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 impact regional performance. By analysing 121 European Union regions between 2012 and 2014, we find that quantity (Kirznerian) entrepreneurship negatively impacts regional performance, while this effect turns positive in the case of quality (Schumpeterian) entrepreneurship. Also, regions with a healthy entrepreneurial ecosystem have a greater capacity to materialize the effects of high business formation rates, regardless of their quality (Kirznerian entrepreneurship), while regions with weak entrepreneurial ecosystem may rely on innovative (Schumpeterian) entrepreneurs to compensate the absence of entrepreneurship support policies and increase their economic outcomes.

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, 2018; 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 at different development levels (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). 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). Yet, the analysis of the effect of

entrepreneurship on economic growth at regional level remains unaddressed.

Many studies claim that intermediate linkages (Wennekers & Thurik, 1999), or contextual factors (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. In this context, the Global Entrepreneurship Index (GEI) has emerged as a relevant EE metric that measures the entrepreneurship system as the complex interactions between entrepreneurial attitudes, abilities and aspirations at country level (Acs et al., 2014). Within the framework of the knowledge spillover theory, Lafuente, Szerb, and Acs (2016) found that GEI explains productivity differences across countries.

Entrepreneurship has been often invoked as a valid mechanism to boost territorial economic performance. Yet, different sources of heterogeneity—which we link to different types of entrepreneurship and to the strength of the entrepreneurial ecosystem at the regional level—may condition the relationship between entrepreneurship and territorial outcomes. Our paper attempts to shed light on the determinants of regional economic growth by connecting the entrepreneurial ecosystem and different types of entrepreneurial activity. More concretely, we study how the entrepreneurship system and different types of entrepreneurship impact employment growth and GVA per worker in 121 European Union regions.

Instead of connecting canonical entrepreneurship ratios (TEA) to territorial outcomes, we propose two entrepreneurship variables rooted in the Kirznerian and the neo-Schumpeterian approach (Aghion, Blundell, Griffith, Howitt, & Prantl, 2009) that measure different types of entrepreneurship. First, and following Kirzner (1973, p. 74), entrepreneurs contribute to the economy by mobilising resources and exploiting market opportunities, a process that we link to increases in the number of businesses in the economy (Kirznerian entrepreneurship). According to Schumpeter (1934, p. 66), the entrepreneurship function is associated with the introduction of disruptive technologies that create new value-adding input combinations that enhance the territories' productive capacity. In line with this argument, our second variable accounts for qualitative improvements in the regions' stock of firms by comparing the creation of high innovative firms and the innovation level of incumbent firms.

The analysis of the outcomes that flow from the connection between the entrepreneurial ecosystem and different types of entrepreneurship contributes to identify policy actions that can help optimise territories' available resources and, ultimately, lead to a greater territorial economic growth.

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, scholars in the entrepreneurial ecosystem (EE) field opened a new entrepreneurship research direction focused on the systemic connections that explain the emergence of high impact ventures. Initially oriented to practitioners, policy makers and stakeholders, the need for rigorous research, theory-based concept creation, solid methodology, and proper measurement have recently contributed to develop the EE approach (Alvedalen & Boschma, 2017; Brown & Mason 2017; Spigel, 2017; Stam, 2015).

Building on the regional development and the strategy literature, EE has its roots in other system type theories of industrial districts, innovation systems, and clusters (Acs et al., 2017; Stam & Spiegel 2017). While most conceptual approaches view the entrepreneurial environment as a bundle of different components, EE adopts a multi-context perspective that highlights the *self-reinforcing* forces, interdependencies, supporting effects, and forward and backward linkages among components (Cook, 2016; Malecki, 2018; Stam, 2015). The evolution of EE components, in particular institutions, takes longer time. This *path dependent* progress leads to the development of unique EE (Cook, 2016; Stam & Spiegel, 2017). *Spillovers* play an important role in locally embedded knowledge transmission (Qian, 2018).

