

**The relevance of quantity and quality entrepreneurship for regional performance: The moderating role of the entrepreneurial ecosystem**

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**Abstract:**

This study analyses how the entrepreneurial ecosystem and different types of entrepreneurship—i.e., quantity (Kirznerian) and quality (Schumpeterian) entrepreneurship—impact regional performance, in terms of gross value added per worker and employment growth. By analysing 121 European Union regions between 2012 and 2014, we find that an enhanced entrepreneurial ecosystem yields to superior regional performance. The results reveal a heterogeneous effect of quantity- and quality-based entrepreneurship on regional performance: quantity (Kirznerian) entrepreneurship negatively impacts regional performance, while this effect turns positive in case of quality (Schumpeterian) entrepreneurship. The findings also suggest that regions with a healthy entrepreneurial ecosystem have a greater capacity to materialize the effects of high regional business formation rates, regardless of their quality level (Kirznerian entrepreneurship), while regions with weak entrepreneurial ecosystem may rely on Schumpeterian entrepreneurs—who channel new and more innovative resources to the economy—to compensate the absence of entrepreneurship policy-support instruments and increase their economic outcomes.

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## 1. Introduction

While entrepreneurship has long been believed to be a major determinant of economic outcomes, even latest empirical studies provide mixed and unconvincing evidence about the ultimate relationship between entrepreneurship and various economic performance metrics (Acs, Estrin, Mickiewicz, & Szerb, 2017; Acs & Varga, 2005; Nightingale & Coad, 2014). Moreover, results vary according to the selection of performance measure chosen (growth, development, prosperity, productivity), the definition and the measure of entrepreneurship (single level/multidimensional, quality/quantity), the analysed geographic unit (country, macro-regional, micro-regional, city level), and the modelling strategy.

A consistent finding of many studies is that both entrepreneurship, measured by activity, and the effect of entrepreneurship on performance vary over development level (Acs, 2006). Entrepreneurship is found to positively and significantly influence territorial performance in developed economies; however, results are less convincing if we include less developed territories (Van Stel, Carree, & Thurik, 2005).

Not all types of entrepreneurship are equally important (Grilo & Thurik, 2008). Wide range of measures like self-employment rates or the Global Entrepreneurship Monitor (GEM) TEA (total early-phased entrepreneurial activity) are found to moderately influence economic growth while innovation-related or high growth start-ups show much stronger impact on economic growth (Wong, Ho, & Autio, 2005). Minniti and Lévesque (2010) propose a model where research-based, Schumpeterian entrepreneurship spurs growth in developed territories, while imitative, Kirznerian entrepreneurship is more important in less developed economies. Scholars propose that national level research is not appropriate and the spillover effects of entrepreneurship can be more effectively captured at sub-national levels (Acs & Armington, 2004; Feldman, 2001). Yet, the proof for the overall effect of entrepreneurship on economic growth at regional level has not been found yet (Müller, 2016).

Many studies claim that intermediate linkages (Carree & Thurik, 2006; Wennekers & Thurik, 1999), or contextual factors (Welter, 2011; Zahra, Wright, & Abdelgawad, 2014) play an important role in the transmission mechanism. Acs, Braunerhjelm, Audretsch, and Carlsson (2009) and Braunerhjelm, Acs, Audretsch, and Carlsson (2010) identify knowledge diffusion as the key mechanism that links entrepreneurship and growth.

Research on the entrepreneurial ecosystem (EE) portrays entrepreneurship as the combination of the above mentioned perspectives: the emergence of productive entrepreneurship as a result of interconnected actors and factors within a focal territory (Acs, Autio, & Szerb, 2014). The EE approach differentiates between environmental, ecosystem

elements and outcome measures. Local development depends on how the EE supports the rise of high growth firms (Alvedalen & Boschma, 2017; Mason & Brown, 2014; Stam, 2015).

In this context, the Global Entrepreneurship Index (GEI) has emerged as a relevant measure of the EE at the territorial level by measuring the entrepreneurship system as the complex interactions between entrepreneurial attitudes, abilities and aspirations (Acs, Autio, & Szerb, 2014). Within the framework of the knowledge spillover theory, Lafuente, Szerb, and Acs (2016) found that GEI is an important driver of national economic growth. Results are less convincing when GEI is applied in the traditional production function framework where GEI is proved to be important only for developing countries (Acs et al., 2017).

Entrepreneurship has been often invoked as a valid mechanism to boost territorial economic performance. Empirical papers mostly investigated this connection at the country or regional level, thus ignoring potential regional research across countries. Our paper attempts to shed light on the determinants of regional economic growth by connecting the entrepreneurial ecosystem and the entrepreneurial activity in 121 European Union regions. More concretely, we study the impact of the entrepreneurship system, the Kirznerian and the Schumpeterian start-ups on employment growth and GVA per worker. Instead of conventional entrepreneurship ratios (TEA), we propose new measures in line with the Kirznerian and the neo-Schumpeterian approach (Aghion, 2017; Aghion & Howitt 1992; Kirzner, 1973).

## **2. Entrepreneurial ecosystem and the Regional Entrepreneurship and Development Index (REDI)**

It has been widely acknowledged that not all types of entrepreneurship—in fact only a fraction of start-ups—are good for national prosperity and that the institutional context regulates the quality of entrepreneurial ventures (Baumol, 1996; Boettke & Coyne, 2009). In this sense, EE scholars opened a new entrepreneurship research direction by examining the systemic connections behind the emergence of high impact ventures. Initially, EE targeted practitioners, local policy makers and stakeholders and not the academic audience (Feld, 2012; Foster et al., 2013). The need for rigorous research, theory-based concept creation, solid methodology, and proper measurement have recently emerged (Alvedalen & Boschma, 2017; Spigel, 2017; Stam, 2015).

There are three distinctive features of the EE research. First, while most conceptual approaches view the entrepreneurial environment as a bundle of different components, EE adopts a multi-context perspective by highlighting the self-reinforcing forces, close relationships, interdependencies, supporting effects, and forward and backward linkages

among the components. Second, EE clearly differentiates the entrepreneurial environment (ecosystem) and the entrepreneurial outputs. Out of different types of entrepreneurial outputs the EE focuses on those opportunity recognition activities that result in high impact, high ambitious start-ups<sup>1</sup> and neglects potentially marginal, non-growth, self-employment initiations. Finally, the performance of the EE depends on the interaction between the entrepreneur, the organisations and the institutions (Alvedalen & Boschma, 2017), being the entrepreneur the most important agent playing multiple roles in the ecosystem—as leader, mentor, and investor—and founding a potentially high impact venture.

Among the many EE research directions, the GEI is probably the most useful approach by providing theoretical base, and a novel methodology to measure the EE at country level (Acs et al., 2014; Acs & Szerb, 2009). According to Acs et al. (2014, p. 119), the EE or the system of entrepreneurship (SE) ‘...is the dynamic, institutionally embedded interaction between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures’. In this study, we proposed a modified version of GEI—that is, the REDI—to measure the entrepreneurial performance of 125 EU regions. The REDI ultimately seeks to explain regional development. Following the EE, the adjustment process referred to changes in the institutional variables to reflect the regional forces of agglomeration, connectivity and clustering (Szerb et al., 2017).

