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JEL: L26, P48, R11, R12
Original scientific article
https://doi.org/10.51680/ev.35.1.1

Received: May 20, 2021
Revision received: November 11, 2021
Accepted for publishing: December 16, 2021

REGIONAL EARLY-STAGE ENTREPRENEURSHIP IN THE EUROPEAN UNION*

Abstract

Purpose: Entrepreneurship is often viewed as a driver of the global economy. However, previous research on the relationship between entrepreneurship and economic growth shows contradictory results depending on the research settings. The purpose of this paper is to investigate how early-stage entrepreneurship - including only enterprises that are less than three and a half years old - affects regional economic growth in the European Union.

Methodology: The methodology includes three methods: bivariate correlation, fixed effects regression with region and time fixed effects and spatial fixed effects regression. The panel sample consists of 273 NUTS 2 regions between 2008 and 2017.

Results: The results support the hypothesis of this research and show that early-stage entrepreneurship has a mild positive effect on the economic growth of European regions. However, the potential bidirectional nature of this relationship obliterates the ability to comment on the causality of this link. The percentage of people in the active population employed in human resources in science and technology and gross fixed capital formation have a significant and impactful effect on regional GDP.

Conclusion: The conclusion can be drawn that the effect of early-stage entrepreneurship on regional economic growth is conditioned by the population density of the region. Although these results show that enterprises founded in densely populated areas such as cities and metropolitan areas tend to have a larger effect on the regional economy, the results are ambiguous.

Keywords: Entrepreneurship, regional economic growth, EU NUTS 2, spatial analysis

1. Introduction

Until half a century ago, economic policy makers did not sufficiently recognise entrepreneurship as the driver of the economy. More recently, many studies have examined the impact of entrepreneurship and small and medium-sized enterprises on overall economic and social impacts. Due to the poor state of affairs following the great global financial crisis, with the aim of making the European economy more competitive and resilient to external eco-

* The research is based on Mateo Ivan Radman's Master's thesis entitled "Early-Stage Entrepreneurship and Regional Economic Growth in the European Union". It was defended on 15 June 2020 at the Utrecht University in the Netherlands.

nomic shocks, the European Commission (2013) decided to amend its economic policy and "reignite the entrepreneurial spirit in Europe" by introducing a review of the Small Business Act and the Action Plan 2020, which are expected to support entrepreneurs around the EU. According to Eurostat (2019), SMEs create four million jobs a year in the European Union and represent the largest body of employers. By giving such importance to the promotion of entrepreneurial activity and knowledge production over the past three decades, politicians, policy makers and scientists have contributed to the creation of a large number of research available today on this topic. In general, entrepreneurship has created a great image and is considered an accelerator of the economy (Acs et al., 2012; Acs et al., 2008; Aparicio et al., 2016).

Although there is a well-documented link between entrepreneurship and economic growth (OECD, 2019), the magnitude of this effect varies from country to country and from region to region. Today, numerous studies can be found that investigate the impact of entrepreneurship on the economic efficiency of neighbourhoods, regions, nations, and even continents (Wennekers & Thurik, 1999; Mitra, 2020). The impact of entrepreneurship on regional development is a very broad and interdisciplinary field that can be studied from multiple perspectives (Schumpeter, 1934; Romer, 1986; Lockett & Wright, 2005).

Historically, Birch (1981) found that two-thirds of all the net new jobs created (out of a total of 5.6 million businesses between 1969 and 1976) were created by small firms with twenty or fewer employees, and about 80% were created by firms with 100 or fewer employees. Furthermore, Birch reports that not all small businesses are job creators, but many job creators are relatively young start-ups. About 80% of the net new jobs are created by businesses four years old or younger. Recent research (Hallak & Harasztosi, 2019) at the level of EU member states shows that even though young small firms are not the largest contributors, their contribution to job creation amounts to 40%, which is far above their share in total employment, which is 15%. However, an overall decline in start-up firms in employment has been observed. Similar results were obtained by Criscuolo et al. (2014). An analysis of OECD countries showed that the contribution to job creation of young small firms is the largest, but this contribution decreases when looking at firms older than 5 years. However, it is important to note that this is subject to the country-specific environment firms are located in.

