Revista de Estudios Empresariales. Segunda época.
Número: 1 (2026). Páginas: 1-26 DOI: https://doi.org/10.17561/ree.n1.2026.9039

UNDERSTANDING SCALEUP LOCATION CHOICES IN EUROPEAN CITIES: AN EMPIRICAL ANALYSIS

ENTENDER LAS ELECCIONES DE LOCALIZACIÓN DE "SCALEUPS" EN LAS CIUDADES EUROPEAS: UN ANÁLISIS EMPÍRICO

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Abstract

This study investigates the factors influencing scaleup location choices in European cities using a diverse dataset and statistical techniques such as PLS-SEM. According to the literature, a scaleup is a new entrepreneurial company, up to 10 years old, that has achieved a stable and consistent growth rate. The results highlight the significant relationships between scaleup location choices and factors like city climate, working environment, technological development, and educational level. A sequential model shows the direct and positive effect of education on scaleup location choices, while also revealing relationships between city climate, working environment and technology. The research offers valuable insights for policymakers and entrepreneurs seeking to enhance cities' attractiveness for scaleup businesses. Fostering a supportive entrepreneurial ecosystem, promoting technological development, and improving the working environment emerge as key strategies for attracting and retaining scaleup companies in European cities. This study contributes to the literature on urban entrepreneurship and regional development by exploring the impact of novel variables and examining the role of the entrepreneurial ecosystem.

Keywords: scaleups, high-growth firms, location, entrepreneurship, entrepreneurial ecosystem.

JEL Codes: M13, M16, O32, O52

Resumen

Este estudio investiga los factores que influyen en la elección de la ubicación de las *scaleups* en las ciudades europeas utilizando un conjunto de datos diverso y técnicas estadísticas como PLS-SEM. Según la literatura, una *scaleup* es una nueva empresa, de hasta 10 años de antigüedad, que ha alcanzado un ritmo de crecimiento estable y constante. Los resultados ponen de relieve la existencia de relaciones significativas entre la elección de la ubicación de las *scaleups* y factores como el clima de la ciudad, el entorno laboral, el desarrollo tecnológico y el nivel educativo. Un modelo secuencial muestra el efecto directo y positivo de la educación en la elección de la localización de las *scaleups*, al tiempo que revela relaciones entre el clima

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de la ciudad, el entorno laboral y la tecnología. La investigación ofrece valiosas ideas a los responsables políticos y a los empresarios que buscan mejorar el atractivo de las ciudades para este tipo de empresas. El fomento de un ecosistema empresarial propicio, la promoción del desarrollo tecnológico y la mejora del entorno laboral se perfilan como estrategias clave para atraer y retener a las empresas *scaleup* en las ciudades europeas. Este estudio contribuye a la literatura sobre emprendimiento urbano y desarrollo regional explorando el impacto de nuevas variables y examinando el papel del ecosistema empresarial.

Palabras clave: scaleups, empresas de alto crecimiento, localización, emprendimiento, ecosistema emprendedor.

Códigos JEL: M13, M16, O32, O52

1. INTRODUCTION

Entrepreneurship can affect economic development in different ways (Stel et al., 2005): by introducing innovations in products and processes (Acs & Audretsch, 2003), by increasing productivity (Nickell et al., 1997) or by improving existing knowledge about consumer preferences (Audretsch & Keilbach, 2004). In the academic literature one can find a multitude of empirical research that studies the impact of entrepreneurship on economic development at the regional or industrial level (Stel et al., 2005), including, for example, the works of Audretsch (1995), Audretsch & Feldman (1996) and Audretsch & Fritsch (2002). Thus, it can be concluded that the economic success of a region depends to a large extent on the entry decisions of firms (Piacentino et al., 2017), and it is therefore important to investigate the factors that determine the entry of firms into a country, region or city.

The decision on the geographical location of companies is strategic and determines business success (Chang & Li, 2019). In making this type of decision, managers take a multitude of factors into account. Theories of business location have evolved over time, from the neoclassical theory based on Weber's model (1929), that considers cost reduction as the main location factor, to more current theories that refer to the importance of innovation, knowledge sharing, networking, local infrastructure and economic conditions, quality of life of employees and potential human capital, and to the importance of the local economy as the main driver of location (Akın & Seyfettinoğlu, 2022; Malecki, 1985; Arauzo-Carod, 2013; Lafuente et al., 2010; Jo & Lee, 2014).

The variables selected—education, working environment, technology, and climate—were chosen based on their relevance in the literature and the availability of consistent, comparable data at the city level across Europe.

Moreover, in addition to addressing the location decision from the point of view of the decision-maker, the issue can be examined from the point of view of the chosen territory, i.e. analysing which characteristics of a territory affect the number of new firms setting up there (Arauzo-Carod et al., 2010). The so-called geography of entrepreneurship approach, in which entrepreneurship is the output variable in the model, can be situated in this line of research. Among the literature on the geography of entrepreneurship, one can find numerous perspectives on the different factors that enhance entrepreneurship in regions. Perhaps the most important of these is having a diverse and skilled workforce (Leendertse et al., 2022).

Taking the above into consideration, the purpose of this research is to analyse whether there are relationships between education, working conditions, technology and the city's climate that may in turn influence the level of entrepreneurship in the city. We focus on variables traditionally studied in the geography of entrepreneurship such as education, employment and technological development (Leendertse et al., 2022) and introduce the more rarely studied climate variable in this field. The level of entrepreneurship will in turn be measured by the number of scaleups in the cities.

A scaleup is a new entrepreneurial company, up to 10 years old, that has achieved a stable and consistent growth rate. The novelty of the study lies in using the number of existing scaleups in the cities as a variable to measure the level of entrepreneurship in the cities, as to our knowledge we have not found any similar study in the literature. It seeks to analyze the effects of city climate, working environment, technology, and educational level on the location decisions of scaleups. Additionally, the research explores the relationships between these factors and their impact on the level of entrepreneurship in the respective cities. This is important in order to identify the entrepreneurial potential of the regions, which is linked, as mentioned above, to their economic growth.

The research focuses on Europe, with data collected from 33 European cities. A structural equation model is used to study the interrelationships between the different constructs. Determining the greater or lesser influence of these on the level of entrepreneurship in the cities, the latter being measured on the basis of the existence of high-growth companies, specifically through the number of scaleups.

