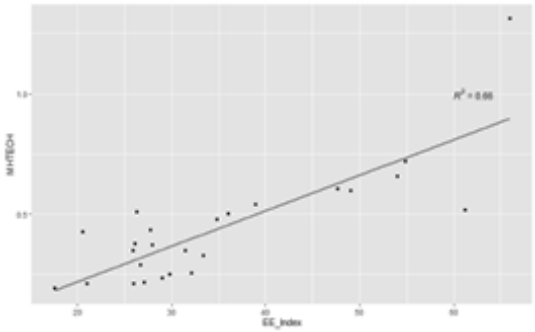
To further explore the relations, several linear regression analyses between the EE index (and its framework and systemic conditions) as independent variables, the outputs and the outcomes, as dependent variables, were performed (Table 3). Regarding the entrepreneurship outputs, the EE index positively explains the number of Crunchbase Firms and Medium-High Technology Firms. Figures 4 and 5 show the scatterplot and the linear relation between the EE index and Crunchbase firms (Figure 4) and Medium-High Technology Firms (Figure 5). This linear model has an R^2= .27 for Crunchbase firms and R^2= .66 for Medium-High Technology Firms, highlighting the causation effect of the elements of the LEE (combined) on productive entrepreneurial activity within a given territory, aligning with previous studies (Stam and van de Ven 2021).

Figure 4 - Regression analysis between EE Index and Crunchbase Firms



Source: Authors using R programming software.

Figure 5 - Regression analysis between EE Index and Medium-High Technology Firms.



Source: Authors using R programming software.

Regarding local social-economic development, the EE index exhibited significant associations with two indicators: Population Change and GDP per capita. In this case, a strong EE can provide individuals with the support and resources necessary to start and grow successful businesses, which can create job opportunities and attract more talented individuals to the region.

However, the EE quality did not show a correlation with the overall quality of life index (QoL), which aligns with findings from other studies. For example, Penco, Ivaldi, and Ciacci (2021) found a positive correlation between EE strength and subjective well-being, primarily in large cities, which did not include any Portuguese cities. Additionally, we assessed the individual dimensions of the QoL index and found that the EE index exhibited positive correlations with socioeconomic enablers and economic and social health dimensions. Conversely, it displayed a negative correlation with the ecological health dimension. Similar patterns have been observed in other studies, where the EE index demonstrated stronger correlations with economic well-being dimensions (Penco, Ivaldi, and Ciacci 2021).

Regarding the resistance to the pandemic crisis, we found that although systemic conditions may explain variations in the unemployment rate, the overall EE index did not exhibit correlations with the two indicators used to measure local resistance during the first year of the COVID-19 pandemic. These findings challenge other studies that have reported a positive and significant effect of EE quality on resilience during crises (Iacobucci and Perugini 2021). However, this observation can be explained by the unique nature of the social and economic crisis caused by the pandemic. It is worth noting that the rural regions, which generally have lower EE indexes in

Portugal, experienced an influx of people during the pandemic due to their lower population density. Consequently, the lockdown measures had a relatively lower impact on these local economies, with many even experiencing growth during the pandemic (Almeida and Daniel 2022).

Table 3 – Regression Analyses between EE index, outputs and outcomes.

Independent Variable	Dependent Variable	R^2	β	*F*	*p*	DW
EE Index	Crunchbase Firms	.273	.523	8.66	.007	1.75
	Medium-High Technology Firms	.662	.813	44.97	<.001	1.60
	High-Growth Firms		.310	2.44	.132	2.24
	Survival Rate	.187	-.432	5.28	.031	1.12
	Population Change	.176	.420	4.92	.037	2.03
	GDP	.415	.664	16.32	<.001	1.23
	Quality of Life		.085	.168	.685	.796
	RES_1		.253	1.58	.222	2.54
	RES_2		.121	.340	.565	1.49

Source: Authors using SPSS software.

3.6 Local Bottlenecks and Regional Priorities

The methodology employed in this study assumes that bottleneck elements have adverse effects on other EE components. Thus, identifying and addressing these bottlenecks is crucial for formulating effective policies that enhance the overall quality of the LEE.

Table 4 provides an overview of the local bottlenecks which are identified as the first and second elements with the lowest scores, for each sub-region. The most frequently observed bottlenecks are 'leadership' (14/25 sub-regions) and 'demand' (5/25 sub-regions). When considering the first and second bottlenecks combined, 'leadership' remains the primary bottleneck in 16/25 sub-regions, followed by 'demand' (13/25), 'finance' (7/25) and 'knowledge' (6/25).