The explanation with the most evidence of the cause of the positive impact of entrepreneurship on regional growth is the claim that high-tech firms significantly improve regional economic growth (Audretsch & Fritsch, 2002). In doing so, according to Fritsch (2013), only high-quality start-ups generate value, as opposed to those that deliver already available products using the same technology as existing companies. Research conducted in Denmark (Eklund, 2020) shows that higher growth is associated with younger companies, human capital measured by the number of highly educated, especially organisational capital (including both management and marketing investments), and ICT capital assets. New high-potential firms, that is, those using new technology, are more prevalent in "R&D rich" countries, Reynolds et al. (2002). Audretsch & Fritsch (2002) and Fritsch (2013) suggest that quality is more important than the number of start-ups. The success of high-tech companies in one region attracts even more human capital and people move to that region to gain knowledge from those who have already started their own business (Porter & Stern, 2001).

According to Bosma et al. (2012), the regional emergence of start-up companies is motivated by regional norms and values that stimulate regional economic growth, which brings individual regions to a location advantage. Moreover, according to Bosma et al. (2020), entrepreneurial activity takes place within the specific context of a given environment, with its own unique social, cultural and economic characteristics. Reynolds et al. (1994) and Audretsch et al. (2015) argue that population growth and population density can positively affect the number of entrepreneurs and economic growth in regions caused by interaction and knowledge exchange. More precisely, Reynolds et al. (2002) and Linan & Fernandez-Serrano (2014) point out that firms in an early stage of development tend to have a positive impact on regional economies.

The aim of this paper is to investigate whether entrepreneurship leads to economic growth of European regions at an early stage. The research intends to fill a gap in the current literature in several ways. Firstly, early-stage entrepreneurship that takes into account the size and maturity of a firm is included in the analysis, so the results of this study are ex-

pected to be more robust and accurate. Secondly, the analysis reveals whether densely populated areas affect the size of the relationship between entrepreneurship and regional economic growth. The ultimate goal is to find evidence to support the hypothesis that early-stage entrepreneurship, measured by the number of companies under 3.5 years of age, causes regional economic growth in the EU-28. The analysis is based on a sample of 273 NUTS 2 regions from 2008 to 2017.

Several control variables were used in the paper, i.e. Human resources in science and technology, Percentage of people with tertiary education, Gross fixed capital formation, Percentage of economically active population, Population density and Intramural R&D expenditure, which are expected to be positively related to Regional GDP per capita.

Given that a large number of authors have concluded that the development of entrepreneurship within a region depends on its social, cultural and economic characteristics, we call for further research in the domain of political and institutional environment to focus on exploring whether such differences exist in East-West or the new-old Member State perspective.

2. Regional entrepreneurship

In the first few decades of the last century, the world was dominated by large corporations and companies that employed thousands of people. The central thought of that time was that the development of both society and the economy is shaped by physical capital (Solow, 1957). According to Audretsch (2018), physical capital and unskilled labour remained the most influential factors in virtually every research, and the only thing that varied is the unexplained residual in growth rates which was attributed to the fluctuations in technological advancement across countries and over time. Like Romer (1986), other studies also support the knowledge-based production function and Romer's theory of endogenous growth (Lucas, 1988; Acs & Audretsch, 1990). Acs et al. (2008) and Boschma (2005) show that new small businesses tend to be located near incumbent companies or sources of knowledge such as universities and science parks. Cross-industry and cross-regional competitiveness drives regional growth of one region and in this process it might hinder the growth of another (Audretsch et al., 2006). In the process of spillover, Boschma (2005) reports that knowledge remains tacit to the region. It does not move freely across space as it was believed in the past which is quite contradictory to globalisation and the rise of the Internet.

Two general levels can be identified that explain the differences in regional entrepreneurship: regional and individual (Chell et al., 1991; Lee et al., 2004; Runco et al., 2011; Batchelor & Burch, 2012). According to Fischer & Nijkamp (2019), while a lot of attention is paid to the characteristics of individuals, e.g. the Global Entrepreneurship Monitor - GEM, much of the research and discussion about what causes growth of entrepreneurial activity neglects the importance of the regional environment. At the macro level, Malecki (1997) points out that the entrepreneurial environment is defined as a socio-economic, political, infrastructural and market environment, crucial for entrepreneurship, but cultural characteristics also play a significant role because they reflect the way of doing business (Roberts, 1991; Woolcock, 2001). Glaeser (2011) concludes that metropolitan regions are the most optimal form of coexistence, where innovation, human capital, and a good entrepreneurial climate have almost no boundaries.

However, Acs and Storey (2004) show that many studies do not provide convincing evidence of the effect of an increase in the number of start-ups on regional growth. Stearns et al. (1995) and O'Reilly & Hart (2005) argue that the level of entrepreneurship varies from region to region, but the relationship between place and decision to engage in entrepreneurship remains unclear (Fritsch & Mueller, 2004). Despite all the evidence, very little is known about the mechanisms of how entrepreneurship affects economic growth taking into account regional differences. Therefore, according to Capello & Lenzi (2016), the impact of entrepreneurship on regional growth should be studied in greater detail.