Four distinctive features characterise EE research. First, EE differentiates the entrepreneurial environment (ecosystem) from entrepreneurial outputs. Out of the many types of entrepreneurial outputs the EE focuses on opportunity recognition activities that result in *high impact*, high ambitious start-ups[1] and neglects potentially marginal, non-growth, self-employment initiations (Acs et al., 2014; Stam, 2015). Second, the performance of the EE depends on the *interaction* between the entrepreneur, organisations and institutions (Alvedalen & Boschma, 2017). Third, the EE is *geographically bounded, place-based* (Audretsch & Belitski, 2017; Qian, Acs, & Stough, 2013). While the EE can be examined and measured at country level (Acs et al., 2014), agglomeration economies, networking and

spillover effects vital for the emergence of high impact start-ups are effective in smaller geographic units like cities or agglomeration zones. Finally, because of the uniqueness and the path dependent nature of EE, its development requires specific, bottom-up, tailor-made as opposed to general universal policies (Acs et al., 2014; Mason & Brown, 2014).

Among the many EE research directions, the GEI is probably the most useful approach as it provides theoretical base, and a novel methodology to measure country-level entrepreneurship (Acs et al., 2014). According to Acs et al. (2014, p. 119), 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*'. This definition resembles other EE definitions (Audretsch & Belitski, 2017; Qian et al., 2013; Spiegel, 2017).[2]

In this study, we proposed a modified version of GEI—that is, the REDI—to measure the entrepreneurial performance of 121 EU regions. Following the EE, the adjustment process; i.e. the movement from GEI to REDI, refers to changes in the institutional variables to reflect the regional forces of agglomeration, connectivity and clustering. Thus, REDI is a more appropriate and more precise measure of EE than GEI (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. While the individual components of REDI have been adjusted to the smaller territorial units but their content is the same as compared to GEI, the institutional components of REDI are much richer than those of GEI with its 16 institutional variables. 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 scholarly literature to identify 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) data availability over the period 2007-2014. A drawback of the REDI sub-indicators is that some important EE attributes are missing. While many dimensions are accurately captured (market, regulation, human capital, culture, networks, knowledge creation and dissemination, infrastructure, and finance) dimensions are mostly captured, there is no indicator on supporting services and mentoring, leadership. The structure of the REDI index and the assigned EE attributes are depicted in Table 1.[3]

--- Insert Table 1 about here ---

While EE scholars have primarily focused on the interrelation between system components, the identification and description of these connections have been largely sidelined. REDI 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. Most indicators are computed as the average of sub-indicators and most variables are calculated as the average of indicators assuming *additive* effects.[4] Notable exceptions include the computation of the Freedom indicator that results from 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 optimisation we equalise the marginal effect of each additional input over the 14 pillars and the 121 regions by using the Average Pillar Adjustment (APA) method. Underlying the APA method is the assumption that the normalised 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 than in Finance. APA corrects this distortion by equalising 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 equalised 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.[5]

The core idea of REDI is that regional system performance is ‘co-produced’ by its constituent elements, meaning that the 14 pillars are interrelated and all support the functioning of the EE. This implies that all pillars should be positively correlated with each other and they should also be positively correlated with the REDI. 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 focal region functions well or not. For each region this means that,

after equalising the averages of all pillars, the value of each pillar is penalised 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 utilising 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 the focal region from fully exploiting its entrepreneurial potential. The REDI complements other case-preferred EE approaches by taking a wider, bird-eye 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 down to those definitions focused on 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 impact has been debated (Audretsch & Fritsch, 2002; Lee, Florida, & Acs, 2004). Various factors have emerged 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 (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, 2015).

Different types of start-ups coexist in economies, and their overall effect also depends on their composition (Vivarelli, 2013). Moreover, the inverse relationship between the number of businesses and their quality (Fritsch & Schroeter, 2009) 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 leads to question the validity of combined, one-size-fits-all activity measures (Marcotte, 2013; Vivarelli, 2013). Entrepreneurial activity measures should be concept based; however, most metrics are ad hoc and have strong presumptions (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).[6] 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, the TEA measures the overall magnitude of entrepreneurial activity by standardizing it to the 18-64 year old population; however, it fails to capture the role of competition on entrepreneurship dynamics that should relate new businesses to existing ones (Boettke & Coyne, 2009; Kirzner, 1973).