The REDI index incorporates three sub-indices, 14 different pillars, 28 variables (14 institutional and 14 individual), 44 indicators and 60 sub-indicators. A valid criticism of many EE models is that component collection is ad-hoc. For creating REDI, the sub-indicator selection was based on 1) a thorough review of theoretical and empirical literature to find sub-indicators that connect best to the entrepreneurial phenomenon, 2) the potential of sub-indicators to assign clear benchmarks to evaluate performance, 3) their capabilities to connect to economic development, and 4) the availability of data over the period 2007-2014. A drawback of the REDI sub-indicators is that some important EE attributes are missing. While the market, the regulatory, the human capital and education, the cultural, the network, the knowledge creation and dissemination, the infrastructure and the finance dimensions are mostly captured; there is no indicator on supporting services and mentoring, leadership, and the effect of universities is partially involved in the educational variables. The structure of the REDI index and the assigned EE attributes are depicted in Table 1.<sup>2</sup>

Table 1. The structure of the Regional Entrepreneurship and Development Index

REGIONAL ENTREPRENEURSHIP INDEX	Sub-indexes	Pillars	Variables ( <i>ind./inst.</i> )	Entrepreneurship attributes	
	ATTITUDES SUB-INDEX	Opportunity Perception		<i>Opportunity Recognition</i>	<b>Market and Regulation</b>
				<b>Market Agglomeration</b>	
		Startup Skills		<i>Skill Perception</i>	<b>Human capital/education</b>
				<b>Quality of Education</b>	
		Risk Acceptance		<i>Risk Perception</i>	<b>Cultural, Regulation</b>
				<b>Business Risk</b>	
	Networking		<i>Know Entrepreneur</i>	<b>Networks</b>	
			<b>Social Capital</b>		
	Cultural Support		<i>Carrier Status</i>	<b>Cultural</b>	
		<b>Open Society</b>			
ABILITIES SUB-INDEX	Opportunity Startup		<i>Opportunity Motivation</i>	<b>Regulation</b>	
			<b>Business Environment</b>		
	Technology Adoption		<i>Technology Level</i>	<b>Knowledge creation/dissemination</b>	
			<b>Absorptive Capacity</b>		
	Human Capital		<i>Educational Level</i>	<b>Human capital/education</b>	
			<b>Education and Training</b>		
Competition		<i>Competitors</i>	<b>Infrastructure</b>		
		<b>Business Strategy</b>			
ASPIRATION SUB-INDEX	Product Innovation		<i>New Product</i>	<b>Knowledge creation/dissemination</b>	
			<b>Technology Transfer</b>		
	Process Innovation		<i>New Technology</i>	<b>Knowledge creation/dissemination</b>	
			<b>Technology Development</b>		
	High Growth		<i>Gazelle</i>	<b>Infrastructure and Finance</b>	
			<b>Clustering</b>		
	Globalization		<i>Export</i>	<b>Market</b>	
			<b>Connectivity</b>		
Financing		<i>Informal Investment</i>	<b>Finance</b>		
		<b>Financial Institutions</b>			

Source: Szerb et al. (2017, p. 13).

While EE scholars have primarily focused on the interrelation between system components, the identification and description of the nature of these connections have been largely sidelined. System components can have (weighted) an additive—the effect of the individual components depends on their weight—or a multiplicative—that is, a combined, interrelated impact on the system performance—influence on the overall system performance. The additive and multiplicative connections of the elements vary at different levels of the

REDI. Indicator and variable calculations are case-dependent. Most indicators are calculated as the average of sub-indicators and most variables are calculated as the average of the indicators assuming *additive* effects.<sup>3</sup> Notable exceptions include the computation of the Freedom indicator that is the result of the multiplication of the Business freedom and the Property rights sub-indices. Each pillar is created as the product of an individual-level and an institutional level variable implying common, *multiplicative* effects.

The most important advantage of REDI relies in its capacity to show how resource allocation can be optimized along the 14 pillars to improve the REDI score and, ultimately, the regional entrepreneurship system performance. To achieve optimization we equalize the marginal effect of each additional input over the 14 pillars and the 125 regions by using the Average Pillar Adjustment (APA) method. Underlying the APA method is the assumption that the normalized average pillar values are different, ranging from 0.36 (Finance) to 0.65 (Product innovation). In our model, the average pillar values reflect the difficulty to reach average pillar performance in reverse order, so that it is about 1.8 times more difficult to reach average performance in Finance compared to Product innovation. This implies that for the same additional input unit we experience 1.8 times larger improvement in Product innovation as compared to Finance. APA corrects this distortion by equalizing pillar averages to the level of the average of the 14 pillars (0.49) and holding all the pillar values in the original [0,1] range. A potential drawback of this approach is that pillar values are only equalized over their averages, and that marginal effects are not necessarily the same if we improve non-average pillars. Monetary differences are also neglected, that is, pillar improvements are computed in natural input units as we cannot estimate the monetary value of input units.

The key idea of REDI is that system performance at region level is ‘co-produced’ by its constituent elements, meaning that the 14 pillars are interrelated and all support the functioning of the EE, that is, the 14 pillars act as complements for each other. This implies that all pillars should be positively correlated with each other and they should also be positively correlated with the REDI score. These two preconditions are essential for the pillar-based policy intervention to improve the REDI and the whole EE.

In the proposed EE approach, the combination of pillar components determines whether the system of a particular region functions well or not. For each region this means that, after equalizing the averages of all pillars, the value of each pillar is penalized by linking it to the score of the ‘bottleneck’ pillar with the weakest performance. The penalty is higher if differences are higher, and pillar components are only partially substitutable with each other. An improvement in the weakest pillar would yield to a significant increase in the focal sub-

index and, ultimately, the overall REDI score. On contrary, improving a high performing pillar would enhance the value of the pillar itself, and in this case the increase in the REDI index will be smaller. A system with a homogeneous pillar configuration (no weak pillar) evidences that the EE is efficiently channelling and utilizing the region's resources.

Some EE scholars argue that each ecosystem is unique in terms of the configuration and the combination of its many components. Therefore, local administrations should not replicate successful policies adopted by other regions; but rather follow a distinctive development strategy based on their own strengths and weaknesses (Mason & Brown, 2014; Spigel 2017). The REDI adopts a partially different view by assuming that a one-size fits all measure of EE is useful but entrepreneurship policy should be tailor-made by identifying local bottlenecks and narrow (or eliminate) gaps that prevent a given region from fully exploiting its entrepreneurial potential. The REDI complements other case-preferred EE approaches by taking a wider, bird-eye and not a microscopic view of the regional EE. To alleviate system failures, this entrepreneurship policy reflects well the traditional economic view linked to relaxing market failures and to the innovation system approach to improve the weak part of the innovation systems components (Stam, 2015).