The originality of this research lies in its focus on scaleups, a concept that remains underdeveloped compared to traditional startups. By analyzing scaleups, we offer a unique perspective on the geography of entrepreneurship, revealing the specific factors that drive the location choices of high-growth firms. The study contributes to the advancement of Partial Least Squares-Structural Equation Modeling (PLS-SEM) in the social sciences, showcasing its applicability and statistical potential for understanding entrepreneurship in the context of scaleups.

The findings of this research hold practical implications for policymakers seeking to strengthen their region's entrepreneurial ecosystem. By identifying the key factors influencing scaleup location choices, policymakers can make informed decisions regarding resource allocation and strategic planning to foster the growth and prosperity of their regions. Moreover, business managers can benefit from the insights gained to make better location decisions for their companies, taking advantage of the most favorable entrepreneurial ecosystems.

Overall, this research contributes to the broader understanding of entrepreneurship's role in regional development and economic growth, while offering practical guidance for stakeholders to create supportive environments for high-growth firms.

The rest of this document is structured as follows: section 2 contains a review of the existing literature on this topic, section 3 explains the data and methodology used in the research, the following section shows the results and their discussion, and finally the main conclusions obtained are summarised.

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1. Literature review

2.1.1. Impact of entrepreneurship on economic development

Regional economic growth has historically been linked to the configuration of the business fabric, showing a high correlation with the abundance of small entrepreneurial firms, and this correlation is even stronger when analysed within cities (Isenberg & Onyemah, 2016; Glaeser et al., 2010). This seems to indicate that the level of entrepreneurship present in the regions influences the economic growth of the regions. Consequently, historically, there has been a concern to identify policies that encourage entrepreneurial activity (Gordon & Sarada, 2018).

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However, there are significant differences in entrepreneurial activity between territories. In this respect, the research by Stel et al. (2005) concludes that TEA (Total Entrepreneurial Activity) is significantly positive in economically rich countries, but significantly negative in developing countries. According to several studies in less developed countries, necessity entrepreneurship plays a more important role in the economy than opportunity entrepreneurship (Simón-Moya et al., 2014; Xavier et al., 2012; Acs et al., 2008). While, in developed economies, the positive relationship is associated with innovation-related start-up entrepreneurship (Beynon et al., 2019; Stel et al., 2005). Nevertheless, not all entrepreneurship has the same economic value, and some scholars suggest that public policy should focus on high-growth new firms (Mason & Brown, 2014; Nightingale & Coad, 2014).

2.1.2. Determinants of regional entrepreneurship

Within the study of entrepreneurship in regions, the concepts of entrepreneurial ecosystem and geography of entrepreneurship emerge. The term "entrepreneurial ecosystem" arises to refer to a set of interdependent elements or factors that facilitate entrepreneurship within a territory (Leendertse et al., 2022; Malecki, 2018; Stam, 2015). Meanwhile, the existing literature on the geography of entrepreneurship provides several studies on the multiple factors that enhance entrepreneurship in regions (Leendertse et al., 2022). This highlights the importance of understanding the factors that influence the level of entrepreneurship in the regions. The most studied factors include access to finance, taxation (Kerr & Nanda, 2009; Mason & Brown, 2014), the purchasing power of the region (Berkowitz & DeJong, 2005), the presence of "talent" (Glaeser et al., 2010; Qian et al., 2013) or the country's culture (Hofstede, 2001). In turn, authors such as Li et al. (2016) demonstrate interactions between entrepreneurship, innovation and location (Li et al., 2016; Beynon et al., 2019).

Having commented on the importance of entrepreneurship for the economic development of regions and the need to find factors that have a positive influence on it, the question arises as to how to measure the level of entrepreneurship. According to academic literature, entrepreneurship can be measured in three alternative ways: 1. as startup, 2. as small business survival and 3. as high growth (Beynon et al., 2019).

The existing literature focuses on the quantity but not the quality of entrepreneurship. The quality emphasises successful start-ups that have expanded rapidly, in contrast to the quantity, which focuses on gross enterprise births (Cheng et al., 2009). However, there is an emerging interest in measuring the quality of entrepreneurship, as opposed to merely the quantity, as a focus on firms with high growth potential is regarded as having a more substantial impact on economic development (Cheng et al., 2009). Likewise, Shane (2009) argues that policymakers should channel resources towards high-growth firms rather than focusing on survivalist firms. But the environment in which high-growth firms thrive is different from that in which high rates of firm creation occur. This, in turn, is because high-growth firms require access to specialised resources that are very different from the resources that support start-ups (Napier & Hansen, 2011). Traditional policies that focus on promoting generic start-ups or providing financial incentives (subsidies, incubators) are criticised as insufficient to create high-growth companies. These policies often fail to promote real growth and long-term sustainability (Mason & Brown, 2014). In this regard, Valliere & Peterson (2009) found that a significant part of economic growth is related to the existence of high-growth focused entrepreneurs exploiting national innovation systems.

With these considerations in mind, in this research we opt for considering high-growth firms as a measure of entrepreneurship. In particular, we use the novel concept of scaleups as new companies focused on high growth.

2.1.3. Relevance of scaleups

A scaleup can be defined as a company that has achieved a stable and consistent growth rate (Isenberg & Onyemah, 2016), unlike the startup, which is a new company that has not yet reached a scalable business model and is therefore still in the experimentation phase, not having reached Moore's (1991) so-called "Growth Chasm" (Autio, 2016).

According to the OECD a scaleup is an enterprise with an average annualised return of at least 20% over the last three years and with at least 10 employees at the beginning of the period (Eurostat, O.E.C.D., 2007). Startup Europe suggests that a scaleup is a new company that has attracted at least one million euros of venture capital (Mind the Bridge, 2018).

Professor Autio (2016) gives an integrative definition of the concept: "A Scaleup is a new, entrepreneurial firm, up to 10 years old, that is strongly growth oriented and has attracted €1 Million or more of venture capital funding."

As can be guessed, the main difference between a startup and a scaleup is based on the challenges each has to face, with the main challenge for scaleups being exponential growth and market development (Onetti, 2014).

The present study employs the concept of scaleups as a metric for entrepreneurship, diverging from the conventional startup approach. This methodological decision serves to enhance the originality and novelty of the research.