Out of the many alternative GEM-based entrepreneurship measures (Levie, Autio, Acs, & Hart, 2014), 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 outcomes. 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 likely 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 (Vivarelli, 2013). Innovation has been invoked as a way to enhance the positive effects of competition (Aghion et al., 2009; 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 therefore propose a new quality- and a quantity-related measure of entrepreneurial activity that reflect the level of competition and innovation among new and incumbent ventures. 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 (new 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):

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

where, for each region (i = 1, …, 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, by comparing start-ups and incumbent firms this variable 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 indicate that the territory does not offer good business opportunities to

entrepreneurs. The main features of this Kirznerian-oriented entrepreneurship variable are opportunity alertness and profit exploitation (Kirzner, 1973). Although this measure includes all types of new businesses, it 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) the industry sector in which businesses operate (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):

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

where, for each region (i = 1, …, 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 constitutes an accurate measure of 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 the autarchy of uniform 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 quality of the entrepreneurial ecosystem and regional performance.

We differentiate 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. On the one hand, Kirznerian entrepreneurship emphasizes the function of entrepreneurship as a market discovery process in which entrepreneurs discover and exploit market failures (Kirzner, 1997, p. 71). New business entry intensifies competition by challenging the market position of established firms (Fritsch & Mueller, 2004). The exploitation of business opportunities arguably contributes to an efficient mobilization of resources in the economy (Kirzner, 1973). But, in a context 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 net effect could be negative (Vivarelli, 2013). On the other hand, Schumpeter conceptualises entrepreneurship as a special economic function in which inventions are transformed into innovations (Kirzner, 1973, p. 81). 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.

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). At the regional level, the EE constitutes the institutional setting backing entrepreneurial activity. Therefore, it seems plausible to argue that 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 if the focal region enjoys a supportive EE. Before we argued that in competitive environments Kirznerian entrepreneurship—which we link to higher rates of new businesses—may produce a negative net effect in the economy via high churning levels that deteriorate resource allocation (Vivarelli, 2013). Yet, a high quality entrepreneurial ecosystem may help alleviate resource allocation problems by promoting the efficient channelling of entrepreneurial outcomes to the economy (Szerb et al., 2017). Thus, the entrepreneurial ecosystem creates the conditions to materialize the effects of high firm formation rates (Kirznerian entrepreneurship).

The proposed effect of Schumpeterian entrepreneurship on regional performance also depends on the innovativeness of existing businesses. Aghion, Bloom, Blundell, Griffith, and Howitt (2005) reveal that innovation can stem both from increased entry rates of innovative (Schumpeterian) firms, and from the response of incumbent firms to business formation rates. In the case of the former effect, a healthy entrepreneurial ecosystem contributes to channel innovations to the market, which will likely translate into high rates of new innovative firms (Schumpeterian entrepreneurship), in terms of newness of product and technology, as well as industry membership (Szerb et al., 2017). In the case of the latter, the reaction of incumbent firms is conditioned by their distance to the technological frontier: ‘frontier firms’ will likely make additional efforts to innovate (‘escape competition effect’), while ‘laggard firms’ that are far from the frontier face further difficulties and have no incentives to innovate (‘discouragement effect’) (Aghion et al., 2005; Aghion et al., 2009). These two effects suggest that an increase in the stock of Schumpeterian entrepreneurs (numerator in equation (2)) may contribute to the innovativeness of incumbent firms, thus improving the quality of the regions’ business stock—in terms of the newness of new ventures—and, ultimately, regional performance. Thus, we complement our previous by formulating 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.

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. The first version of the REDI index based on the 2007-2011 GEM APS dataset was created by Szerb et al (2013), and with the support of the European Union ('Financial and Institutional Reforms to build an Entrepreneurial Society' (FIRES), Horizon 2020 project), the latest REDI scores with an additional extended time period 2012-2014 data were created 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 (2 regions), Czech Republic (1 region), Denmark (5 regions), Estonia (1 region), Finland (4 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 (5 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 2.

