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ENTREPRENEURSHIP CAPITAL AND REGIONAL PRODUCTIVITY REVISITED*

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Public intervention to foster entrepreneurship has been justified by the positive spillovers that regional entrepreneurship capital could have on firms' productivity. The available evidence shows a positive relationship between entrepreneurship capital measures and regional production. This paper argues that this evidence could be explained by the aforesaid spillovers but also by the presence of decreasing returns to scale in firms' production technology. The paper provides a simple methodological benchmark for distinguishing between and measuring both effects. The analysis conducted using a sample of 52 Spanish provinces over eleven years confirms the presence of decreasing returns to scale. Therefore, the previous literature could have overestimated the spillovers of regional entrepreneurship capital on firms' production.

Key words: entrepreneurship capital, regional productivity, scale economies.
JEL classification: R11, L26, O4.

Governments at different territorial levels have implemented increasingly policies to enhance the population's entrepreneurial activity. From an economic perspective, Acs *et al*. (2016) justify such policies by the spatial externalities that the population's entrepreneurial activity, or entrepreneurship capital, has over the rest of production activities. The main evidence related with such externalities has been generated around the Knowledge Spillover Theory of Entrepreneurship (KSTE) [Audretsch and Keilbach (2004a)]. Using aggregated data at the regional level, they estimate production functions considering entrepreneurship to be a productive input that, together with other inputs like labour and capital, contributes to the economy's output. This approach has been applied in different institutional contexts such as Germany [Audretsch and Keilbach (2004a,b,c, 2005); Audretsch *et al*. (2008); Mueller (2006,2007)], European regions [Bönte *et al*. (2008)], Brazil [Cravo *et al*. (2010)], the USA [Stough *et al*. (2008); Chang (2011); Hafer (2013)] and many different countries [Laborda *et al*. (2011)], among others. These studies report posi-

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tive and significant effects of regional entrepreneurship capital on regional production, which are interpreted as evidence of positive spillovers or externalities.

Regional aggregated production functions have been extensively used by economists, but they are not free of limitations [see Fisher (1969, 2005) for further details]. One of these is the need to assume the existence of constant returns to scale. This is important in this case, because the most commonly used indicators of entrepreneurship capital have been based on the number of firms (incumbent or new, in absolute or relative terms, or their respective growth rate over time), so a positive correlation is expected between those entrepreneurship capital measures and the stock of firms in the region. The paper's contributions are related with the recognition that a region's production is the aggregate of all production activities of the firms in the region. When the firms' technology has decreasing returns to scale (this is a necessary condition for the existence of a unique optimal firm size), the number of firms in the region will be positively related with the region's production level. When this is the case, the spillovers of entrepreneurship capital on firms' productivity will be overestimated by the usual estimation procedures in the literature. In other words, given two regions that use the same level of other inputs, a region with a higher number of firms could be more productive for two reasons: first, the technologies present decreasing returns to scale; second, the entrepreneurship capital has positive spillovers or externalities on the firms in the region.

The main contribution of the paper is to provide a simple methodological benchmark to help distinguish between these two effects. The proposal is therefore to estimate the regional differences in the firms' average production depending on the average use of inputs at the firm level (capital and labour) and the inputs available at the regional level (entrepreneurship capital and knowledge). This will provide estimations of the spillovers of entrepreneurship capital on the total factor productivity of the firms in the region and can be applied with the usual data available in the literature. The only special requirement is to have information about the regional stock of firms.

The paper is organized as follows. First, we develop a theoretical framework to interpret the previous empirical literature and to discuss the methodological contributions proposed in this paper. Second, we apply those developments to a data sample covering the 52 provinces into which Spain is administratively divided (NUTS 3 Eurostat) in the 2002-2012 period with information as close as possible to that used in the previously cited literature. Although studies have analysed the economic impact of entrepreneurship capital in Spain [Salas-Fumás and Sánchez-Asín (2008, 2010a, 2010b, 2013); Callejón (2009); Callejón and Ortún (2009)], these use other methodological approaches and aggregate data referring to the Autonomous Communities (NUTS 2 Eurostat) into which provinces are grouped. As the effects of entrepreneurship capital seem to be stronger at the local level, smaller regional divisions are preferred when data is available. Finally, we discuss the paper's implications.