3. Methodology and data

Guided by the research and theoretical contribution presented above, this paper assumes that entrepreneurship at an early stage causes higher economic growth. The reason for this is that the greater concentration of new companies located in the same area creates numerous benefits for the economy and residents in the region.

Total early-stage entrepreneurship denotes new companies younger than 3.5 years, GEM (2013). The number of firms that are in the "first" phase of entrepreneurship in NUTS2 regions was used instead of the number of entrepreneurs.

3.1 Methodology

In order to investigate the relationship between early-stage entrepreneurship and regional economic growth, two methods are employed: fixed effects regression with individual and time effects including the time-lag structure of the independent variable, and spatial econometric analysis including both a temporal and a spatial lag of independent variable X. The Breusch-Pagan LM test suggested the use a fixed or random effect model (Herwartz, 2006) of the panel data instead of the OLS model. The Hausman test (Hausman, 1978) showed that the use of fixed effects was better and more efficient ($p<0.01$). Modelling the regression of fixed effects was preceded by a check to include temporal effects and/or individual (regional) effects, performed by a two-way Lagrange Multiplier test for balanced panels, where statistically significant results recommend the use of both individual and time effects ($p<0.01$) (Lee & Yu, 2010). Choropleth charts were used as regional descriptive statistics.

Changes that occur in the economy as a result of starting a company are a long-term process, hence the time-lag structure is used. Carree & Thurik (2008) tested for the three periods in the time-lag structure and found evidence that the lags influenced their results on three different economic measures: GDP, labour productivity, and employment growth. Fritsch & Mueller (2004) explain that the third and the sixth year of existence correspond to the peak negative and the peak positive effect of new enterprises on regional economic growth, respectively.

In addition to the time-lag model, the spatial effect among European regions was also controlled (see Fujita & Thisse, 2002; Krugman, 1991; Guerrero et al., 2015). In order to take into account spatial spillovers across regions, due to its simplicity and the Hausman endogeneity test (Hill et al., 2018), which can identify the probability of endogenous variables in the model, the spatial econometric model called the spatial lag of X (SLX) was introduced, which empirically assesses the strength of this overflow (Vega & Elhorst, 2015; Capello & Lenzi, 2016). Additionally, this model includes the temporal lag of the independent variable.

Therefore, the final model is a combination of the econometric specification of the fixed effects SLX model with individual and time effects.

$$\begin{aligned}\ln(GDPpc_{it}) = {} & \alpha + \beta_1 \ln(Enterprises_{it}) \\ & + \beta_2 \ln(Enterprises_{it-3}) \\ & + \beta_3 \ln(Enterprises_{it-6}) \\ & + (\beta_4 \ln(Tertiary\ education_{it}) \\ & + \beta_5 \ln(HRST_{it}) + \beta_6 \ln(Capital_{it}) \\ & + \beta_7 \ln(Economic\ activity_{it}) \\ & + \beta_8 \ln(Population\ density_{it}) \\ & + \beta_9 \ln(R\&D\ Expenditure_{it}) \\ & + \ln(WEnterprises)\theta + \mu_i + \lambda_t + \varepsilon_{it}\end{aligned}$$

$i = 1, 2, ..., 273$

$t = 1, 2, ..., 10$

where i stands for any NUTS 2 region in the EU, t stands for the period (year) between 2008 and 2017, $\ln(GDPpc_{it})$ represents the natural log of GDP *per capita* for any given individual region i in any given year t, and the beta coefficient parameters are to be estimated in regression. $Enterprises_{it}$ is the independent variable which is a proxy for early-stage entrepreneurship. It is already by definition lagged forward by three years (see Table 1). $Enterprises_{it-3}$ and $Enterprises_{it-6}$ are additional three-year and six-year time-lagged independent variables, as suggested by the time-lag structure. *WEnterprises* is the spatially lagged independent variable. Control variables are θ, which represents the spatial effect associated with SLX, μ, which is a region-specific fixed effect, and λ_t, which is a time-specific fixed effect. ε_{it} is an error term.

3.2 Data and variables

This research uses the most recent NUTS 2 classification of 2016. The sample includes 273 NUTS 2 regions in the EU-28 in the period between 2008 and 2017, excluding 8 overseas and very distant territories (Açores, Madeira, Martinique, Guadeloupe, Canarias, Mayotte, La Réunion and Guyane). The sample includes the UK since it was still a member state of the European Union in the period of interest. Data were obtained solely from Eurostat to avoid potential bias in the amendment of the NUTS 2 classification across the years.