This study measures territorial performance via two variables. First, we use a measure of economic production, that is, the average gross value added (GVA) per worker (2012-2014) which represents, for each region, the total value of goods and services produced by workers of industry sectors. Second, we employ the employment growth rate between 2012 and 2014.[7]

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 previous periods. In this study, new business refers to those firms with less than 18 months of market experience, and equations (1) and (2) are used to compute the quantity- and quality-related entrepreneurship measures, respectively.

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 average unemployment rate (2012-2014) and the average Gross Domestic Product (GDP) per capita (2012-2014) as indicators of regional economic development (Lafuente et al., 2016). Descriptive statistics are presented in Table 2 and the associated correlation matrix is in Appendix 3.

--- Insert Table 2 about here ---

Given the properties of the dependent variables, we employ OLS regression models to estimate the effect of the entrepreneurial ecosystem and the types of entrepreneurship on regional performance. The full model used in this study has the following form:

$$\begin{aligned}\text{Performance}_i &= \beta_0 + \beta_1 \text{REDI}_i + \beta_2 \text{Kirznerian entrepreneurship}_i \\ &+ \beta_3 \text{Schumpeterian entrepreneurship}_i + \beta_{12} \text{REDI}_i \times \text{Kirznerian entrepreneurship}_i \\ &+ \beta_{13} \text{REDI}_i \times \text{Schumpeterian entrepreneurship}_i + \beta_4 \text{Control variables}_i + \varepsilon_i\end{aligned} \quad (3)$$

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

6. 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 Table 3, 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 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). The average VIF for model 1 is 1.82 (range: 1.05-4.01). The results for this diagnostic test do not raise collinearity concerns.

--- Insert Table 3 about here ---

From model 1 in Table 3 we observe that the variable linked to the entrepreneurial ecosystem (REDI) consistently positively impacts GVA per worker and employment growth. This result is in line 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 quality of the regional entrepreneurial ecosystem and territorial performance outcomes.

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 performance, excepting the case of the base model when employment growth is the dependent variable (model 1). These results are in line with our second hypothesis (**H2**) that states that Kirznerian entrepreneurship negatively impacts regional performance. Also, the results show how the effect of the Schumpeterian entrepreneurship variable is positive and significant for the analysed regional outcomes. The results confirm our hypothesis 3 (**H3**) that proposes a positively relationship between Schumpeterian entrepreneurship and regional performance.

The results in model 2 of Table 3 show that the interaction term between the REDI levels and Kirznerian entrepreneurship is positive and significant. 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 contributes 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 and channel 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 Kirznerian entrepreneurship. Consequently, we support hypothesis 4 (**H4**) that states that the regional entrepreneurship system moderates the relationship between Kirznerian entrepreneurship and regional performance.

The interaction effect between the REDI and Schumpeterian entrepreneurship is negative and statistically significant when the GVA per worker is the dependent variable, while this variable turns not significant in the employment growth model. The result for the GVA per worker points 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 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 shortage of supportive entrepreneurship policies 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. The results underline the employment enhancing capacity of high quality entrepreneurship (model 1 in Table 3). However, we find that the interaction term between the REDI score and the Schumpeterian entrepreneurship variable is not significant.

This implies that the reported positive effect of Schumpeterian entrepreneurship on employment growth is not conditioned by the quality of the entrepreneurial ecosystem, that is, Schumpeterian entrepreneurship generates jobs regardless of the strength of the regional entrepreneurial ecosystem. Based on these results, we cannot support our last hypothesis (**H5**) that proposes that the regional system of entrepreneurship moderates the positive relationship between Schumpeterian entrepreneurship and regional performance.