### **3. Measuring Entrepreneurial Outputs**

EE scholars maintain that local development can be enhanced by improving the ecosystem; however, this effect may well be moderated by entrepreneurial outputs. While several competing definitions of entrepreneurship reflecting the multifaceted nature of entrepreneurship exist (Acs et al., 2014; Wennekers & Thurik, 1999), we narrow to those entrepreneurship definitions that are centred around opportunity utilization via the creation of new ventures (Vivarelli, 2013). In this sense, entrepreneurial activity refers to the process of recognizing and exploiting valuable business opportunities (Kirzner, 1997; Shane, 2009). Although opportunity exploitation can be linked to intrapreneurship or employee-initiated entrepreneurship, in this paper we concentrate on autonomous start-ups.

The importance of regional entrepreneurial activity has long been recognised; however, the direction and magnitude of its economic impact has been debated (Audretsch & Fritsch, 2002; Feldman, 2001; Lee, Florida, & Acs, 2004). Various factors have been proposed to explain the dissimilar findings in prior research, including differences in development, industry composition, the inclusion of contextual factors, and the measurement of entrepreneurial activity (Audretsch, Falck, Feldman, & Heblich, 2012; Fritsch & Storey, 2014).

The previous section dealt with the contextual, ecosystem elements, while this section focuses on the activity perspective. Entrepreneurial firms are not homogeneous, and from the novelty of opportunity recognition perspective, start-ups can be grouped into a large number that merely copy existing ideas, a small proportion that introduce minor innovations, and a very few Schumpeterian new firms with breakthrough innovative ideas (Baumol, 2010).

The territorial contribution of start-ups varies according to their typology (Hessels, Van Gelderen, & Thurik, 2008; Nightingale & Coad, 2014). Contrary to the conventional view that emphasises the need for increasing the quantity of entrepreneurial firms, recent research shows that only a small proportion of start-ups and young businesses are responsible for economic growth, job creation or increased productivity (Acs, Åstebro, Audretsch, & Robinson, 2016; Mueller, 2007; Stam, Hartog, Van Stel, & Thurik, 2011; Stam, 2015).

Different types of start-ups coexist in economies, and their overall effect also depends on their composition (Vivarelli, 2013). Moreover, the relationship between the number of businesses and their quality is inverse (Fritsch & Schroeter, 2009), which calls for a careful policy application to boost the intensity of start-ups (Acs et al., 2016; Shane, 2009). The uneven, unknown distribution of start-ups and their potential substitution effects makes irrational to develop a combined, one-size-fits-all entrepreneurship measure (Marcotte, 2013; Vivarelli, 2013). Moreover, entrepreneurial activity measures should be concept based; however, most of them are ad hoc, assuming presumable effects (Marcotte, 2013). This is particularly true for one of the most popular activity measure: the GEM's TEA ratio. The popularity of GEM based measures is due to the consistent and rigorous data collection that includes multiple years, many countries, regions and different levels of development. Yet, the TEA simultaneously includes the 'speculative' nascent businesses with young firms with less than 3.5 years (Stam & Van Stel, 2011)<sup>4</sup>, opportunity and necessity start-ups, marginal and high growth potential ventures. Also, the TEA is negatively correlated with GDP per capita, which suggests that development is linked to low levels of entrepreneurial activity (SAB Foundation, Allan Grey Orbis Foundation, The Global Entrepreneurship and Development Institute, The Global Entrepreneurship Network South Africa, & SEA Africa, 2017).

Despite its widely recognised weaknesses (Baumol, Litan, & Shramm, 2007), TEA still dominates the GEM reports. Out of the many alternative GEM-based entrepreneurship measures (Levie, Autio, Acs, & Hart, 2014; Marcotte, 2013) the opportunity and necessity entrepreneurship rates (Acs, 2006; Reynolds et al., 2005) and the high aspiration or high growth entrepreneurship rates (Stam & Van Stel, 2011; Wong et al., 2005) report a better (but still limited) capacity to explain territorial development outcomes. The limited explanatory



power of the GEM-based indices may well result from its generalist approach that includes all types of start-ups in the analysis, regardless the type of new venture. Thus, GEM variables measure the overall magnitude of entrepreneurial activity but they fail to capture the role of competition on entrepreneurship dynamics (Boettke & Coyne, 2003; Kirzner, 1973).

This calls for developing new entrepreneurship measures that accurately capture the direct and indirect impact of quantity and quality entrepreneurial outcomes (Acs et al., 2014). Direct effects—e.g., increased output and employment—are likely observable in the short run, while indirect effects—e.g., superior productivity and innovation—will become evident in the long-term (Acs, 2006; Wennekers & Thurik, 1999).

New business entry intensifies competition by challenging the market position of established firms (Fritsch & Mueller, 2004; Kirzner, 1973). In a scenario of high entry rates, incumbent firms may either downgrade/terminate their operation or adapt to the new market conditions. If the overall output remains unchanged the increased competition may lead to high churning—high entry and exit rates at the same time—and the total employment effect could be negative (Fritsch & Mueller, 2004; Vivarelli, 2013). Innovation has been invoked as a way to enhance the positive effects of competition (Aghion, 2017; Aghion & Howitt, 1992). Innovation leads to create new markets and/or new product/service solutions, thus increasing competitiveness by stimulating growth and productivity (Fritsch & Mueller, 2004).

Given the lack of entrepreneurial outputs within the EU regional context, we need to develop new entrepreneurial activity indicators that reflect the level of competition and innovation among new and incumbent ventures. We therefore propose a quality- and a quantity-related measure. The proposed measures use GEM regional data during 2012-2014. We excluded the ‘speculative’ nascent businesses and we used a different temporal horizon to split the analysed businesses (baby businesses and established ventures).

The first suggested measure reflects exclusively quantity characteristics of businesses and it is calculated as the number of start-ups divided by the number of incumbent businesses. We call it as Kirznerian entrepreneurship (equation 1):

$$\text{Kirznerian entrepreneurship}_i = \frac{\text{Number of new businesses}_i}{\text{Number of incumbent businesses}_i} \quad (1)$$

where, for each region ( $i = 1, \dots, m$ ), the number of new businesses refers to those firms with less than 18 months of market experience; and the number of incumbent businesses includes the number of businesses with more than 18 months of market experience.

This entrepreneurship measure is based on the relative start-up rate. More concretely, this variable shows the importance of start-ups compared to incumbent firms, and thus, it measures the competitive pressure of start-ups on established ventures. From the entrepreneurial point of view, a high ratio could indicate that more people see good profit opportunities in the region where they live, while a low ratio may signal missing entrepreneurial opportunities. The main features of this Kirznerian-oriented entrepreneurship variable are opportunity alertness and profit exploitation (Kirzner, 1973). Although it includes different types of businesses including necessity and low growth potential start-ups, this measure corrects for competitive effects. This ‘imperfect’ indicator helps to evaluate the possibility of a one-size fits all activity measure as well as the associated uniform entrepreneurship policy focused on increased start-up rates.

The second variable approaches start-up rates from a quality perspective, and measures the relative innovativeness of new firms compared to that of incumbent ventures. Business innovativeness is calculated from the average of three GEM-based variables: 1) the newness of the product (how many customers consider the product of the firm new or unfamiliar), 2) the newness of technology (whether the firm uses old, new or the latest available technology), and 3) operating in a high impact sector (whether the firm operates in a low tech/low impact, medium/high or high-impact, technological sector).