2.2. Hypotheses

Based on the literature review, this research proposed four key factors that can influence the scaleup entrepreneurial ecosystem: climate, work environment, technology and education. These variables and their interrelationships are modelled in this paper through the following hypotheses.

It should be noted that, although other factors such as access to capital, taxation or entrepreneurial culture are recognised in studies such as Mason & Brown (2014) or Hofstede (2001), their inclusion in a comparative urban analysis on a European scale was ruled out due to the lack of systematic and homogeneous indicators for all the cities analysed.

2.2.1. Education

The level of education in the regions has traditionally been an important factor in business location decisions, as it guarantees companies a skilled workforce. Similarly, Acs & Armington (2004) consider the educational level of the labour force as a key variable influencing the rate of firm creation and show in their empirical study that higher educational attainment influences the growth of new firms. In the same vein Block et al. (2013) find positive effects of education on entrepreneurship. More recent studies by Jafari-Sadegh et al. (2019) show that a higher level of education in the country improves the foresight of entrepreneurs by positively influencing firm creation and international entrepreneurship. In addition, research carried out by Ahn & Winters (2022) demonstrate that an additional year of schooling increases self-employment in high-growth industries by 1.12 percentage points for women and 0.88 percentage points for men, thus suggesting that formal education improves entrepreneurship.

Although there is no strong evidence that education has a negative relationship with entrepreneurship, the study of Jiménez et al. (2015) qualifies that tertiary education has a negative effect on so-called informal entrepreneurship, which focuses on businesses that are not legally registered (Nyström, 2008).

The following observable variables are considered in this study to approximate the level of education: percentage of population with secondary education, percentage of population with tertiary education, PISA scores and number of universities in the city included in the top 500 of the QS Top Universities ranking (QS Quacquarelli Symonds Limited 1994 - 2022, s.f.). The first hypothesis is therefore the following:

Hypothesis 1: *A higher level of education in the city positively influences the level of entrepreneurship by attracting the entry of high-growth firms (scaleups).*

2.2.2. Technology

The presence of technological infrastructures and innovation ecosystems has been highlighted as a key enabler of entrepreneurship, especially in urban contexts (Audretsch & Belitski, 2017).

Existing technology and innovation in the city can influence entrepreneurship in some way. In this sense, several studies show positive relationships between household broadband availability and entrepreneurship (Luo et al., 2022; Stephens et al., 2022). On the other hand, in today's knowledge society, innovation is extremely important, becoming a valuable tool for entrepreneurs (Ribeiro-Soriano & Huarng, 2013). With regard to the relationship between technology and education, it can be seen how technological development has in turn made possible the emergence of new tools for educational innovation that promote and improve the educational process, such as mobile applications, online learning platforms, game-based techniques, e-learning, etc. (Hosseini et al., 2021). Similarly, Marchesani et al. (2022) show that local Italian high-tech firms influence the flow of knowledge and student mobility, creating a virtuous circle in which innovation attracts and retains skilled workers, thereby increasing the attractiveness of the city.

Although most research shows that the relationship between technology and education is positive, some studies, such as Vázquez-Cano et al. (2022), show that digital intoxication and distraction can cause problems in the educational process. Similarly, Vargas-Montoya et al. (2023) show a negative relationship between the use of ICT for learning in school and student performance which is stronger for students in developing countries than in developed countries.

In this study, technology is a latent variable that analyses the technological level of each city. To define this construct, the following indicators have been included: City score in the Innovation Cities Index ranking (2thinknow, 2019), city country score in the WebIndex (World Wide Web Foundation, 2014), percentage of households with internet access at home, percentage of households with broadband access, internet speed and city's country score on the Global Innovation Index (Soumitra Dutta & Wunsch-Vincent, 2020). The hypothesis put forward in relation to technology is as follows:

Hypothesis 2: *A higher level of technological development in the city improves the level of education in the city.*

2.2.3. Working environment

Urban areas, particularly cities, have become engines of economic growth and employment in developing countries (OECD, 2018). Recent empirical research by Chen et al. (2023) shows that the urbanisation rate is negatively correlated with the level of vulnerable employment in countries, such that a higher urbanisation rate decreases the vulnerable employment rate. Another aspect to be taken into account is working hours. The length of the working day is not the same in all cities and is a factor that differentiates the working environment in each city. In this respect, there are different studies on optimal working time, in particular recent research by Darwish (2023) showing that the usual 8-hour working day does not imply optimal daily gain, with a 4-day working week being more appropriate for situations with low or moderate fatigue growth factors. The trend in OECD countries over the last 20 years has been to reduce the number of hours worked per day (Skans, 2004).

On the other hand, cities are areas that are becoming more and more technologically developed, in this context the term "Smart cities" emerged in reference to the increasing application of Information and Communication Technology (ICTs) in urban development (Rosol & Blue, 2022; Alizadeh & Sharifi, 2023). Two positions on the economic effects of technology coexist in the academic literature, an optimistic position that focuses on job creation and a pessimistic one that warns of possible inequalities for low-skilled workers (Lee & Rodríguez-Pose, 2016; Lee & Clarke, 2019). In addition, recent research indicates that employee well-being is influenced by technological factors, suggesting a complex relationship between the work environment and technology (Parteka et al., 2024). Although the relationship between technology and employment is widely developed in the academic literature, the same is not true of the inverse relationship, i.e. the influence of the working environment on the technological development of territories, so it is difficult to find studies that address the existing links in this sense. This research aims to analyse in particular the relationships between the existing working environment in the city and the technological development of the city. To this end, the labour environment construct is measured through the following indicators: unemployment rate (percentage of the active population), the city's position in the Doing Business ranking (World Bank, 2020), the Gini inequality coefficient and average weekly working hours. The hypothesis is as follows.