1. Methodological discussion

The measurement and concept of entrepreneurship capital have generated some discussion [Erikson (2002); Audretsch (2009); Bönte *et al*. (2008)] as the measurement of whatever other kind of input. For example, the empirical applications

work with different measures that range from the stock of firms in the region [Stough *et al*. (2008)] to the entry rate of firms in key industries [Chang (2011)]. Audretsch and Keilbach (2004a,b, 2008) used the annual average of new firms with 1,000 workers created in a three year period. Mueller (2006, 2007) also uses this indicator along with the number of new firms created in one year. Sutter and Stough (2009) use the average number of technological and innovative firms created in the last five years; while Bönte *et al*. (2008), Salas-Fumás and Sánchez-Asín (2008, 2010a, 2010b, 2013) and Stough *et al*. (2008) use the self-employment rate on a regional level. Inevitably, all of those entrepreneurship capital measures are (or could be) related with the number of firms in the region.

To estimate the impact of regional entrepreneurship capital on the production for region i and period t, $Y_{i,t,}$ the usual method in the literature is to follow Solow (1956). The inputs considered are capital ($K_{i,t}$), labour ($L_{i,t}$), knowledge ($R_{i,t}$) and entrepreneurship capital ($E_{i,t}$). The output obtained as a combination of those inputs is estimated in most cases by Cobb-Douglas (1928) functions:

$$\ln Y_{i,t} = \mu \ln R_{i,t} + \delta \ln E_{i,t} + \alpha \ln K_{i,t} + \beta \ln L_{i,t} + \varepsilon_{i,t} \qquad [1]$$

Hence, the parameters to be estimated are production elasticity with respect to capital (α), labour (β), entrepreneurship capital (δ) and knowledge (μ). As usual, the error terms ($\varepsilon_{i,t}$) follow normal independent and identical distributions. Studies with panel data can control for the regional and time fixed effects. When it is assumed that production technologies present constant returns to scale for private inputs ($\beta = 1 - \alpha$) the production per employee ($y_{i,t} = Y_{i,t} / L_{i,t}$) will be:

$$\ln y_{i,t} = \ln Y_{i,t} - \ln L_{i,t} = \mu \ln R_{i,t} + \delta \ln E_{i,t} + \alpha \ln k_{i,t} + \varepsilon_{i,t} \qquad [2]$$

where $k_{i,t} = K_{i,t} / L_{i,t}$. The above production function has been estimated in several studies using one method [2] [Audretsch and Keilbach (2004a)] or another [1] [Audretsch and Keilbach (2004b); Audretsch *et al*. (2008); Mueller (2006,2007); Bönte *et al*. (2008); Stough *et al*. (2008)]. In all studies that estimate Equation [1], with the exception of Audretsch and Keilbach (2004b), there are decreasing returns to scale ($\beta + \alpha < 1$), although only Mueller (2006) reports a test of their significance. In their estimations, the elasticity of production with respect to knowledge (μ) and entrepreneurship capital (δ) are positive and statistically significant.

In the previous literature it has been interpreted the elasticity of production with respect to entrepreneurship capital (δ) as a measure of its spillovers or externalities. This requires some simplifying assumptions regarding the aggregation process of the firms' production functions at the regional level.

To show this, we consider $Y_{i,t}$ to be the aggregation of the production of the $n_{i,t}$ firms operating in region i during period t. Define $Y_{i,t,j}$ as the production of firm j in region i during period t. In algebraic terms:

$$Y_{i,t} = \sum_{j=1}^{n_{i,t}} Y_{i,t,j} = n_{i,t} \overline{Y}_{i,t} \quad \text{where} \quad \overline{Y}_{i,t} = \sum_{j=1}^{n_{i,t}} Y_{i,t,j} / n_{i,t} \qquad [3]$$