To compute a realistic picture of the regional innovation capacity of start-up/incumbent businesses, for each innovation variable we used the weighted arithmetic average of firms. After calculating the innovativeness of both new and incumbent businesses, our Schumpeterian entrepreneurship measure was computed as follows (equation 2):

$$\text{Schumpeterian entrepreneurship}_i = \frac{\text{Innovativeness of new businesses}_i}{\text{Innovativeness of incumbent businesses}_i} \quad (2)$$

where, for each region ( $i = 1, \dots, m$ ), the innovativeness of new businesses is the innovation level of firms with less than 18 months of market experience, while the innovativeness of incumbent businesses refers to the innovation level of businesses with over 18 months of market experience.

This quality measure shows the innovativeness of start-ups compared to that of incumbent businesses. This variable also captures the competitive pressure of innovative new businesses over existing businesses, that is, it measures what Schumpeter called ‘creative destruction’ (Schumpeter, 1934). We, therefore, name this indicator Schumpeterian entrepreneurship.

#### **4. Research framework and hypotheses**

After the review of the most important determinants of territorial performance, our conceptual model is based on the following assumptions. First, contrary to the view that promotes commitment to the autarchy of institutional contexts or entrepreneurial actors, we argue that a holistic approach should be adopted based on the EE literature that recognizes the complementary and organic relationship between these two concepts should be adopted. As a complex measure, we assume that REDI captures the overall performance of the regional EE by taking into account the sub-national diversity (Acs & Armington, 2004). We propose that the EE is conducive to territorial performance and, thus, we hypothesise:

**H1:** There is a positive relationship between the entrepreneurial ecosystem and regional performance.

We differentiated quality- and quantity-based start-up measures seeking to capture the importance of competition between businesses at different stages of the life cycle. Recent empirical findings underpin the need for incorporating the effects of market competition on territorial economic performance. For example, Fritsch and Changoluisa (2017) find that new firms, irrespectively to their innovation and technology level, contribute to higher productivity of established businesses operating in the region. The authors consider four potential effects of business entry on the productivity of established firms (output market competition, input market competition, knowledge spillover from new to established firms, and provision of better inputs), and their results indicate that only output and input market competition have a significant positive effect. Therefore, start-ups and incumbent businesses complement each other, regardless of the industry sectors where these businesses operate.

However, the effect of Kirznerian entrepreneurship—characterised by opportunity alertness and profit exploitation—and Schumpeterian entrepreneurship—that is, creative destruction—on territorial performance must be distinguished. First, as Kirznerian entrepreneurship is based on increases in the quantity of businesses, higher business density may be detrimental to economic performance due to excessive competition and lower available profit in the region. On contrary, innovative businesses are more competitive and, therefore, they can create new profit opportunities and break into market niches within and/or outside the region (e.g., via internationalization). Thus, the following hypotheses emerge:

**H2:** Kirznerian entrepreneurship has a negative effect on regional performance.

**H3:** Schumpeterian entrepreneurship has a positive effect on regional performance.

Nevertheless, the scope and quality of entrepreneurial activity are not independent from the environment within which businesses operate. In particular, EE takes a significant part in shaping quantity- and quality-related business structures, and they are the hotbed of start-ups (Acs et al., 2016). The regional environmental context conditions the outcome of Kirznerian and Schumpeterian business dynamics in different ways. In the case of Kirznerian entrepreneurship, it seems logical that entrepreneurial opportunity recognition and exploitation yield better results in a healthy, supportive EE. Also, higher REDI value points to more favourable conditions for high quality, innovative start-ups; while lower REDI suggests a less supportive context, which may lead to low quality, less innovative start-ups.

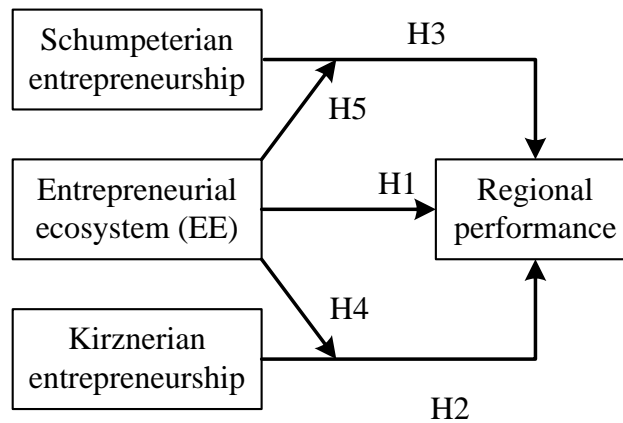
The contextualized effect of Schumpeterian entrepreneurship also depends on the innovativeness of start-ups and existing businesses. Aghion, Bloom, Blundell, Griffith, and Howitt (2005) reveal that innovation can stem not only from increased business entry rates, but also from the response of incumbent businesses to the new ones. This reaction is conditioned by their distance to the existing technological frontier. Therefore, as a reaction to new entry, ‘frontier firms’ likely make additional efforts to innovate (‘escape competition effect’), while ‘laggard firms’ that are far from the frontier face further difficulties and they have no incentives to introduce further improvements (‘discouragement effect’). These two effects suggest an inverse U-shaped effect of competition over innovation and, indirectly, over economic growth (Aghion et al., 2005; Aghion, Blundell, Griffith, Howitt, & Prantl, 2009). Thus, we complement our previous assumptions, and formulate the following hypotheses:

**H4:** The entrepreneurial ecosystem moderates the negative relationship between Kirznerian entrepreneurship and regional performance.

**H5:** The entrepreneurial ecosystem moderates the positive relationship between Schumpeterian entrepreneurship and regional performance.

Figure 1 presents the proposed research framework and hypotheses

Figure 1. Research framework



## 5. Data, variable definition and method

The data used in this study come from three sources. First, regional figures related to gross value added (GVA) per worker, GDP per capita, unemployment, and population density were obtained from Eurostat. Second, information on business formation rates was collected from the Global Entrepreneurship Monitor (GEM) databases. Third, the variables measuring the quality of the entrepreneurial ecosystem across European regions were gathered from the Regional Entrepreneurship and Development Index (REDI) databases. With the support of the European Union (‘Financial and Institutional Reforms to build an Entrepreneurial Society’ (FIRES), Horizon 2020 project), the latest REDI index was created by researchers from the University of Pécs (Hungary) with the objective of scrutinizing and understanding the entrepreneurial ecosystem in Europe (Szerb et al., 2017).

The unit of analysis is the region and the final sample includes information for 121 EU regions (NUTS 1 and NUTS 2). For all variables, values refer to averages between 2012 and 2014. Note that the representativeness of the sample is ensured insofar as it includes 24 European countries: Austria (3 regions), Belgium (3 regions), Croatia (3 regions), Czech Republic (1 region), Denmark (5 regions), Estonia (1 region), Finland (5 regions), France (8 regions), Germany (16 regions), Greece (3 regions), Hungary (7 regions), Ireland (2 regions), Italy (4 regions), Latvia (1 region), Lithuania (1 region), Netherlands (4 regions), Poland (6 regions), Portugal (3 regions), Romania (4 regions), Slovak Republic (4 regions), Slovenia (2 regions), Spain (15 regions), Sweden (8 regions), and the United Kingdom (12 regions). The list of the study regions is presented in Appendix 1.