Hypothesis 3: *An improved working environment improves the city's technology.*

2.2.4. Climate

Climatic conditions influence the activity of many economic sectors, such as agriculture (Vital et al., 2022), transport (Jiang & Cai, 2023; Theofilatos & Yannis, 2014; Guo et al., 2007), tourism (Craig et al., 2021; Craig & Feng, 2018; Day et al., 2013) and other sectors. Among them, the services sector is of growing importance in the economies of developed countries. In particular, international tourism leads the world economy (World Tourism Organization, 2019). In the context of entrepreneurship, research findings indicated that elevated temperatures were associated with a decline in entrepreneurial activity within Chinese cities (Zhao et al., 2023). Furthermore, meteorological conditions, notably elevated temperatures and extreme precipitation, have been demonstrated to exert a substantial influence on working hours and economic activities. Specifically, elevated temperatures have been observed to result in a reduction of working hours within specific industries (Neidell et al., 2021). Conversely, Cai et al. (2018) found that there is no significant effect of temperature on work attendance or hours worked. On the other hand, some research, such as Spencer & Urquhart (2021), does not demonstrate a significant influence of certain weather conditions (hurricanes, excessive rainfall) on temporary absenteeism in specific contexts.

From this, it can be intuited that climate affects the working environment of regions. In this study, a climate index developed by Soler et al. (2020) was used to define the climate of each city, taking into account the average temperature, the amount of precipitation and the number of rainy days. The hypothesis is as follows.

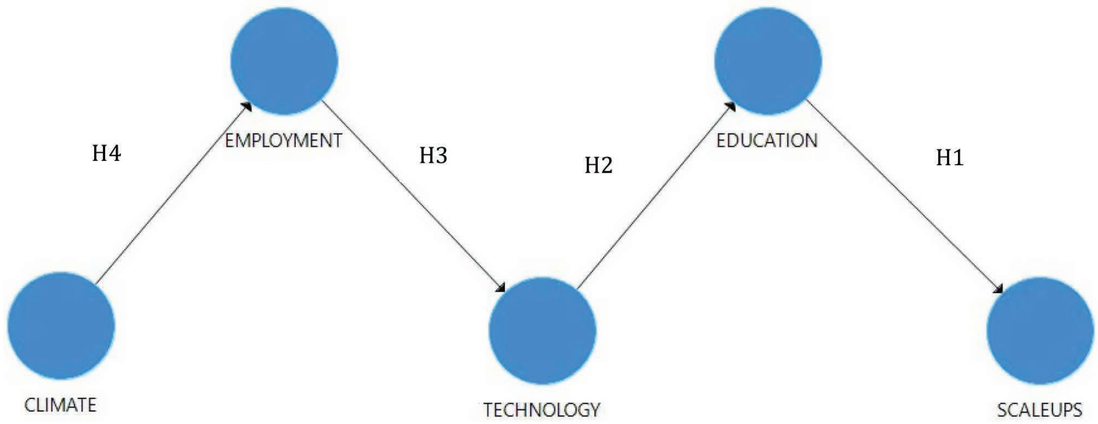
Hypothesis 4: *The city's climate has a direct impact on their working environment*

2.2.5. Model structure

Having detailed the hypotheses, we propose a sequential model to link the four key factors to entrepreneurship in European cities. In this way, we aim to show that the urban climate affects the working environment in the city, the working environment affects the technological environment, which is related to the level of education in the city, and the latter finally affects the level of entrepreneurship in the cities, measured as the number of scaleups. Structural equation modelling (SEM-PLS) is used to analyse and validate these relationships.

Figure 1 (section 8 at the end of this document) represents the structure of the proposed model including the above assumptions and the direct relationships between the latent variables. The proposed model shows that entrepreneurship (measured by the number of scaleups) is directly dependent on the educational level of the city, and the relationships between the other proposed factors are manifested through the sequential model.

FIGURE 1. STRUCTURAL MODEL AND PROPOSED HYPOTHESES



Source: Own elaboration.

3. MATERIALS AND METHODS

3.1. Data and variables

The database used for this study is based on different indicators from reliable official sources such as the OECD, the World Bank, Eurostat, etc. The period runs from 2014 to 2020, including the latest year available according to the indicator. It is imperative to elucidate that the selection of the four factors incorporated in our analysis was predicated on those for which comparable and consistent city-level data were available in the European context. During the exploratory phase, other relevant factors – including access to capital, taxation, safety and cultural aspects – were considered. However, these factors presented important limitations in terms of the availability of homogeneous data for a comparative analysis across cities.

As illustrated in Table 1 (section 8 at the end of this paper), the observable variables for each construct are detailed, along with the original sources utilised. It is noteworthy that the variables forming the construct 'employment' exhibit a negative orientation, suggesting that they function in the sense of 'less is better'. It is further clarified that EMP2 corresponds to the city's position in a ranking, implying that a lower value indicates a superior position.

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TABLE 1. OBSERVABLE VARIABLES OF EACH CONSTRUCT AND THEIR SOURCES

Constructs	Observable Variables	Acronyms	Unit	Year	Source
Education	Population with secondary education	EDU1	Percentage	2019	Eurostat
Education	Population with tertiary education	EDU2	Percentage	2019	Eurostat
Education	PISA score Reading	EDU3	Number	2018	OECD
Education	PISA score Maths	EDU4	Number	2019	OECD
Education	PISA score Science	EDU5	Number	2020	OECD
Education	PISA score	EDU6	Number	2021	OECD
Education	Ranking universities	EDU7	Number	2019	QS Top universities
Employment and income	Unemployment rate	EMP1	Percentage	2019	Eurostat
Employment and income	Ease of doing business ranking	EMP2	Number	2019	World Bank
Employment and income	Gini inequality coefficient	EMP3	Number	2014	OECD
Employment and income	Weekly working hours	EMP4	Hours	2019	Eurostat
Climate	Climate Index	CL1	Number	2020	(Soler et al., 2020)
Technology	Innovation Cities Index	TEC1	Number	2019	Innovation Cities Program
Technology	Web Index	TEC2	Number	2015	World Wide Web Foundation
Technology	Internet speed	TEC3	Mbps	2020	Nomad List
Technology	Internet access	TEC4	Percentage	2019	Eurostat
Technology	Broadband access	TEC5	Percentage	2019	Eurostat
Technology	Global Innovation Index	TEC6	Number	2020	World Intellectual Property Organization
Entrepreneurship	Scaleups	SCA1	Number	2018	Mind the Bridge

Source: Own elaboration.

Similarly, the European cities for which data are available are listed in Table 2 (section 8). This Table also shows the number of scaleups in each city.