Additionally, Table 4 also presents the regional priorities based on the most common bottlenecks in each NUTS 2 region. In cases where the NUTS 2 and NUTS 3 sub-regions coincide (*AM Lisboa, Algarve, RA Madeira and RA Açores*), the identified bottlenecks are the same. For the *Norte* region, the regional priorities should focus on 'leadership' and 'finance'. In the *Centro* region, attention should be given to enhancing 'leadership' and addressing 'demand'. Lastly, the *Alentejo* region should prioritize improving the available 'demand' and 'finance' within the regional ecosystem.

Portugal's cultural and educational context may influence the lack of leadership. Entrepreneurship might not be widely promoted or encouraged in the country's educational system, leading to a limited pool of individuals with the necessary leadership skills and entrepreneurial mindset (Banha et al. 2017). On the other hand, the lack of demand may be influenced by Portuguese market characteristics and economic conditions. Portugal's market dynamics, including limited market size, low consumer purchasing power, or specific sectorial limitations, may create challenges for entrepreneurs in generating demand for their products or services. Finally, limited access to financial resources, such as venture capital, angel investment, or traditional funding options, can hamper entrepreneurial activities and restrict new ventures' growth potential (Banha et al. 2017).

These bottlenecks can be targeted through various policy actions, such as identifying and empowering individuals or organizations capable of assuming leadership roles, digitalizing local businesses to stimulate market demand (Xu and Dobson 2019), or promoting alternative funding sources such as angel investors, crowdfunding, peer-to-peer lending, and impact investors (Bruton et al. 2015). Additionally, long-term policies and coordinated efforts from local and regional governance are essential to sustaining and further developing the entrepreneurial ecosystems in the respective sub-regions (Almeida and Daniel, 2023).

Table 4 - Local Bottlenecks and Regional Priorities.

Region (NUTS 2)	Sub-Region (NUTS 3)	Typology	Rank	LEE Index	Local Bottleneck	2nd Local Bottleneck	Regional Priorities
Norte	Alto Minho	Predominantly Rural	20	26.10	Leadership	Demand	Leadership/Finance
	Cávado	Intermediate	6	47.63	Demand	Finance	
	Ave	Intermediate	11	32.12	Leadership	Demand	
	Área Metropolitana do Porto	Predominantly Urban	3	54.89	Leadership	Formal Institutions	
	Alto Tâmega	Predominantly Rural	23	21.02	Leadership	Demand	
	Tâmega e Sousa	Intermediate	25	17.52	Talent	Knowledge	
	Douro	Predominantly Rural	21	25.95	Demand	Finance	
	Terras de Trás-os-Montes	Predominantly Rural	17	27.09	Leadership	Finance	
Centro	Oeste	Predominantly Rural	9	34.81	Leadership	Finance	Leadership/Demand
	Região de Aveiro	Intermediate	4	54.01	Demand	Entrepreneurial Culture	
	Região de Coimbra	Predominantly Rural	2	61.19	Demand	Finance	
	Região de Leiria	Predominantly Urban	7	38.92	Leadership	Demand	
	Viseu Dão Lafões	Predominantly Rural	15	27.91	Leadership	Demand	
	Beira Baixa	Rural	8	36.03	Leadership	Demand	
	Médio Tejo	Predominantly Rural	12	31.45	Leadership	Knowledge	
	Beiras e Serra da Estrela	Rural	16	27.71	Leadership	Demand	
AM Lisboa	Área Metropolitana de Lisboa	Predominantly Urban	1	65.96	Finance	Leadership	Finance
Alentejo	Alentejo Litoral	Predominantly Rural	22	25.87	Knowledge	Leadership	Demand/Finance
	Baixo Alentejo	Rural	14	28.96	Finance	Demand	
	Lezíria do Tejo	Predominantly Rural	10	33.34	Leadership	Knowledge	
	Alto Alentejo	Rural	13	29.77	Leadership	Finance	
	Alentejo Central	Rural	5	49.02	Demand	Talent	
Algarve	Algarve	Intermediate	19	26.25	Networks	Knowledge	Networks
RA Açores	Região Autónoma dos Açores	Outermost Region	18	26.70	Leadership	Knowledge	Leadership
RA Madeira	Região Autónoma da Madeira	Outermost Region	24	20.52	Formal Institutions	Finance	Formal Institutions

Source: Own.

CONCLUDING REMARKS

Entrepreneurship has long been recognized as a significant driver of local development, playing a crucial role in creating jobs, increasing productivity, promoting innovation, and stimulating economic growth (Vázquez-Barquero and Rodríguez-Cohard 2019). Notwithstanding, fostering entrepreneurship requires a supportive environment to innovate and develop new businesses (Cowell, Lyon-Hill, and Tate 2018). This study provides valuable insights into the nature and dynamics of EEs at the local level in Portugal and their implications for local economic and social development.