7. Concluding remarks, implications and future research lines

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 canonical 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 EU regions. The results of this study tend to go against quantity-based entrepreneurship support policies, 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). Additionally, the results of this study fuel the debate on how to operationalise the entrepreneurial ecosystem (EE) at the territorial level. We argue that the mismatch between the analysed concept (EE) and the selected variables used to measure it may explain the unclear relationship between country-level entrepreneurship and territorial outcomes found in previous work (e.g., Bruns, Bosma, Sanders, & Schramm, 2017; Nightingale & Coad, 2014). In this sense, the REDI score—that captures the systemic relationships between entrepreneurs and markets—and the proposed Kirznerian (quantity) and Schumpeterian (quality) entrepreneurship variables represent valid metrics that can contribute both to operationalise territories' EE and different dimensions of entrepreneurship,

respectively; and to better understand how the EE shape territorial outcomes.

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. Additionally, our results suggest that Schumpeterian entrepreneurship may act as a substitute for the shortage of an appropriate entrepreneurial ecosystem. 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. This aspect is of crucial importance as it suggests that, in EU regions with a poor entrepreneurial ecosystem, policy makers may foster regional performance by re-directing resources to innovation-driven entrepreneurship.

It must, however, be mentioned a series of limitations to the present study that, in turn, represent avenues for future research. First, our study employs two measures focused on quantity and quality aspects of entrepreneurship. Future studies should evaluate whether other entrepreneurship variables—e.g., linked to the creation of high growth firms or to the industry configuration of the newly created firms—contribute to explain performance differences across territories. A similar argument holds for the analysed territorial outputs (e.g. Aghion et al 2017, Audretsch et al 2015). Future work should verify the role of the entrepreneurial ecosystem and different types of entrepreneurship on other, equally relevant, territorial outcomes. Second, and in a closely related manner, future studies could expand the variables used in the REDI score by including factors related to supporting services, mentoring or leadership in the analysis. Additionally, the computation of the REDI score (or other similar index numbers) in other geographic contexts—e.g., Africa, Asia, and North and Latin America—constitutes a challenge for future research on entrepreneurial ecosystems that can contribute both to expand the geographic scope of the REDI score and to better understand

the drivers and economic consequences of territories' entrepreneurial ecosystem. Finally, the findings in this study are based on the cross-sectional analysis of 121 EU regions. Obviously, we cannot evaluate the short- and long-run effects of entrepreneurship over regional outcomes, nor do we assess the causality between entrepreneurship and territorial outcomes. Nevertheless, the results presented in this study have a strong intuitive and conceptual appeal, and are open to future verification. In this sense, specifically designed future work should evaluate our arguments on the determinants of regional performance using longitudinal data.

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Endnotes

1. Startups can be autonomous or employee initiated, intrapreneurial (Stam, 2015).
2. For a more comprehensive summary about EE definitions see Malecki (2018).
3. The detailed description of the REDI components and the calculation methodology is presented in Szerb et al. (2017), and can be found in Appendix A.
4. For example, in the Quality of education institutional variable there are four sub-indicators: three of them come 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.
5. For more details about the APA methodology see Acs et al. (2014) and Szerb et al. (2017).
6. 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.
7. Regression results using the GDP per capita growth rate as dependent variable are inconclusive. See Appendix 4.

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List of Tables

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

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

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

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.