The selection of cities for the study was based on the Mind the Bridge report. According to this report, there are 5,596 scaleups in Europe, spread across 476 cities. However, it is worth noting that 67% of this total number of scaleups are located in only 48 cities, which are likely to be the drivers of the European economy in the coming years (Mind the Bridge, 2018). Consequently, the selection of cities was made among these top 48, with the additional

TABLE 2. EUROPEAN CITIES INCLUDED AND NUMBER OF SCALEUPS

Country	Ciudades	Number of scaleups
United Kingdom	London	1153,00
France	Paris	487,00
Sweden	Stockholm	309,00
Germany	Berlin	288,00
Ireland	Dublin	157,00
Finland	Helsinki	132,00
Spain	Barcelona	125,00
The Nederlands	Amsterdam	115,00
Denmark	Copenhagen	101,00
Spain	Madrid	93,00
Italy	Milan	80,00
Austria	Vienna	41,00
Estonia	Tallinn	38,00
Belgium	Brussels	38,00
Greece	Athens	36,00
Portugal	Lisbon	32,00
Poland	Warsaw	31,00
Iceland	Reykjavik	30,00
Portugal	Porto	26,00
Hungary	Budapest	25,00
Czechia	Prague	24,00
Lithuania	Vilnius	22,00
Slovenia	Ljubljana	15,00
Luxembourg	Luxembourg	14,00
Romania	Bucharest	14,00
Italy	Rome	13,00
Poland	Krakow	13,00
Bulgaria	Sofia	13,00
Latvia	Riga	11,00
Slovakia	Bratislava	10,00
Cyprus	Nicosia	6,00
Malta	Valleta	5,00
Croatia	Zagreb	4,00

Source: (Mind the Bridge, 2018).

criterion that data on the remaining indicators for the other factors analysed - namely education, technology, working environment and climate - had to be available for the selected cities. In this way, our sample was finally reduced to 33 cities on the basis of the availability of data for the indicators analysed. The inclusion of cities in the study therefore varies according to the availability of data, resulting in differences in the number of cities represented in each country.

3.2. Methodology

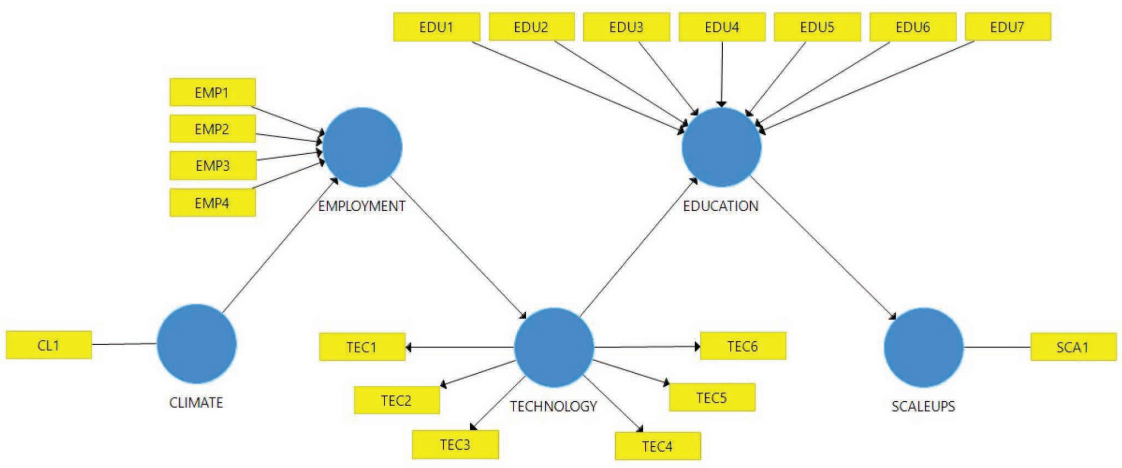
Structural equation modelling (SEM) is a multivariate statistical analysis technique that is very useful for evaluating complex theoretical relationships between multiple variables (Hair & Alamer, 2022). Basically, two methods are proposed to run SEM, on the one hand, the covariance-based structural equation model (CB-SEM) proposed by Jöreskog (1970) and on the other hand, the partial least squares structural equation model (PLS-SEM), originally developed by Wold (1982). For many years, CB-SEM structural equation modelling was the dominant model, but in recent years there has been a significant increase in the use of PLS-SEM (Hair, Hult et al., 2017). In particular, many authors highlight the great relevance PLS-SEM has gained in social science research (Hair et al., 2019; Sarstedt et al., 2021; Chin et al., 2020; Sosik et al., 2009; Ali et al., 2018). The appeal of PLS-SEM lies in several aspects, the most important of which is that it is a causal-predictive approach that emphasises prediction in the estimation of statistical models (Wold, 1982; Hair et al., 2019). In addition, PLS-SEM is a less restrictive model than CB-SEM, as it does not impose distributional assumptions on the data or sample size, allowing work with smaller samples (Hair, Hult et al., 2017). Another important advantage of PLS-SEM is that it easily handles both reflective and formative constructs (Hair et al., 2019).

In consideration of the aforementioned points, this research proposes the utilisation of PLS-SEM as the optimal approach for the following reasons: the available sample is small but representative, direct relationships are established, the constructs are both reflective and formative, and the main objective of the study is to predict the behaviour of the dependent variable. Furthermore, the SmartPLS3 software developed by Ringle et al. (2015) has been used to apply the model.

3.3. Proposed structural model

As indicated in section 2, an extensive literature review has been carried out, culminating in the formulation of four hypotheses. These hypotheses can be represented graphically by the structural model shown in Figure 2 (section 8 at the end of this paper). It shows the independent construct, which is climate, and the dependent constructs: work environment,

FIGURE 2. PROPOSED STRUCTURAL MODEL



Source: Own elaboration based on SmartPLS results.

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technology, education and entrepreneurship (scaleups). According to the hypotheses stated, climate directly influences the work environment (H4), the work environment in turn influences technology (H3), technology influences education (H2) and finally education directly influences entrepreneurship (H1).

In turn, the constructs 'work environment' and 'education' are considered formative, as the indicators cause the construct and consequently a change in the indicators will cause a change in the construct. The technology construct is regarded as reflective, given its representation through multiple indicators (Hanafiah, 2020; Diamantopoulos, 1999).