This study measures territorial performance via two variables. First, we use the rate of gross value added (GVA) per worker, which represents the total value of goods and services produced by workers of industry sectors in a focal economy. Second, we employ the

employment growth rate.<sup>5</sup>

The measurement of the regional entrepreneurial ecosystem is critical for this study. Above the complexity that most EE measures embrace, REDI is a suitable option in the context of our analysis (see section 2). REDI can range from the potential values of 0 to 100. The higher the regional REDI score, the better the quality of the entrepreneurial ecosystem is.

We use data from the GEM databases to create the variables related to Kirznerian (quantity) and Schumpeterian (quality) entrepreneurship. From the GEM databases it is possible to identify the exact start-up year for the surveyed entrepreneurs, and distinguish businesses created in the same year of the survey (firms with less than 6 months of market experience) from firms created in years prior to the survey. In this study, we define new businesses as those firms with less than 18 months of market experience.

We control for various economic and demographic factors in the different model specifications. First, we include two variables related to urbanization. Urbanization economies are a type of agglomeration externality that helps firms to capitalize on mostly financial advantages such as increased local demand and access to cheaper production factors (Bottazzi & Gragnolati, 2015), knowledge spillovers (Glaeser, Kallal, Scheinkman, & Shleifer, 1992), and more efficient regional innovation systems. Additionally, location in large or densely populated cities may prove itself critical to access skilled labour resources (Meliciani & Savona, 2015). In our study, we follow the practice by Meliciani and Savona (2015) and assess the role of urbanization by introducing regional population density and a dummy for regions with a capital city. Finally, we include the Gross Domestic Product (GDP) per capita as an indicator of regional economic development (Lafuente et al., 2016).

Table 2. Descriptive statistics for the study variables

	Mean	Std. dev.	Q1	Q3
GVA per worker	60.19	22.70	41.74	75.83
Employment growth rate	-0.0010	0.0197	-0.0163	0.0099
REDI score	44.57	14.84	33.20	55.90
Kirznerian entrepreneurship	0.1738	0.0924	0.1080	0.2250
Schumpeterian entrepreneurship	2.0308	1.4573	1.4230	2.1410
Capital city (dummy)	0.1901	0.3940	0.0000	0.0000
Population density	349.80	907.56	73.37	285.83
Unemployment rate	0.1085	0.0652	0.0650	0.1307
GDP per capita	25.96	9.15	19.60	30.35

Monetary values (GVA per worker and GDP per capita) are expressed in thousands of euro. Number of observations: 121 regions.

We employ OLS regression models to estimate the effect of the entrepreneurial ecosystem and the type of entrepreneurship on territorial performance. The full model used in this study has the following form:

$$\begin{aligned} \text{Performance}_i = & b_0 + b_1 \text{REDI}_i + b_2 \text{Kirznerian entrepreneurship}_i \\ & + b_3 \text{Schumpeterian entrepreneurship}_i + b_{12} \text{REDI}_i \cdot \text{Kirznerian entrepreneurship}_i \\ & + b_{13} \text{REDI}_i \cdot \text{Schumpeterian entrepreneurship}_i + b_4 \text{Control variables}_i + e_i \end{aligned} \quad (3)$$

In equation (3) performance refers to the GVA per worker and the employment growth rate at the regional level,  $b_j$  are parameter estimates estimated for the independent variables ( $j$ ), and  $e$  is the normally distributed error term that varies across regions.

In a second stage we propose a cluster analysis (Everitt, 1980) to further evaluate regions' performance, given their differences in terms of the quality of their entrepreneurial ecosystem and of their entrepreneurial activity (quantity and quality). The variables included in the cluster model are the analysed regional performance metrics (GVA per worker and employment growth), the REDI score, and the variables linked to the quantity (Kirznerian) and quality (Schumpeterian) regional entrepreneurial activity. This complementary analysis seeks to identify specific patterns among European regions.

To attain the second stage analysis we apply a non-hierarchical cluster analysis (K-means) using the aforementioned variables as inputs. However, the efficient optimization of the within-cluster homogeneity and between-cluster heterogeneity implies that the number of clusters has to be specified prior to the estimation. This represents the main pitfall of non-hierarchical cluster analysis, because in many research fields (including social sciences) cluster analyses are often exploratory. Consequently, we conducted two robustness checks to corroborate the number of clusters and the validity of our analysis. First, we computed the

Calinski and Harabasz (1974) statistic. This index is obtained as  $CH(k) = \frac{B(k)/k - 1}{W(k)/n - k}$ , where

$B(k)$  and  $W(k)$  are the between and within-cluster sums of squares, with  $k$  clusters. Since the between cluster difference should be high, and the within cluster difference should be low, a largest  $CH(k)$  value indicates the best clustering. From our data, the number of clusters that maximizes the  $CH(k)$  index is 5 (*pseudo-F value*: 488.35). Therefore, the final non-hierarchical cluster asks for a five-way division. Second, a discriminant analysis further validates the cluster analysis. Results from the discriminant analysis presented in Appendix 2 indicate that our approach to cluster is appropriate.

## 6. Results and analysis

### 6.1 Regression results

The findings for the effect of the entrepreneurial ecosystem and different types of entrepreneurship (Kirznerian and Schumpeterian) on regional performance (GVA per worker and employment growth) are presented in this section. In Tables 3 and 4, model 1 shows the results for the baseline model estimating regional performance as a linear function of the analysed types of entrepreneurship (Kirznerian and Schumpeterian). Specification 2 considers the potentially differentiating effect of low and high quality EE, while model 3 reports the results for the full model that includes interaction terms between the quality of the regional entrepreneurial ecosystem (REDI) and the analysed types of entrepreneurship.

To evaluate the threat of collinearity, we computed the average variance inflation factor (VIF) for all variables. The only VIF values that exceed 10—a generally accepted rule of thumb for assessing collinearity—were observed for the interaction terms between the REDI and the entrepreneurship variables (Kirznerian and Schumpeterian). By construction these terms are correlated and—even if computationally correct—this explains the VIF results (Greene, 2003). We also computed VIFs for the variables used in models 1 and 2, and the resulting average VIF is 1.44 (range: 1.07-2.47) and 1.46 (range: 1.08-2.11), respectively. The results for this diagnostic test do not raise collinearity concerns.

Concerning the results of the study, from models 1 and 2 in Tables 3 and 4 we observe that the variable linked to the entrepreneurial ecosystem (REDI) consistently positively impacts territorial GVA per worker, and explain employment growth only among high-REDI regions. This result is consistent with prior studies emphasizing that a healthy entrepreneurial ecosystem is conducive to territorial performance (see e.g., Acs et al., 2014; Lafuente et al., 2016). Therefore, we support our first hypothesis (**H1**) that proposes a positive relationship between the regional entrepreneurial ecosystem and territorial performance only when the GVA per worker is the regional outcome.