Table 3. Regression results

	Gross value added per worker		Employment growth	
	Model 1	Model 2	Model 1	Model 2
REDI	0.0075*** (0.0023)	0.0090** (0.0044)	0.0012** (0.0002)	0.0010*** (0.0003)
Kirznerian entrepreneurship	–0.8959*** (0.2599)	–2.5077*** (0.7001)	–0.0021 (0.0171)	–0.0921** (0.0438)
Kirznerian entrepreneurship X REDI		0.0362** (0.0142)		0.0020** (0.0009)
Schumpeterian entrepreneurship	0.0757* (0.0443)	0.3632*** (0.1214)	0.0069*** (0.0025)	0.0161* (0.0096)
Schumpeterian entrepreneurship X REDI		–0.0075*** (0.0022)		–0.0002 (0.0002)
Capital dummy	–0.3134*** (0.0539)	–0.3142*** (0.0530)	0.0059* (0.0031)	0.0063** (0.0029)
Population density	–0.0134 (0.0178)	–0.0097 (0.0185)	0.0011 (0.0016)	0.0013 (0.0016)
Unemployment rate	2.5184*** (0.5302)	2.0657*** (0.5432)	–0.0842** (0.0390)	–0.1056*** (0.0397)
GDP per head	0.9557*** (0.0913)	0.8747*** (0.0934)	–0.0367*** (0.0072)	–0.0411*** (0.0074)
Country dummies	Yes	Yes	Yes	Yes
Intercept	0.7696*** (0.2741)	0.9671*** (0.3571)	0.0645*** (0.0181)	0.0874*** (0.0247)
F-test	110.93***	93.71***	23.56***	18.82***
Adjusted R2	0.7796	0.8160	0.6464	0.6551
RMSE	0.1431	0.1938	0.0117	0.0156
Average VIF	1.82	6.93	1.82	6.93
Observations	121	121	121	121

Robust standard errors are presented in brackets. The UK is the omitted country dummy variable. *, **, *** indicate significance at the 10%, 5% and 1%, respectively.

Appendices

Appendix 1. The Regional Entrepreneurship and Development Index (REDI) calculation methodology

In the constructing the index we followed eight points:

1 ***The selection of variables:*** We start with the variables that come directly from the original sources for each region involved in the analysis. The variables can be at the individual level (personal or business) that are coming from the GEM Adult Population Survey or the institutional/environmental level that are coming from various other sources. Altogether we use 14 individual and 14 institutional variables. Individual data are calculated from the 2007-2011 pooled dataset. In the case of the institutional variables we used the most recent available data on 31. December 2013. Altogether, we have data for a mix of 125 NUTS1 and NUTS2 regions.

2 ***The construction of the pillars:*** We calculate all pillars from the variables using the interaction variable method; that is, by multiplying the individual variable with the proper institutional variable. This results pillar values for all the 125 regions.

$$z_{i,j} = IND_{i,j} * INS_{i,j} \qquad \text{(F1)}$$

for all j= 1 ... k, the number of individual and institutional variables
$IND_{i,j}$ is the original score value for region i and variable j individual variable
$INS_{i,j}$ is the original score value for region i and variable j institutional variable
$z_{i,j}$ is the original pillar value for region i and pillar j

3 ***Normalization:*** pillars values were first normalized to a range from 0 to 1:

$$x_{i,j} = \frac{z_{i,j}}{\max z_{i,j}} \qquad \text{(F2)}$$

for all j= 1 ... k, the number of pillars
where $x_{i,j}$ is the normalized score value for region i and pillar j
$z_{i,j}$ is the pillar value for region i and pillar j
$max\ z_{i,j}$ is the maximum value for pillar j

4 ***Capping:*** 95 All index building is based on a benchmarking principle. In our case we selected the 95 percentile score adjustment meaning that any observed values higher than the 95 percentile is lowered to the 95 percentile.

5 ***Average pillar adjustment:*** The different averages of the normalized values of the pillars imply that reaching the same pillar values require different effort and resources. Since we want to apply REDI for public policy purposes, the additional resources for the marginal improvement of the pillar values should be the same for all pillars. Therefore, we need a transformation to equate the average values of the components. Equation F2 shows the calculation of the average value of pillar j:

$$\bar{x}_j = \frac{\sum_{i=1}^{n} x_{i,j}}{n} \qquad \text{(F3)}$$

We want to transform the $x_{i,j}$ values such that the potential minimum value is 0 and the maximum value is 1:

$$y_{i,j} = x_{i,j}^k \qquad \text{(F4)}$$

where k is the "strength of adjustment", the k-th moment of X_j is exactly the needed average, $\bar{y}_j$. We have to find the root of the following equation for k

$$\sum_{i=1}^{n} x_{i,j}^k - n\bar{y}_j = 0 \qquad \text{(F5)}$$

It is easy to see based on previous conditions and derivatives that the function is decreasing and convex which means it can be quickly solved using the well-known Newton-Raphson method with an initial guess of 0. After obtaining k, the computations are straightforward. Note that if

$$\bar{x}_j < \bar{y}_j \quad k < 1$$
$$\bar{x}_j = \bar{y}_j \quad k = 1$$
$$\bar{x}_j > \bar{y}_j \quad k > 1$$

that is k be thought of as the strength (and direction) of adjustment.