The findings reveal the existence of diverse EEs within each Portuguese region, emphasizing the importance of analysing EEs at the local level. This underscores the limitations of existing studies that primarily focus on national or regional levels, overlooking the unique characteristics and developmental stages of local EEs. Secondly, a clear division between urban and rural EEs is observed in Portugal, particularly in terms of demand, support infrastructure, and talent availability, with exceptions made for places that are regional capitals or possess universities. This highlights the need for tailored strategies that address the specific needs and challenges faced by different types of EEs in various geographical contexts.

Furthermore, the study establishes a positive relationship between the quality of the Local Entrepreneurial Ecosystem (LEE) and entrepreneurship outputs, such as the number of Crunchbase firms and medium-high tech firms. While systemic conditions contribute to the growth of high-growth firms, the study suggests that framework conditions, including culture, networks, and formal institutions, may have hindering effects on entrepreneurship outputs. On the other hand, we should highlight the negative relationship between EE index and the business survival rate, arguing that policymakers should consider these dynamics and implement policies that support both the establishment and sustainability of new ventures within the LEE.

Regarding outcomes, a strong LEE has the potential to attract and retain talented individuals, which can influence population change. Additionally, the quality of the LEE is positively associated with regional GDP, emphasizing the role of entrepreneurship in driving economic prosperity. However, no significant correlation is found between LEE quality, quality of life, and resistance to crises within a region. This indicates the need for a more comprehensive understanding of the multifaceted impacts of EEs on regional well-being and resilience.

Lastly, this study identifies leadership, demand, and finance as the critical dimensions of the EE that require attention from local and regional policymakers. Addressing these bottlenecks through targeted policies and initiatives, such as empowering local actors, stimulating market demand, and diversifying funding sources, can enhance the overall quality of the LEEs and contribute to fostering a thriving entrepreneurial environment.

Overall, this study contributes to the growing body of research on EEs by confirming the systemic nature of EEs and the positive relationship between LEEs and entrepreneurship outputs and outcomes, emphasizing the significance of ongoing research into the nature and dynamics of EEs, particularly at the local level, to enhance our understanding of their implications for entrepreneurship and regional economic development.

Implications for Policy-Making

The findings of this study hold significant implications for policymaking. Our research underscores the importance of cultivating an ecosystem that facilitates entrepreneurship and innovation as a means of promoting sustainable social and economic development within a given territory. The local and regional bottlenecks identified should be targeted by policymakers to improve the quality of the LEEs. By tackling these bottlenecks, policymakers can actively create a supportive environment for entrepreneurs and promote the growth of new firms. This needs a nuanced understanding of the local ecosystem and tailoring policy interventions to suit the unique conditions of each region.

Furthermore, empowering local actors and decentralizing competencies can enhance the capacity of local and regional policymakers to implement effective strategies for promoting EEs as drivers of local development. By engaging and collaborating with local stakeholders, policymakers can leverage their expertise and insights to design policies that align with the specific needs and opportunities within the LEE.

Limitations and Further Research

Our study acknowledges certain methodological challenges that should be considered. While the use of equal weighting in index construction is common practice, it may introduce limitations as different EE elements may have varying degrees of importance (Corrente et al. 2019). On the other hand, while the PFB methodology used in this study helped to reduce some of the compensability issues in the aggregation procedure, further research should explore alternative weighting and aggregation procedures to enhance the accuracy of the LEE index. In addition, due to the unavailability of longitudinal data, this study did not account for the backward causation effects, where prior entrepreneurial activities feedback into EE elements (Stam and van de Ven 2021). Further research should investigate this causation effect to gain a better understanding of the evolution of the LEE over time.

Although our analysis indicated that sub-regions in proximity to high-performing areas tend to exhibit better performance, this relationship was not empirically tested. Thus, future studies should explore the effects of high-performing LEEs on neighbouring sub-regions. Additionally, one pertinent question is raised through our findings related to the interaction between LEEs and other ecosystems, such as regional or national ecosystems, and their reciprocal influences. Examining the interdependencies and synergies between different ecosystems can provide a comprehensive understanding of their collective impact on entrepreneurship and regional economic development.

Another crucial area of research pertains to understanding why rural regions exhibit lower LEE quality compared to urban areas. This raises two important questions: Are EEs predominantly urban phenomena, with entrepreneurship struggling to thrive in rural areas? Or do the frameworks and measurement tools used for EEs have an inherent bias toward urban contexts?

Finally, future research should strive to enhance EE empirical analyses by conducting cross-country comparisons and incorporating additional relevant indicators at the country level. This would provide a broader perspective on the similarities and differences in EEs across various contexts, enriching our understanding of the factors influencing EEs from a local to a global scale.

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