In the first step of this study, a confirmatory factor analysis (CFA) was carried out in order to assess the suitability of the proposed model. This analysis showed that a number of indicators must be eliminated: EDU1, EDU3, EDU4, EDU5, EDU6, EMP3 and TEC3. Subsequently, the validity of the constructs was assessed through reliability analysis, followed by convergent and discriminant validity assessments.

To estimate the significance of the parameters, the Bootstrapping technique was used, which consists of creating random samples from the original sample using the substitution with replacement procedure. Bootstrapping was chosen as a robust non-parametric resampling method that does not require assumptions about data normality and is particularly well-suited for smaller samples, as noted by Hair et al. (2019; 2014). This technique ensures precise estimates of parameter significance by creating multiple subsamples from the original data.

4. ANALYSIS AND RESULTS

The results of the reliability and validity analysis are shown in Table 3 (section 8 at the end of this document). It is found that for the Technology reflective construct, the simple reliability criterion is met, with Cronbach's Alpha (CA) being above 0.70 (Nunnally & Bernstein, 1994). The composite reliability (CR) is also assessed and must be greater than 0.60 (Bagozzi & Yi, 1988) also meets the criterion of Fornell & Larcker (1981) that it should be greater than 0.7. Convergent validity is assessed according to the criteria of Fornell & Larcker (1981), according to which the average variance extracted (AVE) must be greater than 0.50. Furthermore, it is verified that the loadings of the indicators are all greater than 0.70 and are therefore considered significant according to the criterion of Hair et al. (2014). The Education and Employment constructs are formative, and therefore metrics such as Cronbach's Alpha, Composite Reliability (C.R.), and Average Variance Extracted (A.V.E.) are not directly applicable. This is consistent with the literature, which highlights that these metrics are suitable only for reflective constructs (Hair et al., 2014; Hair, Hollingsworth et al., 2017).

After applying the bootstrapping technique, as can be seen in Table 3, all p-values are less than 0.01, so it can be concluded that the parameter estimates are statistically significant.

An analysis of the relationship between the weight and loading of the indicators of the formative constructs and their significance was also carried out by bootstrapping. Following Hair et al. (2014), when indicators have a significant weight greater than 0.50, they are retained in the model (see Table 3). If they have a non-significant weight, the weight-to-load ratio of each indicator will be assessed and the indicator will be kept if its load is higher than 0.5, even if it has a non-significant weight. In this case, it is decided to keep the indicators whose weight is not significant due to their weight-to-load ratio. The weight-to-loading ratio was applied to assess indicators with non-significant weights. Indicators were retained if their loadings exceeded 0.5, even if their weights were non-significant. This approach aligns with guidelines from Hair et al. (2014) and Diamantopoulos (1999), ensuring valid construct measurement.

TABLE 3. RELIABILITY AND CONVERGENT VALIDITY OF THE MEASUREMENT INSTRUMENT

Constructs	Indicators	Loadings		Weights		T Statistics	CA	CR	AVE
Education	EDU2			0,333	**	2,140			
	EDU7			0,789	***	6,802			
Employment	EMP1			0,493	**	2,910			
	EMP2			0,364	**	2,234			
	EMP4			0,631	**	3,389			
Technology	TEC1	0,755	***			9,345	0,918	0,939	0,757
	TEC2	0,863	***			23,994			
	TEC4	0,919	***			41,261			
	TEC5	0,881	***			27,839			
	TEC6	0,921	***			34,210			

Note: *** $p<0.001$, ** $p< 0.05$, and *$p< 0.10$, n/a = not applicable.

The results of the discriminant validity analysis are shown in Table 4 (section 8 at the end of this document). The criteria of Fornell & Larcker (1981) were used to estimate the correlation matrix between latent variables and the Hetero-Trait-Monotrait (HT/MT) correlation ratio proposed by Henseler et al. (2015). Following Clark & Watson (1995) and Kline (2011) discriminant validity is considered to exist if the HT/MT ratio is less than 0.85. Table 4 shows that this ratio is below the previous limit, thus confirming discriminant validity.

TABLE 4. DISCRIMINANT VALIDITY

	Climate	Education	Employment	Scaleups	Technology
Climate	1,000	n/a	n/a	0,182	0,216
Education	0,189	n/a	n/a	n/a	n/a
Employment	0,577	-0,318	n/a	n/a	n/a
Scaleups	0,182	0,896	-0,299	1,000	0,593
Technology	-0,059	0,624	-0,664	0,571	0,870

Note: n/a = not applicable, values in the diagonal: square roots of AVE, below the diagonal: correlations between factors, on the diagonal: HT/MT ratios.

Table 5 (section 8 at the end of the document) shows the results of the collinearity analysis carried out to assess the validity and reliability of the formative constructs work environment and education. It is found that the Variance Inflation Factor (VIF) of each of the indicators is less than 5, so that according to the criteria of Hair et al. (2011) there is no problem of collinearity.

To evaluate the structural model, the coefficient of determination R^2 was calculated to see how much of the variance of the dependent variable is explained by the independent constructs. The results are shown in Table 6 (section 8 at the end of the document), where it is observed

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TABLE 5. COLLINEARITY STATISTICS (VIF)

Factor	Indicator	Outer VIF Value
Education	**EDU2**	1,345
	EDU7	1,345
Employment	**EMP1**	1,037
	EMP2	1,193
	EMP4	1,157

TABLE 6. DEPENDENT LATENT VARIABLES´ VARIANCE EXPLAINED BY CONSTRUCTS THAT PREDICT THEM (R2)

Factor	R^2	Adjusted R^2
Education	0,389	0,369
Employment	0,333	0,311
Scaleups	0,804	0,797
Technology	0,441	0,423

that the R^2 values are not lower than 0.1 in any of the factors, thus complying with the criteria of Falk & Miller (1992).

In addition, the blindfolding technique (Geisser, 1975; Stone, 1974) was applied to assess the predictive validity of the model. The results, shown in Table 7 (section 8 at the end of the document), conclude that the model has predictive validity as Q^2 is greater than 0 in all cases.

Finally, the significance of the structural relationships was assessed by again applying the bootstrapping technique. As shown in Table 8 (section 8 at the end of the document), all hypotheses were confirmed with no risk of rejecting a null hypothesis.

Figure 3 (section 8 at the end of this document) shows the final fitted model including the weights and loadings of the formative and reflective indicators and also the variance of the dependent latent variables explained by the predicting constructs.