Firm j can use a set of private inputs purchased on the market. To reduce notation and be consistent with previous literature we will only consider capital $K_{i,t,j}$ and

labour $L_{i,t,j}$ as the inputs purchased by the firms while entrepreneurship capital and knowledge are available to all the firms and inhabitants of region i. The following Cobb-Douglas (1928) function summarizes the relationship between the production and inputs used:

$$Y_{i,t,j} = R_{i,t}^{\mu} E_{i,t}^{\delta} K_{i,t,j}^{\alpha} L_{i,t,j}^{\beta} \quad [4]$$

The estimation of regional production by equations [3] and [4] requires information about the level of output and private inputs used by all the firms in the region. With aggregate data at the regional level, the best approximation to each firm output and private inputs is the firm average for this region, $\bar{Y}_{i,j}$, $\bar{K}_{i,j} = \sum_{j=1}^{n_{i,t}} K_{i,t,j}/n_{i,t}$ and $\bar{L}_{i,j} = \sum_{j=1}^{n_{i,t}} L_{i,t,j}/n_{i,t}$. So we can rewrite equation [4] as follows:

$$\bar{Y}_{i,t} = R_{i,t}^{\mu} E_{i,t}^{\delta} \bar{K}_{i,t,j}^{\alpha} \bar{L}_{i,t,j}^{\beta} \quad [5]$$

Given that the Cobb-Douglas is a homogenous function of degree $\theta = \beta + \alpha$, $f(\bar{K}, \bar{L}) = (\frac{K_{i,t}}{n_{i,t}})^{\alpha} (\frac{L_{i,t}}{n_{i,t}})\beta = n_{i,t}^{-\theta} K_{i,t}^{\alpha} L_{i,t}^{\beta}$, then from equations [3] and [5] we can obtain:

$$Y_{i,t} = n_{i,t}^{1-\theta} R_{i,t}^{\mu} E_{i,t}^{\delta} K_{i,t}^{\alpha} L_{i,t}^{\beta} \quad [6]$$

This approach can easily be implemented, but we have not found estimations of Equation [5] or [6] in the reviewed literature. Instead, the previous literature has (implicitly or explicitly) assumed that f is homogenous of degree 1, $\theta = \beta + \alpha = 1$, and has estimated Equation [2].

In short, given two regions with an equal level of private inputs, ($K_{i,t}$, $L_{i,t}$), the region with a higher number of firms ($n_{i,t}$) could be more productive for two reasons. First, the production has decreasing returns to scale ($\theta < 1$). Second, the number of firms is a proxy or a measure of entrepreneurship capital $E_{i,t}$. In fact, if we assume that $\theta = 1$ (which implies that there is no single, optimal and finite firm size), the only possible explanation is the second one. This is what previous literature has done; disparage the explanation for returns to scale.

Consequently, one could argue that the main empirical contribution of this literature is to suggest that, in terms of regional production, not only is the level of private inputs used at the regional level important, but the number of firms among which they are distributed is also relevant. Regions with a higher number of firms (smaller average firm size in terms of inputs) will be more productive. We genuinely believe that this is an important contribution.

Our proposal is to look in more depth at two possible causes; there are decreasing returns to scale or the regional entrepreneurship capital affects the total factor productivity of the firms in the region. A priori, we do not know which is the case, and it could in fact vary between studies. In accordance with the discussion in this section, it will depend on the importance of returns to scale and the correlation between the entrepreneurship capital measure and the number of firms. In fact, this is an empirical query and we provide a methodological benchmark for addressing it: the estimation of Equation [5] is a first and easy step for advancing in this direction. The following section provides some evidence in this regard.

2. An application to Spanish provinces

Translated to empirical terms, the above section suggests to present estimations of the Equation [5], as well as the estimation of the Equation [1], the one estimated in the previous literature:

$$\ln \overline{Y}_{i,t} = \mu \ln R_{i,t} + \delta_6 \ln E_{i,t} + \alpha \ln \overline{K}_{i,t} + \beta \ln \overline{L}_{i,t} + \varepsilon_{i,t} \quad [5]$$

$$\ln Y_{i,t} = \mu \ln R_{i,t} + \delta \ln E_{i,t} + \alpha \ln K_{i,t} + \beta \ln L_{i,t} + \varepsilon_{i,t} \quad [1]$$

From the coefficients estimated in both equations we can split the effect of entrepreneurship capital on production estimated in accordance with the previous literature (δ in Equation [1]) as the aggregation of two components: i) the presence of decreasing returns to scale ($\delta - \delta_6$) and ii) the effect of entrepreneurship capital spillovers (δ_6 in Equation [5]).