Table 1 Variables in the study

	Variable name	Eurostat code
Dependent variable	Regional GDP per capita [log GDPpc] (log)	nama_10r_2gdp
Independent variable	Number of regional enterprises founded in t-3 and still active in t (number of three-year-old enterprises) [N enterprises] (log)	bd_hgnace2_r3 (indicator: V11943)
Control variables	Percentage of people with tertiary education [Tertiary education] (log)	edat_lfse_04
	The number of people in Human Resources in Science and Technology (HRST) in high-tech (percentage of the active population) [hrst] (log)	hrst_st_rcat
	Gross fixed capital formation (in millions of EUR) [Capital] (log)	nama_10r_2gfcf
	Economic activity rate relative to the population (in percentage) [Economic activity] (log)	lfst_r_lfp2actrt
	Population density (people per square kilometre) [Population density] (log)	demo_r_d3dens
	Intramural R&D expenditure (in billions of EUR) [R&D expenditure] (log)	rd_e_gerdreg

Note: Where applicable, measurement units are reported in round brackets. Variable abbreviations that are used throughout the paper are reported in square brackets.

Source: Authors

The panel collected from Eurostat was not complete. Roughly 8% of the panel was missing and were imputed semi-automatically using the 'mice' package in R. 'Mice' uses a very complex algorithm which performs multiple imputations by using fully conditional specification (van Buuren & Groothuis-Oudshorn, 2011). Therefore, the panel is complete with 2,730 observations. The entire panel is transformed using a natural logarithm.

The dependent variable is regional economic growth, which tends to have direct positive effects on the region and the quality of life of its inhabitants. The measure of regional economic growth is the natural logarithm of regional gross domestic product per inhabitant, ln ($GDPpc_{it}$).

Linan & Fernandez-Serrano (2014) investigated the impact of early-stage entrepreneurship on national economic growth using cross-sectional data. Early-stage entrepreneurship, which is a term coined by the GEM, refers to all enterprises which are less than 3.5 years old. The unit of observation is an early-stage enterprise, or namely, the number of enterprises born in *t-3* having survived to *t*. Early-stage entrepreneurship is expected to positively affect regional economic growth.

The analysis included control variables that are expected to have a positive influence on GDP of NUTS 2 regions. They are chosen subject to the conceptual model outlined above and the availability of Eurostat data. Human capital is an important factor for regional economic growth (Glaeser, 2011). Human capital is measured in this study by means of two variables. Firstly, as a percentage of the regional population holding a tertiary degree. Secondly, as the percentage of people aged between 15 and 74, who fulfil the condition of Eurostat's definition of HRST. Capital is one of the most influential factors that determine economic growth (Solow, 1957). It is measured by Eurostat as regional gross fixed capital formation. Moreover, economic activity refers to the percentage of people who are eligible to work and supply labour (Eurostat, 2019). Population density, which represents a number of people per km^2, is an important factor because densely populated regions with large cities are believed to be more efficient and have higher economic growth (Glaeser, 2011). Innovation, measured as intramural R&D expenditure, refers to an increase in the stock of knowledge and the application of that knowledge (OECD, 2015).

Table 2 Descriptive statistics

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Ln GDPpc	2730	10.02	0.60	8.04	9.70	10.42	12.33
N Enterprises	2730	7446	7650	139	2979	8960	67618
Tertiary education	2730	27.60	9.65	6.80	20.20	33.50	74.70
HRST	2730	39.75	9.79	12.90	32.70	45.60	81.80
Capital	2730	9539	11091	216.4	3449	11950	154285
R&D expenditure	2730	929	1576	63.30	113.02	1134	18664
Economic activity	2730	63.83	5.69	41.30	60.43	68.10	76.80
Population density	2730	464.36	1208	2.70	74.23	322.77	11357

Source: Authors

The data deviate a lot because of divergence between EU regions. Variables such as population density, the number of enterprises founded three years ago and still active, and intramural R&D expenditure have a standard deviation greater than the mean and the data suggest that the sample is remarkably diverse.

3.3 Space dimension

Analysis of data from 273 EU-28 regions shows the existence of spatial clusters and spatial heterogeneity. The largest cities are the hotspots and have the highest number of enterprises that are in the young business phase (less than 3.5 years). This is in line with scholars who argue that cities offer the best opportunity for business success (Glaeser, 2011). Patterns identified on the maps plotted show that there is spatial heterogeneity among NUTS 2 regions in the EU-28. It is also possible to observe Tobler's first law of geography (1970), which states that everything is related to everything else, but near things are more related than distant ones. The spatial effect should lose strength across larger distances.