As a result, all the proposed hypotheses are confirmed by means of a sequential model. It is shown that higher levels of education have a positive impact on the level of entrepreneurship

TABLE 7. CONSTRUCT CROSSVALIDATED REDUNDANCY

Factor	SSO	SSE	Q^2 = (1-SSE/SSO)
Climate	33,000	33,000	
Education	66,000	53,791	0,185
Employment	99,000	88,657	0,104
Scaleups	33,000	12,929	0,608
Technology	165,000	113,269	0,314

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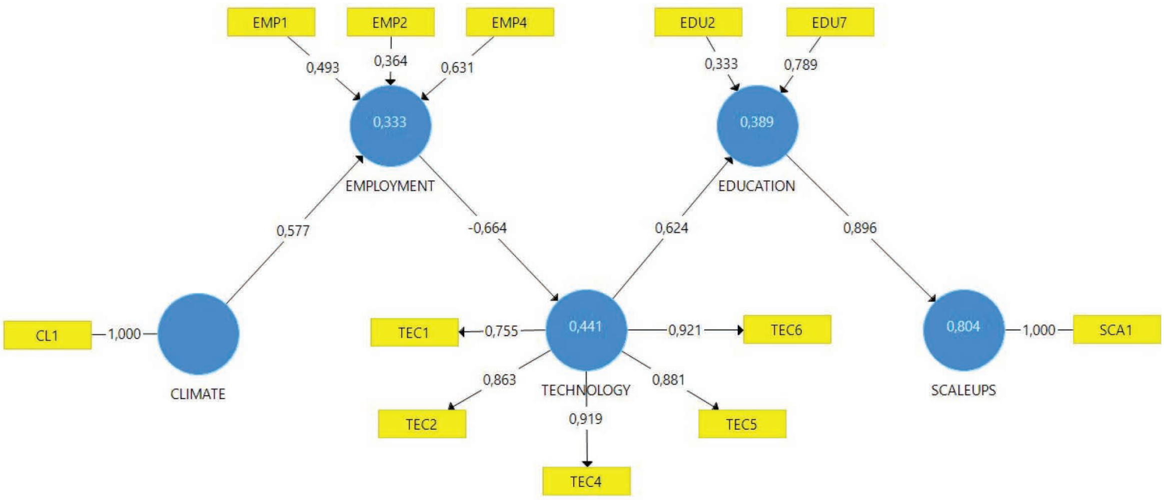
TABLE 8. CONTRAST OF HYPOTHESES

Contrast of hypotheses				
Hypotheses		**SD**	**Sig**	**T-Statistic**
H1	Education -> Scaleups	0,110	***	8,162
H2	Technology -> Education	0,077	***	8,135
H3	Employment -> Technology	0,179	***	3,706
H4	Climate -> Employment	0,177	**	3,266

R^2(Education)=0,389; R^2(Employment)=0,333; R^2(Scaleups)=0,804; R^2(Technology)=0,441
Q^2(Education)=0,185; Q^2(Employment)=0,104; Q^2(Scaleups)=0,608; Q^2(Technology)=0,314
*** p<0,001; ** p<0,01; * p<0,05

FIGURE 3. ESTIMATED FINAL MODEL



Source: Own elaboration based on SmartPLS results.

(H1), that higher levels of technological development have a positive impact on education (H2), that a better working environment improves the existing technological level in cities (H3), and finally that the climate of the city directly influences the existing working environment (H4).

5. DISCUSSION

This research demonstrates the interrelation of the various dimensions analysed in European cities, ultimately influencing the level of entrepreneurship in these locations. The specific factors analysed include climate, working environment, technology and education.

Concerning climate, the results obtained demonstrate that the climatic conditions of the city, in terms of temperature and precipitation, exert a direct and significant influence on the city's working environment. This finding extends the research by other authors, demonstrating how climate affects economic activity in various sectors, such as agriculture (Vital et al., 2022), transport (Jiang & Cai, 2023; Theofilatos & Yannis, 2014; Guo et al., 2007), tourism and services

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(Craig et al., 2021; Craig & Feng, 2018; Day et al., 2013). Furthermore, it is consistent with other research highlighting the influence of weather conditions, such as high temperatures and precipitation, on working hours (Neidell et al., 2021). However, there are conflicting results in Spencer & Urquhart (2021) and Cai et al. (2018), which found no significant influence between certain weather conditions and the work absence.

The relationship between the working environment and technology was negative, which means that environments characterised by higher unemployment, longer working hours and greater difficulties in doing business have a negative impact on technological development in the city. This supports our hypothesis H3, as improvements in the working environment by reducing unemployment and working hours will lead to improvements in technological development. This finding is related to research showing a tendency for OECD countries to reduce working hours (Darwish, 2023; Skans, 2004).

It is important to note that the relationship between the work environment and technology demonstrated in this study is a novel concept, as it has traditionally been studied in the opposite direction. Thus, there is a considerable literature that studies the influence of technology on the work environment, which is complex as it involves both positive and negative effects on work performance and worker well-being (Parteka et al., 2024; Lee & Clarke, 2019; Lee & Rodríguez-Pose, 2016). However, the inverse relationship of the work environment on technology has received comparatively little attention.

The relationship between technology and education has been demonstrated to be a positive one, which appears to justify the considerable support that ICT and innovation have provided in the development of new educational tools and environments that facilitate learning and enable higher levels of education for the general population. In this sense, the present study aligns with the optimistic stance that highlights the positive effects that technology and innovation have on education and the attraction of human capital (Hosseini et al., 2021; Marchesani et al., 2022). However, our results appear to contradict those of Vargas-Montoya et al. (2023), as well as Vázquez-Cano et al. (2022), who emphasise the negative consequences of adopting new technologies in education.

Also noteworthy is the dual role of education as an outcome of technological development and as a driver of entrepreneurship. These findings align with prior research on the interconnectedness of urban systems, offering deeper insights into the dynamics of entrepreneurial ecosystems in cities (Leendertse et al., 2022; Malecki, 2018).