For that purpose we created panel data covering an eleven-year period from 2002 to 2012 (t = 1, ..., 11), for the 52 Spanish provinces (i = 1, ..., 52), a total of 572 observations. This could at least enable us to control for regional fixed effects and time fixed effects.

The output and inputs considered, and their measures, are as similar as possible to those used in the reviewed literature. We collected this information from different sources.

The regional aggregate output is measured by the Gross Value Added ($Y_{i,t}$). The Spanish National Statistics Institute (INE) generates periodically disaggregated information at the provincial level on the annual value of the production of goods and services minus intermediate consumption. Like all the other monetary variables, this will be expressed in constant million euros for the year 2000.

The BBVA Foundation and the Valencian Institute of Economic Research provide monetary values of the set of assets accumulated in each province, Capital stock ($K_{i,t}$). Labour ($L_{i,t}$) is measured by the number of employees engaged in production activities in each province. This is derived from the Economically Active Population Survey, which is periodically produced by the INE.

Following Bönte *et al*. (2008), knowledge ($R_{i,t}$) is measured by the number of patents filed each year based on the data available on a provincial level in the Spanish Patents and Trademarks Office. We will not have access to other proxies used before at the regional level, such as, for example: the number of people employed in private companies or universities in areas related to R&D (Mueller 2007) and the annual R&D costs (Griliches 1998). Table 1 presents descriptive statistics of the variables.

The stock of firms ($n_{i,t}$) is required to compute firms' average production and average private inputs. This information is available from the Central Business Register (DIRCE) database. Table 2 presents descriptive statistics of this variable per region. The number of firms in one region can be considered a measure of the Entrepreneurship Capital of this region. Unfortunately, we do not have data for the regional startups for each year; therefore, we cannot provide empirical evidence using the ratio of new firms per inhabitant as in Audretsch and Keilbach (2004a,b, 2008). Entrepreneurship capital has also been measured in previous literature as the entrepreneurs per inhabitant (Acs *et al*. 2012). The main conclusions are similar using this ratio or the number of entrepreneurs. For simplicity's sake we only present the re-

Table 1: DESCRIPTIVE VARIABLES

Variable	Average	Standard Deviation
$lnY_{i,t}$	15.9535	0.9620
$lnK_{i,t}$	17.1079	0.9935
$lnL_{i,t}$	12.2875	0.9709
$lnR_{i,t}$	3.1233	1.4702
Observations	572	

Table 2: NUMBER OF FIRMS BY PROVINCE AND FIRM SIZE

	Number of firms	
	Mean over years	Standard Deviation
Alava	20.747,0910	928,7867
Albacete	25.903,0000	1.672,4648
Alicante	129.322,8200	9.742,3576
Almeria	40.740,1820	3.339,7839
Asturias	69.429,0000	2.495,9637
Avila	10.894,8180	529,1153
Badajoz	38.614,0910	2.185,5507
Barcelona	446.137,8200	23.567,3510
Burgos	24.634,6360	1.201,5965
Caceres	24.915,0910	1.681,5950
Cadiz	60.047,0000	3.023,4469
Cantabria	37.881,7270	1.914,0257
Castellon	39.740,3640	2.703,1652
Ceuta	3.663,9091	62,9038
Ciudad Real	30.521,4550	1.731,1113
Cordova	46.716,0910	2.518,1718
Coruña	79.842,1820	3.922,1760
Cuenca	13.853,0910	780,2130
Girona	53.007,2730	5.190,8535
Granada	56.589,2730	4.005,9918
Guadalajara	12.268,9090	1.559,9707
Guipuzcoa	58.322,7270	2.959,4098
Huelva	25.424,6360	1.459,8271
Huesca	16.041,5450	838,7669
Balearic Is.	87.298,2730	4.684,1157

Table 2: NUMBER OF FIRMS BY PROVINCE AND FIRM SIZE (continuation)