Row-standardised spatial weights matrix W, which is based on spatial connections between regions, presents quantification of the spatial structure of NUTS 2 regions (Abreu et al., 2005). According to Smit (2017), the Gabriel matrix is a good choice for NUTS 2 regions since it does not allow a region to have neighbours and has the power of capturing remote territories and islands. The results of creating a spatial weight matrix show that there is no region without a link and 2 regions have only 1 link. The maximum number of links is 7 and there is an average of 4.17 links between every region.

Table 3 Summary statistics of weight matrices

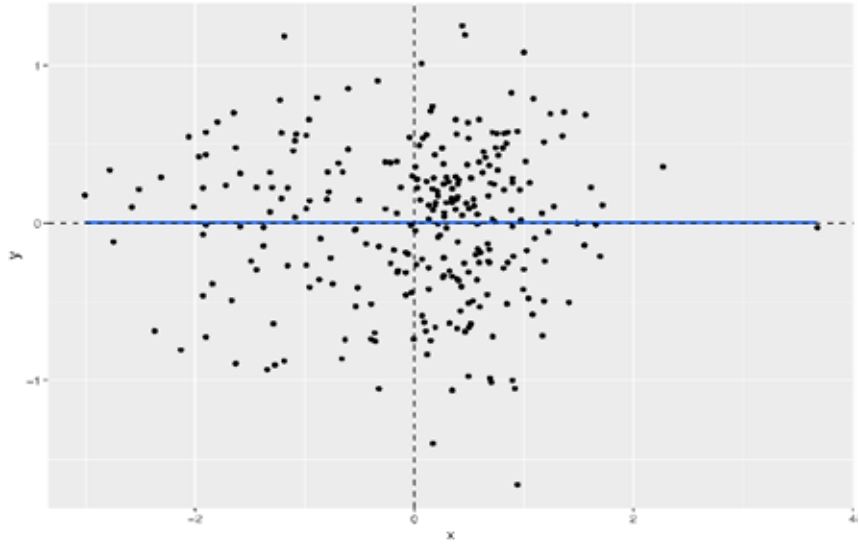
	Complete Gabriel Matrix	Within-country Matrix	Cross-border Matrix
Matrix dimensions	273 × 273	273 × 273	273 × 273
Number of links	1138	673	276
Minimum links	1	1	1
Maximum links	7	7	5
Average links	4.17	2.97	0.33

Source: Authors

In addition to the complete Gabriel matrix, two additional weight matrices were created, which separate within-country and cross-border neighbours to check whether border effects significantly change the results. The within-country matrix is calculated using the Hadamard product of the original Gabriel matrix and a binary matrix of equal dimensions. The cross-border matrix is then calculated as the Hadamard product of the original Gabriel matrix and the within-country matrix (Table 3).

The results of the Moran plot (Figure 1) suggest that most of the points are located on the right-hand side of the scatterplot, in the right upper and lower quadrant. Global Moran's I is statistically insignificant with the p-value of 0.39, which suggests that there is no spatial autocorrelation or spatial effect in this subsample.

Figure 1 Moran plot



Note: Standard deviations from the mean of the natural logarithm of GDP per capita are plotted on the x-axis.
Source: Authors

After unsatisfactory results from Global Moran's I, a plot of local indicators of spatial association (LISA) was made (Figures 2 and 3) according to (Anselin, 1995). Cluster maps show spatial association among EU regions based on *ln* ($GDPpc_{it}$) in 2008 and 2017. The plots are derived from the calculation of Local Moran's I. The results are presented on a coloured map and clusters are identified according to the similarity of the value with their neighbouring regions. Low-high and high-low combinations were not found. The results suggest that there are several statistically significant high-high and low-low clusters across the EU (Figures 2 and 3).

Figure 2 LISA map for ln ($GDPpc_{it}$) in the EU, by NUTS2 region for 2008

Figure 3 LISA map for ln ($GDPpc_{it}$) in the EU, by NUTS2 region for 2017

Note: LISA map was constructed using R.
Source: Authors

Overall, exploratory spatial analysis showed mixed results of the existence of spatial autocorrelation and spatial heterogeneity among NUTS 2 regions. On the one hand, Global Moran's I is insignificant. On the other hand, Local Moran's I and the local indicator of spatial association (LISA) show that there is a spatial effect present in the data (figures 1, 2 and 3). Consequently, spatial effects in spatial regressions were modelled and tested.