In case of Kirznerian entrepreneurship capturing quantity entrepreneurship at regional level, results in Table 3 show that this variable has a negative impact on regional GVA per worker, while this relationship turns not significant in the employment growth model (Table 5). We therefore confirm our second hypothesis (**H2**) that states that Kirznerian entrepreneurship negatively impacts regional performance when the dependent variable is the GVA per worker, while we find no support for this hypothesis for the model using employment growth as dependent variable. Additionally, results in Tables 3 and 4 show how



the effect of the Schumpeterian entrepreneurship variable is positive and significant when employment growth is the analysed regional outcome. Thus, we partially support our hypothesis 3 (**H3**) that proposes a positively relationship between Schumpeterian entrepreneurship and regional performance.

The results in model 3 of Table 3 show that the interaction term between the REDI levels and Kirznerian entrepreneurship is significant only in regions with an underdeveloped entrepreneurial ecosystem. That is, creating more businesses is not always enough neither to increase the economic output of industrial activities, nor to improve regional employment levels. Regions with high rates of new businesses are exposed to a quality threat associated with low rates of quality entrepreneurship; however, our results suggest that the regional entrepreneurial ecosystem contribute to alleviate this threat. A healthy entrepreneurial ecosystem facilitates the efficient allocation of entrepreneurial resources to the economy. This is a necessary condition for effective entrepreneurship, and regions with superior entrepreneurial ecosystems may have a greater capacity to exploit the entrepreneurial outcome of individual efforts. Thus, the entrepreneurial ecosystem creates the conditions to materialize the effects of high business formation rates, regardless of their quality level (Kirznerian entrepreneurship). This complementary effect helps explaining the positive finding for the parameter of the interaction term between the REDI score and the Kirznerian entrepreneurship variable. Consequently, we partially support hypothesis 4 (**H4**) that states that the regional entrepreneurship system moderates the negative relationship between Kirznerian entrepreneurship and regional performance. This hypothesis is confirmed for the model using GVA per worker as dependent variable, while we find no support for this hypothesis when the dependent variable is employment growth.

Table 3. Regression results: Gross value added per worker

	Model 1	Model 2	Model 3
REDI	3.0834*** (0.2113)		
Low REDI		3.8782*** (0.3588)	1.2693 (1.1978)
High REDI		2.3795*** (0.2845)	3.0986*** (0.8427)
Kirznerian entrepreneurship	-0.8177** (0.3165)	-0.7928*** (0.2863)	-0.4939 (0.3831)
Kirznerian entrepreneurship X Low REDI			5.8525* (3.7022)
Kirznerian entrepreneurship X High REDI			1.7146 (2.8886)
Schumpeterian entrepreneurship	-0.0098 (0.0716)	-0.0089 (0.0616)	0.1153* (0.0750)
Schumpeterian entrepreneurship X Low REDI			1.4506* (0.7814)
Schumpeterian entrepreneurship X High REDI			-0.9240** (0.4517)
Capital dummy	-0.2091*** (0.0592)	-0.2004*** (0.0633)	-0.2311*** (0.0637)
Population density	-0.0184 (0.0247)	-0.0103 (0.0245)	-0.0123 (0.0259)
Unemployment rate	2.5888*** (0.3843)	2.7413*** (0.3883)	2.3582*** (0.4278)
Country dummies	Yes	Yes	Yes
Intercept	2.5906*** (0.1642)	4.0001*** (0.1490)	3.8755*** (0.2019)
F-test	40.42***	54.85***	33.93***
Adjusted R2	0.7606	0.7758	0.7856
RMSE	0.2211	0.2139	0.2092
Average VIF	1.44	1.46	7.72
Observations	121	121	121

Robust standard errors are presented in brackets. \*, \*\*, \*\*\* indicate significance at the 10%, 5% and 1%, respectively.

Table 4. Regression results: Employment growth

	Model 1	Model 2	Model 3
REDI	0.0075 (0.0167)		
Low REDI		-0.0466* (0.0221)	0.0909 (0.0691)
High REDI		0.0554*** (0.0205)	0.0114 (0.0545)
Kirznerian entrepreneurship	-0.0022 (0.0203)	-0.0039 (0.0189)	-0.0201 (0.0273)
Kirznerian entrepreneurship X Low REDI			-0.1531 (0.2490)
Kirznerian entrepreneurship X High REDI			0.1527 (0.1563)
Schumpeterian entrepreneurship	0.0073** (0.0037)	0.0072** (0.0032)	0.0014 (0.0040)
Schumpeterian entrepreneurship X Low REDI			-0.1069** (0.0431)
Schumpeterian entrepreneurship X High REDI			0.0162 (0.0259)
Capital dummy	0.0077* (0.0045)	0.0073* (0.0045)	0.0075* (0.0044)
Population density	-0.0006 (0.0014)	-0.0011 (0.0013)	-0.0014 (0.0014)
Unemployment rate	-0.1283*** (0.0286)	-0.1386*** (0.0295)	-0.1344*** (0.0337)
Country dummies	Yes	Yes	Yes
Intercept	0.0016 (0.0081)	0.0029 (0.0067)	0.0127 (0.0093)
F-test	22.99***	30.83***	22.57***
Adjusted R2	0.4664	0.5037	0.5026
RMSE	0.0144	0.0138	0.0139
Average VIF	1.44	1.46	7.72
Observations	121	121	121

Robust standard errors are presented in brackets. \*, \*\*, \*\*\* indicate significance at the 10%, 5% and 1%, respectively.

The interaction effect between the REDI and Schumpeterian entrepreneurship is negative and statistically significant, thus pointing to a substitution effect between these variables. Schumpeterian (quality) entrepreneurship is often linked to highly skilled entrepreneurs who create businesses with superior innovative capacities that may potentially redirect consumer preferences by offering high value-added goods or services.

The economic outcome of regions with low-quality innovation systems/ entrepreneurial ecosystems may be restrained by the lack of appropriate mechanisms to allocate entrepreneurial resources to the economy. In this context, innovative entrepreneurs

whose businesses are of high quality constitute a substitute for the shortage of an adequate entrepreneurial ecosystem. Therefore, regions with low REDI scores may rely on Schumpeterian entrepreneurs—who channel new and more innovative resources to the economy—to compensate the absence of entrepreneurship policy-support instruments and increase their economic outcomes, in terms of GVA per worker. This substitution effect may explain the negative result for the interaction term between the REDI score and the Schumpeterian entrepreneurship variable.

The picture is quite different when territorial performance is measured via employment growth. While the results underline the employment enhancing capacity of high quality (Schumpeterian) entrepreneurship often linked to highly skilled entrepreneurs, we find that high quantity-based entrepreneurial rates (Kirznerian entrepreneurship) are not conducive to higher employment levels. Based on these arguments, we therefore cannot support our last hypothesis (**H5**) that proposes that the regional system of entrepreneurship moderates the positive relationship between Schumpeterian entrepreneurship and regional performance.

### *6.2 Behavioural paths followed by European regions*

This section complements the regression assessment by introducing the results of the cluster analysis. Table 5 presents the results for the five different groups of regions that emerge from the cluster analysis. Additionally, Figure 2 graphically presents the distribution of the analysed regions according to the results of the cluster analysis.

The nine regions included in Group 1 are located in developed economies, namely Denmark (Hovedstaden), France (Île-de-France), Finland (Helsinki-Uusimaa), Germany (Hamburg), Ireland (Southern and Eastern), Sweden (Stockholm and South Sweden), and the UK (London and South-East). These high-performing regions show the greatest values in terms of the five analysed variables.