Moreover, the present study finds that education exerts a significant direct and positive influence on the level of entrepreneurship, as measured by the number of scaleups. This finding serves to reinforce the notion that the educational level of the population is a crucial factor in the economic development of regions. Cities characterised by a higher proportion of the educated population are likely to be more attractive for investment purposes, as high-growth firms tend to locate in cities where they can access highly qualified personnel. On the other hand, at the local level, the findings suggest that if citizens are better educated and trained, they will be able to opt for self-employment, create their own business and lead it to success with greater guarantees. These findings are in line with research by other authors such as Acs & Armington (2004) and Block et al. (2013). By contrast, Jiménez et al. (2015) found a negative correlation between tertiary education and entrepreneurship. Nevertheless, it should be noted that this negative relationship only relates to informal entrepreneurship.

Cities such as Stockholm and Berlin exemplify how investing in education, talent development, and digital infrastructure fosters robust entrepreneurial ecosystems. These cities combine high levels of human capital with advanced technological capabilities, leading to increased innovative firm formation and economic dynamism (Audretsch & Belitski, 2017; Leendertse et al., 2022). Particularly, their ecosystems benefit from systemic complementarities among elements such as formal institutions, access to finance, leadership, and entrepreneurial culture, which reinforce the emergence of high-growth ventures (Leendertse et al., 2022). Conversely, cities like Lisbon demonstrate how improvements in quality of life, flexible workspaces, and urban regeneration policies can partially offset limitations in technological intensity, attracting creative entrepreneurs and fostering innovation-driven coworking communities (Morgado, 2021; Tomaz & Henriques, 2023).This contrast highlights the importance of tailoring entrepreneurial policy mixes to the unique configurations of each urban ecosystem.

6. CONCLUSIONS

This research uses the PLS-SEM technique to determine the direct positive or negative influence of certain factors on the location of high-growth firms, known as scaleups, in different European cities. It also shows the relationships between different factors such as climate, working environment and technology.

6.1. Theoretical implications

The present study contributes to the broadening of the field of knowledge on the entrepreneurial ecosystem in cities. Furthermore, it introduces a novel approach to measuring the level of entrepreneurship, such as the number of scaleups, thus focusing on productive entrepreneurship. Consequently, this approach prioritises the quality of new ventures over the conventional startup approach, which places greater emphasis on quantity.

On the other hand, it also contributes to the field of study of the geography of entrepreneurship. In this sense, certain variables and relationships shown in the research are considered novel. Specifically, the incorporation of the city climate variable and its importance in relation to entrepreneurship. The relationship between the working environment and technology is also shown, revealing how certain environments influence the technological development of cities. This is a direction that has not been studied much so far, as the relationship has traditionally been studied in the opposite direction, focusing on how technology influences the working environment. With respect to education, the findings confirm the importance of the educational level of the city in relation to entrepreneurship, as well as the great influence that technological development in turn has on education.

6.2. Practical implications

The conclusions obtained in this research are expected to be useful for policymakers, since the economic growth and prosperity of the regions is linked to the strength of their business fabric and it is therefore essential to know the levers that promote the creation and consolidated growth of companies in order to improve strategic decision-making, resource allocation and therefore the competitiveness of the regions. In this sense, it is noteworthy that the findings of this research demonstrate a direct correlation between education and entrepreneurship. This observation calls for policy makers to allocate resources towards educational initiatives, as this investment is likely to yield tangible benefits, enhancing and elevating the quality of entrepreneurship within their respective regions. Policymakers in cities with fewer scaleups could focus on improving access to education and technology infrastructure, as seen in high-performing cities such as London and Paris, where these factors are key drivers of entrepreneurial success. Similarly, business leaders can leverage these findings by prioritizing locations with robust working environments and advanced technological ecosystems, drawing inspiration from cities like Berlin and Stockholm, which showcase how such conditions foster dynamic entrepreneurial ecosystems and scaleup growth. These insights provide actionable strategies for decision-makers aiming to enhance entrepreneurial outcomes and economic development.

Also at the microeconomic level, it is important for managers to know the influence of the factors investigated here to enable better location decisions for their companies by analysing the most favourable entrepreneurial ecosystems. In this regard, it is imperative for managers to consider the climatic conditions, working environment, technology and educational level of the cities in order to choose the optimal location for their companies. Specifically, cities with superior working and technological environments and a high level of education among their citizens appear to be optimal ecosystems for quality entrepreneurship.

6.3. Limitations and future lines of research

An important limitation of the study is the difficulty in obtaining disaggregated data (at the city level), which may limit the ability to generalize findings to other cities or contexts beyond those included in the sample. Additionally, due to the novelty of the scaleup concept, the sample of cities with at least one scaleup is relatively small, which may also influence the robustness and applicability of the results. These data limitations could affect the representativeness of the conclusions at a global scale.

The analysis was conducted with data from the 2014-2020 period, which limits the ability to address recent changes that may have influenced the results, such as the Covid-19 pandemic. For future research, it would be important to update the data with more recent periods, so that the impact of the health crisis on the scaleup and entrepreneurship ecosystem in the studied cities can be assessed.

In future research, cities from other continents could be included, which would allow for exploring whether the relationships observed between the factors analysed in this study are similar in other economic and cultural contexts. Moreover, including additional variables, such as cultural or political factors, could provide a more holistic view of entrepreneurial ecosystems globally

Another line of future research could consider a mediation model, statistically testing the possible indirect effects of climate, working environment and technology on entrepreneurship in the city.

Finally, since climate has been identified as a relevant factor in the research, it would be interesting to explore in future studies whether certain types of climates have a more positive impact on entrepreneurship in different regions. This line of research could delve into how specific climatic conditions differentially influence entrepreneurial opportunities, something that was not explored in depth in this study.

7. FUNDING

This research has been funded by the Andalusian Public Foundation Center for Andalusian Studies (ROR: https://ror.org/05v01tw04 and Crossref Funder ID 100019858), through the project PRY081/22 titled: Seeking sustainability of organizations in strategic sectors: tourism and bioeconomy.

8. AUTHOR CONTRIBUTIONS

Conceptualisation, V.P.B., P.G. and G.G.; Methodology, V.P.B., P.G. and G.G.; Data collection, V.P.; Data analysis, V.P.B., P.G. and G.G.; Writing – Original draft preparation, V.P.B., P.G. and G.G.; Writing – Review and editing, V.P.B., P.G. and G.G.; Supervision, V.P.B., P.G. and G.G.

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