6 ***Penalizing:*** After these transformations, the PFB methodology was used to create indicator-adjusted PFB values. We define our penalty function following as:

$$h_{(i),j} = min\, y_{(i),j} + (1 - e^{-(y_{(i)j} - min\, y_{(i),j})}) \qquad \text{(F6)}$$

where $h_{i,j}$ is the modified, post-penalty value of pillar j in region i
$y_{i,j}$ is the normalized value of index component j in region i
y_{min} is the lowest value of $y_{i,j}$ for region i.
i = 1, 2,……n = the number of regions
j= 1, 2,…….m= the number of pillars

7. The pillars are the basic building blocks of the sub-index: entrepreneurial attitudes, entrepreneurial abilities, and entrepreneurial aspirations. The value of a sub-index for any region is the weighted average of its average equalized pillars for that sub-index multiplied by a 100. The maximum value of the sub-indices is 100 and the potential minimum is 0, both of which reflect the relative position of a region in a particular sub-index.

$$ATT_i = 100 \sum_{j=1}^{5} h_{i,j} \quad \text{(F7a)}$$
$$ABT_i = 100 \sum_{j=6}^{9} h_{i,j} \quad \text{(F7b)}$$
$$ASP_i = 100 \sum_{j=10}^{14} h_{i,j} \quad \text{(F7c)}$$

where $h_{i,j}$ is the modified, post-penalty value of pillar j in region i
i = 1, 2,……n = the number of regions
j= 1, 2,…….14= the number of pillars

8. The super-index, the Global Entrepreneurship Index, is simply the average of the three sub-indices. Since 100 represents the theoretically available limit the GEDI points can also be interpreted as a measure of efficiency of the entrepreneurship resources

$$REDI_i = \frac{1}{3}(ATT_i + ABT_i + ASP_i) \quad \text{(F8)}$$

where $REDI_i$ is the regional entrepreneurship and development index score of region i.
i = 1, 2,……n = the number of regions

Appendix 2. List of sampled regions

Country	**NUTS level**	**Regions**	**Sample (2012-2014)**
Austria	NUTS 1	Eastern Austria, Southern Austria, Western Austria	9102
Belgium	NUTS 1	Brussels-Capital Region, Flemish Region, Walloon Region	6015
Croatia	NUTS 2	Continental Croatia, Adriatic Croatia	6000
Czech Republic	NUTS 1	Czech Republic	4967
Denmark	NUTS 2	Hovedstaden, Sjælland, Southern Denmark, Midtjylland, Nordjylland	4225
Estonia	NUTS 1	Estonia	6365
Finland	NUTS 2	West Finland, Helsinki-Uusimaa, South Finland, North & East Finland	6043
France	NUTS 1	Île-de-France, Bassin Parisien, Nord, Est, Ouest, Sud-Ouest, Centre-Est, Méditerranée	8010
Germany	NUTS 1	Baden-Württemberg, Bayern, Berlin, Brandenburg, Bremen, Hamburg, Hessen, Mecklenburg-Vorpommern, Niedersachsen, Nordrhein-Westfalen, Rheinland-Pfalz, Saarland, Sachsen, Sachsen-Anhalt, Schleswig-Holstein, Thuringen	14607
Greece	NUTS 1	Voreia Ellada, Kentriki Ellada, Attiki	5286
Hungary	NUTS 2	Central Hungary, Central Transdanubia, Western Transdanubia, Southern Transdanubia, Northern Hungary, Northern Great Plain, Southern Great Plain	6003
Ireland	NUTS 2	Border, Midland and Western NUTS-II Region, Southern and Eastern NUTS-II Region	5801
Italy	NUTS 1	Northwest Italy, Northeast Italy, Central Italy, South Italy	5390
Latvia	NUTS 1	Latvia	4000
Lithuania	NUTS 1	Lithuania	6003
Netherlands	NUTS 1	Northern Netherlands, Eastern Netherlands, Western Netherlands, Southern Netherlands	8730
Poland	NUTS 1	Region Centralny, Region Południowy, Region Wschodni, Region Północno-Zachodni, Region Południowo-Zachodni, Region Północny	6004
Portugal	NUTS 2	Norte Region, Algarve, Centro Region, Lisboa Region, Alentejo Region	6009
Romania	NUTS 1	Macroregion one, Macroregion two, Macroregion three, Macroregion four	6007
Slovak Republic	NUTS 2	Bratislava Region, Western Slovakia, Central Slovakia, Eastern Slovakia	5987
Slovenia	NUTS 2	Eastern Slovenia, Western Slovenia	6016
Spain	NUTS 2	Galicia, Asturias, Cantabria, Basque Country, Navarre, La Rioja, Aragon, Madrid, Castile-Leon, Castile-La Mancha, Extremadura, Catalonia, Valencian Community, Andalusia, Region of Murcia	64200
Sweden	NUTS 2	Stockholm, East Middle Sweden, Småland and the islands, South Sweden, West Sweden, North Middle Sweden, Middle Norrland, Upper Norrland	7477
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	15024