4. Empirical results and discussion

Table 4 shows the results of two-way fixed effect regression with the within estimator.

Table 4 Two-way fixed effect regression with the within estimator

	Dependent variable:		
	Regional gross domestic product per capita (log)		
	(1)	**(2)**	**(3)**
N enterprises (log)	0.015***	0.017***	0.051***
	(0.007)	(0.007)	(0.019)
Third lag of N enterprises (three-year-old enterprises three years ago) (log)		0.012	0.009
		(0.007)	(0.004)
Sixth lag of N enterprises (six-year-old enterprises six years ago) (log)		0.016	-0.003
		(0.019)	(0.004)
HRST (log)	0.138***	0.202***	0.199***
	(0.040)	(0.051)	(0.052)
Tertiary education (log)	-0.046*	-0.075**	-0.070**
	(0.028)	(0.030)	(0.033)
Capital (log)	0.283***	0.304**	0.303***
	(0.013)	(0.019)	(0.014)
Economic activity (log)	0.073	-0.069	-0.068
	(0.123)	(0.179)	(0.174)
Population density (log)	-0.010	-0.018	0.080**
	(0.009)	(0.012)	(0.034)
R&D expenditure (log)	0.465	-1.032	-0.889
	(0.638)	(0.547)	(0.940)
N Enterprises (log) *Population density (log)			0.008**
			(0.003)
Observations	2730	2724	2724
Adjusted R^2	0.108	0.187	0.191
Time-fixed effects	Yes	Yes	Yes
Region-fixed effects	Yes	Yes	Yes
LM spatial lag test	10.32***	11.79***	17.35***
LM spatial error test	4.35	5.01*	6.43

Note: Significance *p<0.1, **p <0.05, ***p<0.01. Standard errors are reported in parentheses.

Source: Authors

The first part of the analysis is a panel fixed effects regression with regional and time effects estimating three models. Model 1 introduces a time-lag structure consisting of two lagged independent variables enterprises *t-3* and *t-6* to the first model. Model 3 introduces an interaction variable between the number of enterprises in *t-3* and still active in *t* and population density. This way, it is possible to control for the effect of densely populated areas such as large cities on the impact of early-stage entrepreneurship on the regional economy (Audretsch et al., 2015). Results of fixed effects regression with individual and time effects on all three models (Table 4) show that the model, although acceptable (Mooi & Sarstedt, 2011), does not explain much of the variance in the dependent variable (adjusted R^2 = 0.11 do 0.19). The spatial error LM test yields insignificant results, except in model 2 ($p<0.1$). The LM spatial lag test shows statistical significance in all three models ($p<0.01$), which suggests that it is necessary to introduce a spatial lag.

These three models suggest that early-stage entrepreneurship positively affects regional economic growth ($p<0.01$).This result was expected and it is in line with previous literature on this topic (Capello & Lenzi, 2016). Every percentage increase in the total number of three-year-old enterprises is associated with 0.015, 0.017, and 0.051 percentage change in regional GDP*pc*, respectively. Translated, Île de France had 45,356 enterprises qualified as early-stage in 2008. However, in just 10 years that number has risen to 67,618. The difference between those two numbers is 22,262 and the percentage change is 49.08%. Therefore, regional GDP per capita of Île de France is expected to rise in these ten years by 0.74, 0.83, and 2.5%, respectively.

The percentage of the active population employed in HRST has a significant and positive impact on regional GDP*pc*. A10% increase in the share of HRST in the active population is expected to result in an approximately 2% increase (depending on the model) in regional GDP *per capita*. Since the HRST variable represents human capital in the region, evidence is in line with previous literature which suggests that human capital positively impacts the regional economy (Audretsch & Keilbach, 2008; Faggian et al., 2019).

Surprisingly, the percentage of people with tertiary education has a significant ($p<0.1$) negative effect on regional growth. Every increase by 10% in the share of the population holding a tertiary degree results in a circa 0.7% decrease in regional GDP. Considering that a percentage of people with tertiary education is a proxy for human capital, the results are undeniably opposed to prior research studies (Audretsch & Keilbach, 2008; Faggian et al., 2019). The results are contrary to the results of the relationship between HRST and GDP, which suggests that higher education alone is not a predictor of value-added.

Adding temporal lead variables to the model as part of the time-lag structure does not change the results at all. The results remain consistent throughout the analysis. Therefore, the results differ from Fritsch & Mueller (2004), who claim that the peak negative effect of the newly founded enterprise on regional growth is three years, and the peak positive effect six years after its inception. All in all, results of fixed effects regression with regional and time effects show that early-stage entrepreneurship is positively associated with regional GDP*pc*.