Regions from nine developed countries form Group 2: Austria (Eastern Austria), Belgium (Brussels-Capital Region), Denmark (Midtjylland, Nordjylland, and Southern Denmark), France (Centre-Est), Germany (Baden-Württemberg, Bayern, Berlin, Bremen, Hessen, Nordrhein-Westfalen, and Saarland), Ireland (Border, Midland and Western), Netherlands (Northern Netherlands, Eastern Netherlands, Western Netherlands, Southern Netherlands), Sweden (East Middle Sweden, Upper Norrland, and West Sweden), and UK (Yorkshire and The Humber, East Midlands, West Midlands, East of England, South West, Scotland, and Northern Ireland). These regions report high values for the REDI score (58.78), GVA per worker (73.91) as well as positive employment growth between 2012 and 2014

(0.99%); however, values for the REDI score ( $t$ -test: 10.66 and  $p$ -value < 0.001) and the GVA per worker ( $t$ -test: 4.92 and  $p$ -value < 0.001) are significantly lower than those reported for regions in Group 1.

We note a drastic performance gap between regions in the first two high-performing groups (Groups 1 and 2) and regions positioned in the rest of groups.

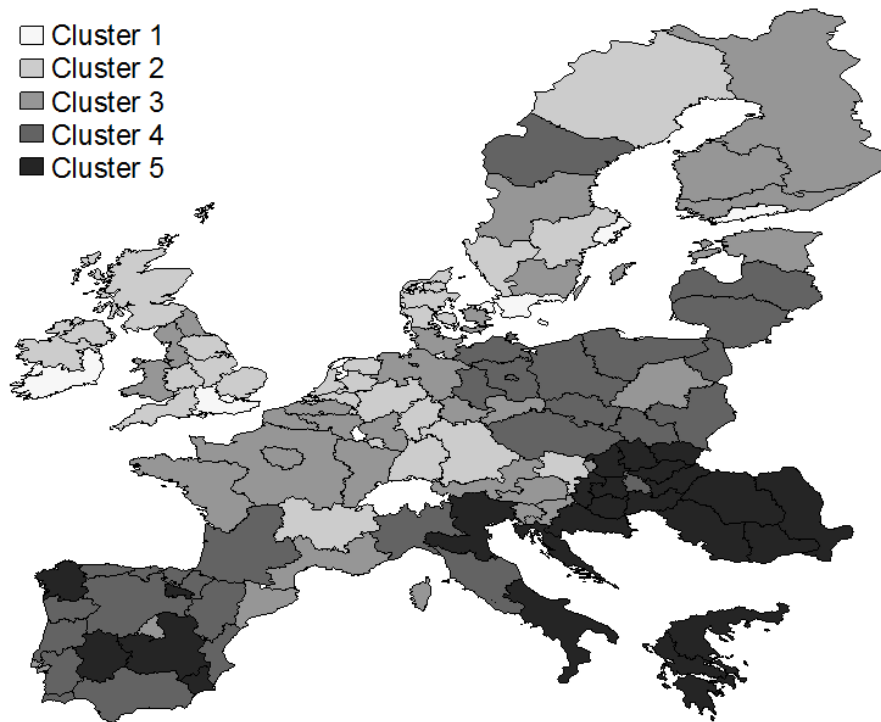
Group 3 includes regions from ten Western European countries and four developing economies mostly located in Central and Eastern Europe: Austria (Southern Austria, and Western Austria), Belgium (Flemish Region, and Walloon Region), Denmark (Sjælland), Estonia, Finland (West Finland, South Finland, North & East Finland), France (Bassin Parisien, Nord, Est, Ouest, Méditerranée), Germany (Niedersachsen, Rheinland-Pfalz, Sachsen, Schleswig-Holstein, Thüringen), Poland (Region Centralny), Portugal (Lisbon), Slovak Republic (Bratislava Region), Slovenia (Eastern Slovenia and Western Slovenia), Spain (Catalonia and Madrid), Sweden (Småland and the Islands and North Middle Sweden), and UK (North East, North West and Wales).

Although these regions show the levels of quantity (Kirznerian) and quality (Schumpeterian) entrepreneurship comparable to those reported by regions in Group 1 and 2, their results for the innovation system/ entrepreneurial ecosystem (REDI:  $t$ -test: 14.78 and  $p$ -value < 0.001) and for the performance variables (GVA per worker:  $t$ -test: 3.14 and  $p$ -value < 0.01; Employment growth:  $t$ -test: 2.96 and  $p$ -value < 0.01) are significantly lower, relative to values observed for regions in high performing groups.

Table 5. Results: Cluster analysis

Variable / Group	1	2	3	4	5	Total
REDI score	73.29	58.88	47.28	35.43	25.10	44.57
GVA / worker	96.47	73.91	63.53	49.36	39.76	60.19
Employment growth	0.0184	0.0099	-0.0021	-0.0095	-0.0094	-0.0010
Quantity churning	0.1950	0.1810	0.1758	0.1483	0.1842	0.1738
Quality churning	2.8882	2.0673	2.0733	1.9837	1.6815	2.0308
Observations	9	28	31	28	25	121

Figure 2. Geographic distribution according to the results of the cluster analysis



Regions in groups 4 and 5 show the poorest results, with the exception of the quantity entrepreneurship variable (Kirznerian entrepreneurship).

Group 4 includes regions from six Western economies and five Central and Eastern European countries: Czech Republic, France (Sud-Ouest), Germany (Brandenburg, Mecklenburg-Vorpommern, Sachsen-Anhalt), Hungary (Central Hungary), Italy (Northwest Italy, Central Italy), Latvia, Lithuania, Poland (Region Południowy, Region Wschodni, Region Północno-Zachodni, Region Południowo-Zachodni, Region Północny), Portugal (Alentejo, Algarve, Centro, Norte), Spain (Andalusia, Aragón, Asturias, Basque Country, Cantabria, Castilla León, Navarra, Valencia), and Sweden (Middle Norrland). Compared to values reported by regions in Group 3, regions in Group 4 show significantly lower levels of the REDI score ( $t$ -test: 15.13 and  $p$ -value < 0.001) and performance: GVA per worker ( $t$ -test: 3.22 and  $p$ -value < 0.01), Employment growth ( $t$ -test: 1.69 and  $p$ -value < 0.10).

Finally, Group 5 comprises poor performing regions from mostly developing countries (four out of the seven countries represented in this group are from Central and Eastern Europe): Croatia (Continental Croatia and Adriatic Croatia), Greece (Voreia Ellada, Kentriki Ellada, Attiki), Hungary (Central Transdanubia, Western Transdanubia, Southern Transdanubia, Northern Hungary, Northern Great Plain, Southern Great Plain), Italy (Northeast Italy, South Italy), Romania (Macroregion one, Macroregion two, Macroregion

three, Macroregion four), Slovak Republic (Western Slovakia, Central Slovakia, Eastern Slovakia), and Spain (Castilla La Mancha, Extremadura, Galicia, La Rioja, Murcia). These regions show the lowest value for the REDI score, the GVA per worker, and the quality (Schumpeterian) entrepreneurship.