	Number of firms	
	Mean over years	Standard Deviation
Jaen	34.947,3640	1.641,7038
La Rioja	22.426,3640	1.136,1248
Las Palmas	68.874,0000	4.237,9413
Leon	32.382,8180	1.167,6203
Lleida	34.493,0000	2.467,3645
Lugo	23.982,2730	934,2235
Madrid	482.953,4500	35.165,9080
Malaga	106.690,0000	8.327,3874
Melilla	3.683,5455	85,7734
Murcia	89.650,3640	6.925,2530
Navarra	41.522,9090	1.523,0878
Ourense	22.830,3640	620,9752
Palencia	10.706,5450	268,9332
Pontevedra	66.071,8180	3.676,2084
Salamanca	22.751,0000	861,8835
Segovia	11.133,9090	610,3754
Seville	110.561,0900	7.978,8579
Soria	5.876,8182	143,2179
Tarragona	53.375,5450	3.799,8152
Tenerife	63.088,1820	3.733,2914
Teruel	9.131,0909	418,2252
Toledo	43.201,7270	3.760,8704
Valencia1	74.680,5500	10.505,2220
Valladolid	33.771,4550	1.904,5800
Vizcaya	83.581,2730	3.714,1327
Zamora	12.055,8180	321,9298
Zaragoza	64.566,6360	2.376,1499
Total	3.181.546,91	183.676,49
0 Employees	1.672.297,09	117.662,13
1-9 Employees	1.335.419,64	80.236,00
10-99 Employees	161.413,82	20.600,93
100-499 Employees	10.697,27	985,89
>500 Employees	1.719,09	121,13

sults using the stock of firms ($n_{i,t}$) as the measure of entrepreneurship capital[1]. Note that, in this case, the estimations of equation [1] and [5] only differ in the value of the estimations of the elasticity of production with respect to entrepreneurship capital ($\delta = 1 - \alpha - \beta + \delta_{\tilde{n}}$). So we are only going to present the estimations of Equation [1] and infer from them $\delta_{\tilde{n}} = \delta + \alpha + \beta - 1$.

Table 3 provides such estimations. In the first column, the estimated models do not include province fixed effects or time fixed effects. In the second column, only province fixed effects are included and in the last column both fixed effects have been included. Following the econometric literature on data panels; the group model, the province fixed effects model and the random effects model have been estimated for all the equations. The main results referring to the elasticity of production with respect to entrepreneurship capital are maintained. For reasons of expositional simplicity, we only provide the estimations of the fixed effects model because the Breush and Pagan (1979) and Hausman (1978) tests indicate that this is the most appropriate method for modelling the non-observable heterogeneity among provinces in the analysed sample.

Table 3: Impact of entrepreneurship capital on production
Equation [1]: Dependent Variable: ln $Y_{i,t}$

Independent Variables	Coefficient	Model 1	Model 2	Model 3
Constant		4,5947***	6,0940***	13,1106***
		[0,238]	[0,273]	[0,769]
$\ln K_{i,t}$	α	0,1404***	0,2158***	0,0774**
		[0,021]	[0,016]	[0,041]
$\ln L_{i,t}$	β	0,6175***	0,2103***	0,0081
		[0,062]	[0,033]	[0,035]
$\ln R_{i,t}$	μ	0,0839***	0,0103***	0,0086**
		[0,009]	[0,004]	[0,003]
$\ln E_{i,t}$	δ	0,1055**	0,3383***	0,1254***
		[0,060]	[0,049]	[0,048]
Regional Effects		No	Yes	Yes
Temporal Effects		No	No	Yes
Observations		572.0000	572.0000	572.0000
Groups: Provinces			52.0000	52.0000
R-squared		0.9841	0.7451	0.8142

*: Significant at the 0.10 level. **: Significant at the 0.05 level. ***: Significant at the 0.01 level. Clustered by province standard errors in brackets.

(1) This and all the other estimations cited in the paper but which do not appear in the text can be provided upon request to the authors.