Table 5 Two-way fixed effect regression with the within estimator with a spatial lag of independent variable (FESLX)

	Dependent variable:		
	Regional gross domestic product per capita (log)		
	(1)	(2)	(3)
N enterprises (log)	0.014***	0.057***	0.015**
	(0.004)	(0.019)	(0.005)
Third lag of N enterprises (log)		0.011	0.013
		(0.009)	(0.011)
Sixth lag of N enterprises (log)		0.013	0.014
		(0.008)	(0.024)
HRST (log)	0.231***	0.193***	0.199***
	(0.041)	(0.051)	(0.061)
Tertiary education (log)	-0.088***	-0.072**	-0.120***
	(0.033)	(0.034)	(0.042)
Capital (log)	0.309***	0.360***	0.296***
	(0.013)	(0.015)	(0.022)
Economic activity (log)	-0.077	-0.088	-0.232
	(0.170)	(0.170)	(0.211)
Population density (log)	-0.010	0.080**	-0.020
	(0.002)	(0.030)	(0.014)
R&D expenditure (log)	-1.001	-0.886	0.773
	(1.110)	(1.103)	(1.219)
Spatially lagged N enterprises	0.016*	0.016	
	(0.009)	(0.008)	
N enterprises (log) * Population density (log)		0.008**	
		(0.002)	
Spatially lagged N enterprises (**within-border**)			0.014
			(0.008)
Spatially lagged N enterprises (**cross-border**)			0.008
			(0.006)
Observations	2730	2724	2724
Adjusted R^2	0.118	0.207	0.154
Time-fixed effects	Yes	Yes	Yes
Region-fixed effects	Yes	Yes	Yes
LM spatial lag test	5.03*	5.52	4.22
LM spatial error test	3.9	6.93	3.03
Spatial matrix	Entire	Entire	Split
Note: Significance *p<0.1, **p <0.05, ***p<0.01. Standard errors are reported in parentheses.			

Source: Authors

Since the analysis of spatial data showed that there may be spatial autocorrelation and heterogeneity in the data, spatial weights were included in regression. Three variables, i.e. a spatial lag, a spatial lag within-border and a spatial lag cross-border, were added (Table 5). A slight improvement in the explanatory power is observed, and insignificant spatial LM tests suggest that the models successfully control spatial variations in the sample. The significance and regression coefficients of entrepreneurship, HRST, tertiary education, and capital remain almost equal and statistically significant. The economic activity rate does not affect GDP.

In model 1, the spatially lagged number of three-year-old enterprises is statistically significant ($p<0.1$), which suggests that there is a spatial effect in the sample and neighbouring regions tend to positively affect each other, although not largely (0.016). This result is in line with the so-called spillover effect of entrepreneurship (Audretsch & Keilbach, 2008).

In the second model, the interaction variable was added, and the explanatory power of the model measured in Adjusted R^2 jumped to 0.207. The third model includes two spatially lagged independent variables which control for border effects (Smit, 2017). This effect is split into cross-border and within-country to control for regions that interact with other countries and regions, which interact only with the ones on the domestic territory. Both spatially lagged numbers of three-year-old enterprises (within-border) and (cross-border) are statistically insignificant, which signals that there is no border effect in this sample, which is contrary to the results obtained by Smit (2017).

Models in Tables 4 and 5 estimate that every percentage increase in capital results in an approximately 0.3 percent increase in regional GDP *per capita*. To put this into perspective, the Austrian NUTS2 region 'Vienna' had approximately €16.9 billion of capital in 2010. However, in 2016, this number rose to €20.3 billion. This presents a 20.12% increase in only 6 years. Therefore, these models would likely estimate regional economic growth of 6% based on just this steep increase in physical capital. This result is in accordance with the research study suggesting that physical capital belongs to the production function and positively affects the economy (Solow, 1957).

Intramural R&D expenditure, a time-lagged number of enterprises, a spatially lagged number of three-year-old enterprises (within-border), and a spatially lagged number of three-year-old enterprises (cross-border) all have an insignificant effect in spatial analysis. Therefore, these results suggest that the time-lag structure does not apply to this case, and the border effect is not present in the sample.

Population density coefficients have a statistically significant effect ($p<0.05$) only in models where the interaction between it and the number of enterprises variable is included (Table 4 - Model 3, and Table 5 - Model 2). The results confirm that the effect of early-stage entrepreneurship on regional economic growth is conditioned by the population density of the region. Although these results show that enterprises founded in densely populated areas such as cities and metropolitan areas tend to have a larger effect on the regional economy, the results are ambiguous and partially differ from the literature on regional development and economic growth (Glaeser, 2011; Audretsch et al., 2015).