## **7. Concluding remarks**

In this study, we proposed that quantity- and quality-based entrepreneurship have a heterogeneous impact on territorial outcomes, measured via GVA per worker and employment growth. Furthermore, we emphasised the relevance of the regional entrepreneurial ecosystem as a key factor moderating the role of different types of entrepreneurship on regional performance. Our approach offers a compelling vision of how to measure quantity and quality entrepreneurship as well as the regional entrepreneurial ecosystem.

The proposed analysis provides further evidence to understand how the entrepreneurial ecosystem contributes to capitalise on regions' entrepreneurial outcomes. Overall, and instead of contemporary quantity-based (Kirznerian) entrepreneurship metrics, our results are consistent with the notion that high quality entrepreneurial activity—which we link to Schumpeterian entrepreneurship—is a relevant outcome conducive to territorial performance across European regions. The results of this study tend to go against policy makers' efforts which have traditionally underlined the use of local resources to encourage entrepreneurial activity, and emphasise the relevance of the quality of the new ventures created in the region and to the characteristics of the regional entrepreneurial ecosystem.

This paper has relevant implications for scholars and policy makers. From an academic perspective, the results of the study help unveil the sometimes unclear relationship between entrepreneurial activity and territorial performance reported in previous studies (see e.g., Acs et al., 2017; Acs & Varga, 2005). We found that quantity entrepreneurship is negatively associated with regional outcomes; however, this type of entrepreneurship may prove itself efficient in territories that benefit from a superior entrepreneurial ecosystem that helps channel entrepreneurial resources to the economy, thus contributing to optimise the impact of new entrepreneurial ventures. We suggest that policy makers need to turn their attention to the characteristics of the entrepreneurial ecosystem when considering the adoption of entrepreneurship support measures. The prioritization of policies oriented to increase quantity entrepreneurship in the short-run may yield sterile outcomes if the region does not enjoy a healthy entrepreneurial ecosystem that contributes to pursue regional goals.

Schumpeterian entrepreneurship—which we link to the creation of high innovative

businesses with disruptive potential—is consistently associated with superior territorial performance. However, the outcomes of this type of entrepreneurship may be restrained by the lack of appropriate mechanisms that allocate entrepreneurial resources to the economy (low-quality entrepreneurial ecosystem). Our results suggest that high quality entrepreneurship may act as a substitute for the shortage of an appropriate entrepreneurial ecosystem. Therefore, regions lacking the appropriate mechanisms to allocate entrepreneurial resources to the economy may rely on Schumpeterian entrepreneurial activity to channel new innovative resources to the economy, thus compensating the absence of entrepreneurship policy-support instruments and, consequently, increase their economic outcome of industries. This aspect is of crucial importance as it suggests that, in regions with a poor entrepreneurial ecosystem, policy makers may foster regional performance by re-directing resources to promote entrepreneurship high in innovativeness.

### **Endnotes**

1. Startups can be autonomous or employee initiated, intrapreneurial (Stam & Spiegel, in press).
2. The detailed description of the REDI components and the calculation methodology is presented in Szerb et al. (2017).
3. For example, in the Quality of education institutional variable there are four sub-indicators: three of them comes from the PISA survey (low achievers in reading, math and science) and one is the creative class sub-indicator. The PISA indicator is calculated as the average of the three PISA sub-indicators.
4. The TEA rate is the ratio of 18-64-year-old adult population who is in an active phase of startup (nascent) or owns and manages a startup aged less than 42 month.
5. We calculated the GDP per capita growth rates but results proved to be inconclusive. This might be explained by the questionable reliability of regional GDP statistics.

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## Appendix

### Appendix 1. List of sampled regions

Country	NUTS level	Regions
Austria	NUTS 1	Eastern Austria, Southern Austria, Western Austria
Belgium	NUTS 1	Brussels-Capital Region, Flemish Region, Walloon Region
Croatia	NUTS 2	Continental Croatia, Adriatic Croatia
Czech Republic	NUTS 1	Czech Republic
Denmark	NUTS 2	Hovedstaden, Sjælland, Southern Denmark, Midtjylland, Nordjylland
Estonia	NUTS 1	Estonia
France	NUTS 1	Île-de-France, Bassin parisien, Nord, Est, Ouest, Sud-Ouest, Centre-Est, Méditerranée
Finland	NUTS 2	West Finland, Helsinki-Uusimaa, South Finland, North & East Finland
Germany	NUTS 1	Baden-Württemberg, Bayern, Berlin, Brandenburg, Bremen, Hamburg, Hessen, Mecklenburg-Vorpommern, Niedersachsen, Nordrhein-Westfalen, Rheinland-Pfalz, Saarland, Sachsen, Sachsen-Anhalt
Greece	NUTS 1	Voreia Ellada, Kentriki Ellada, Attiki
Hungary	NUTS 2	Central Hungary, Central Transdanubia, Western Transdanubia, Southern Transdanubia, Northern Hungary, Northern Great Plain, Southern Great Plain
Ireland	NUTS 2	Border, Midland and Western NUTS-II Region, Southern and Eastern NUTS-II Region
Italy	NUTS 1	Northwest Italy, Northeast Italy, Central Italy, South Italy
Latvia	NUTS 1	Latvia
Lithuania	NUTS 1	Lithuania
Netherlands	NUTS 1	Northern Netherlands, Eastern Netherlands, Western Netherlands, Southern Netherlands
Poland	NUTS 1	Region Centralny, Region Południowy, Region Wschodni, Region Północno-Zachodni, Region Południowo-Zachodni, Region Północny
Portugal	NUTS 2	Norte Region, Algarve, Centro Region, Lisboa Region, Alentejo Region
Romania	NUTS 1	Macroregion one, Macroregion two, Macroregion three, Macroregion four
Slovak Republic	NUTS 2	Bratislava Region, Western Slovakia, Central Slovakia, Eastern Slovakia
Slovenia	NUTS 2	Eastern Slovenia, Western Slovenia
Spain	NUTS 2	Galicia, Asturias, Cantabria, Basque Community, Navarre, La Rioja, Aragon, Madrid, Castile-Leon, Castile-La Mancha, Extremadura, Catalonia, Valencian Community, Andalusia, Region of Murcia
Sweden	NUTS 2	Stockholm, East Middle Sweden, Småland and the islands, South Sweden, West Sweden, North Middle Sweden, Middle Norrland, Upper Norrland
United Kingdom	NUTS 1	North East, North West, Yorkshire and the Humber, East Midlands, West Midlands, East of England, London, South East, South West, Wales, Scotland, Northern Ireland

Appendix 2. Results of the discriminant analysis

True groups: Cluster analysis	Classification according to the discriminant analysis					Total
	1	2	3	4	5	
Group 1	9 (100.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	9
Group 2	0 (0.00%)	27 (96.43%)	1 (3.57%)	0 (0.00%)	0 (0.00%)	28
Group 3	0 (0.00%)	0 (0.00%)	30 (96.77%)	1 (3.23%)	0 (0.00%)	31
Group 4	0 (0.00%)	0 (0.00%)	0 (0.00%)	27 (96.43%)	1 (3.57%)	28
Group 5	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (4.00%)	24 (96.00%)	25