Appendix 3. Correlation matrix

		1	2	3	4	5	6	7	8	9
1	GVA per worker (ln)	1								
2	Employment growth	0.0212	1							
3	GDP growth	-0.5024***	0.2782***	1						
4	REDI score	0.7051***	0.4589***	-0.1375	1					
5	Kirznerian entrepreneurship	-0.2689***	0.1888**	0.3153***	0.0582	1				
6	Schumpeterian entrepreneurship	0.1209	0.1876	-0.0153	0.1340	-0.0790	1			
7	Capital dummy	0.0441	0.1041	0.1140	0.2859***	0.2622***	-0.1850**	1		
8	Population density (ln)	0.2348***	0.2027**	0.1553*	0.4308***	0.2321**	-0.0226	0.3733***	1	
9	Unemployment rate	-0.0998	-0.5551***	-0.1598*	-0.4982***	-0.1665*	-0.1342	-0.0285	-0.1349	1
10	GDP per head (ln)	0.5122***	0.1241	-0.2868***	0.7919***	-0.0766	0.1138	0.3590***	0.4620***	-0.3281***

*, **, *** indicate significance at the 10%, 5% and 1% level, respectively.

Appendix 4. Regression results: The relationship between entrepreneurship and GDP growth

	Gross Domestic Product (GDP) growth (2012-2014)	
	Model 1	Model 2
REDI	0.0010** (0.0004)	0.0003 (0.0009)
Kirznerian entrepreneurship	0.0645 (0.0393)	0.0491 (0.1019)
Kirznerian entrepreneurship X REDI		0.0005 (0.0020)
Schumpeterian entrepreneurship	–0.0004 (0.0071)	–0.0287 (0.0305)
Schumpeterian entrepreneurship X REDI		0.0006 (0.0005)
Capital dummy	0.0179** (0.0089)	0.0192** (0.0091)
Population density	–0.0024 (0.0044)	–0.0025 (0.0045)
Unemployment rate	–0.2660*** (0.0898)	–0.2623*** (0.0982)
GDP per head	–0.0486*** (0.0129)	–0.0496*** (0.0148)
Country dummies	Yes	Yes
Intercept	0.1658*** (0.0375)	0.2028*** (0.0691)
F-test	9.71***	9.39***
Adjusted R2	0.5103	0.5075
RMSE	0.2372	0.2378
Average VIF	1.82	6.93
Observations	121	121

Robust standard errors are presented in brackets. The UK is the omitted country dummy variable. *, **, *** indicate significance at the 10%, 5% and 1%, respectively.