The results of this study show a positive relationship between early-stage entrepreneurship and regional economic growth in the EU. The extent of this effect is measured by the regression coefficient which ranges from 0.10 to 0.50, depending on the model. In other words, every percentage increase in the number of three-year-old enterprises results in a 0.1 to 0.5% increase in regional GDP *per capita*.

5. Conclusion

The magnitude of the impact of entrepreneurship on economic growth has been documented by numerous studies showing that it varies from country to country and from region to region. If fast-growing companies are studied, extremely good results of the impact of entrepreneurship on economic effects are likely to be found. However, if research is repeated using only small enterprises in the sample, the results are unlikely to be similar. The same is true for the maturity of companies and companies belonging to different regions. To avoid the methodological problems mentioned, this research has tried to fill the gap in the current literature in several ways. First, a significant proportion of scholars exploring the interrelationship of entrepreneurship and economic growth try to do so at the national level. If they choose to zoom in and inquire about the impact on the regional economy, researchers typically select regions in only one country or select a few countries. However, this paper contributes to

a small body of literature that investigates entrepreneurship in NUTS 2 regions in the European Union. Second, in contrast to previous papers on this topic, a measure for early-stage entrepreneurship which controls for both the size and the maturity of the enterprise was used in the analysis. Therefore, the results in this paper are more robust and accurate. Third, often scientists who have researched this topic at EU level do not control NUTS 2 regions that contain large cities within their borders. Therefore, the effect of the city on the countryside was introduced in this paper, which will reveal whether densely populated areas affect the size of the relationship between entrepreneurship and regional economic growth.

The main goal of this paper is to examine the link between early-stage entrepreneurship and economic growth in the NUTS 2 regions in the European Union between 2008 and 2017. Three statistics methods are employed: bivariate correlation analysis, fixed effects regression with individual and time effects including the time-lag structure of the independent variable, and spatial econometric analysis including both temporal and spatial lag of independent variable X.

Findings suggest that total early-stage entrepreneurship measured by the number of three-year-old enterprises has a mild positive effect on regional GDP per capita and does not change with the maturity of the enterprise. Results suggest that the time-lag structure does not apply to this case, and the border effect is not present in the sample. In other words, successful regions do not make their neighbours more or less successful.

The effect of early-stage entrepreneurship on regional economic growth is conditioned by the population density of the region but these results are not confirmed in all analysis models. The percentage of HRST has a significant and impactful effect on regional GDP. And an increase in physical capital results in an increase in regional GDP per capita. The results showed that a higher percentage of people with tertiary education harm regional GDP, which is in contrast to most past research studies and requires additional analysis in future research. Gross fixed capital formation significantly affects a region's GDP increase, which is not the case for the economic activity rate and intramural R&D expenditure. Importantly, there is a positive spatial spillover effect in the data. In other words, new enterprises formed in one region are likely to be somewhat related to economic growth in the neighbouring region.

The analysis presented in this paper also has some limitations. The research covered the end of 2017 due to the availability of data on the observed variables and the possibility of comparison. The period between 2008 and 2017 potentially creates a bias in the data since panel data over a longer period of time tends to be more accurate. As the literature on the economic benefits of entrepreneurship suggests that data for smaller administrative units yield more accurate results, data for the NUTS 3 region level would be more appropriate for this type of research but such data are not available. Causality cannot be asserted in the relationship between total early-stage entrepreneurship and regional economic growth based on the results of this study. The relationship between entrepreneurship and economic growth is often bidirectional and influenced by exogenous factors which may have been omitted in this study.

Due to the complex nature of the relationship between entrepreneurship and regional growth, it would be incorrect to affirm that there is causality present. However, policymakers can certainly use the results of this research. One potential policy-related problem would be to consider a larger investment in new enterprise formation, where lagging regions in the European Union would be able to offer their citizens an opportunity to start their business and become self-employed. Entrepreneurial opportunities should be available to everyone regardless of their education, social status, age, race, and other characteristics.

The link between early-stage entrepreneurship and regional economic growth has not yet been fully explored. Since a large number of authors have concluded that the development of entrepreneurship within a region depends on its social, cultural and economic characteristics, further research should focus on exploring whether there are such differences between East-West countries or the new-old member state perspectives. Research on the impact of the cultural and political environment and the quality of institutions is excluded, although they are considered very important for the impact on entrepreneurs, and ultimately on economic growth in the regions, and may hence be the subject of further research.

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