The elasticity of production with respect to capital (α), to labour (β) and to knowledge (μ) are in all cases positive and statistically significant at 1% in all the estimations except in model 3. When the province and time fixed effects are included, the values of such elasticities are substantially lower. In all cases, the estimated values indicate that production technology presents decreasing returns to scale[2] ($\alpha + \beta < 1$). Previous estimations of the production function at the Spanish province level present mixed results. Pablo-Romero *et al*. (2008) report constant returns to scale for the 1990-1999 period, while Alvarez-Ayuso, *et al*. (2016) report decreasing returns to scale for the 1980-2007 period.

Elasticity of production with respect to regional entrepreneurship capital is in all cases (δ) positive and statistically significant at the usual levels. This result is consistent with the positive relationship obtained by the previous literature. Using the methodology proposed in the paper, the effect of entrepreneurship capital on production estimated in accordance with the previous literature is positive due to the presence of decreasing returns to scale ($\theta = \alpha + \beta < 1$) but not to the presence of entrepreneurship capital spillovers, which in accordance with our estimations are negative ($\delta_1 < 0$). The estimated values using Equation [5] are -0.1368 in model 1 (significant at 1%), -0.2374 in model 2 (significant at 1%) and -0.7869 in model 3 (significant at 1%).

3. Conclusion and discussion

As in the previous literature, this paper shows a positive impact of regional entrepreneurship capital on regional production. We argue that from a theoretical point of view, the firms in those regions could be more productive for at least two reasons: because there are decreasing returns to scale or due to the fact that the number of regional entrepreneurs produces positive externalities. Previous literature on entrepreneurship capital has not properly distinguished between both effects, so the previous evidence has only been interpreted in terms of positive externalities.

The paper presents a methodology to help to distinguish between both effects. The methodology is simple; it can be applied with data aggregated at the regional level and only requires information about the number of firms in the region. This is a starting point for analysing the sources of differences in productivity between regions as detected previously by the entrepreneurship capital literature.

Note that the proposed methodology is not about the measure of entrepreneurship capital used, it is about the kind of equations estimated. The methodology suggests that the number of firms has to be used in order to control for the existence of returns to scale, but it does not claim to be the best measure of entrepreneurship capital.

We provide evidence related with all these aspects in a data sample of Spanish provinces in the 2002-2012 period. In accordance with the estimations presented, production technologies present decreasing returns to scale in the use of private inputs; labour and capital. This seems to be the norm, and not the exception, in the reviewed literature. In this paper, this is the main explanation for the estimated positive relationship between entrepreneurship capital and production at the regional level. Ac-

(2) The null hypothesis that $\beta + \alpha = 1$ is rejected at the 1% level in all equations.

cording to our estimations, regional entrepreneurship capital has negative spillovers. The provided evidence cannot be understood as evidence against the knowledge spillover theory of entrepreneurship [Acs *et al*. (2009)]. This is merely a preliminary warning that the spillovers of regional entrepreneurship capital may be overestimated when we do not correct for decreasing returns to scale.

There is therefore a need for further evidence in order to confirm these results in other contexts. The literature has used other measures of entrepreneurship capital and we cannot verify exactly what would have happened in previous studies if we had applied the proposed methodology. Furthermore, we do not address other relevant issues concerning the reviewed entrepreneurship capital literature, such as the measurement of inputs or reverse causality problems. As discussed in the theoretical sections, without information that has been disaggregated at the firm level, it is difficult to distinguish between regional entrepreneurship capital spillovers or the existence of correlations between the size of firms and their total factor productivity. Furthermore, regional information disaggregating outputs and inputs at the sectorial level will be valuable for several reasons: i) the production functions could vary between sectors, ii) some sectors could benefit more from entrepreneurship capital spillovers and iii) sectorial entrepreneurship capital could generate different spillovers. The proposed methodology can easily be adapted to this kind of information. Indeed, it can be extended to the consideration of new theoretical or empirical relationships that have not been explored in this study. Theoretical developments may improve our understanding of the relationships between the different inputs and outputs measured. In future empirical studies, it would be useful to control for such sources of endogeneity.

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RESUMEN

La intervención pública para favorecer el emprendimiento se ha justificado por las externalidades que la actividad emprendedora de una región puede tener sobre la productividad de las empresas ubicadas en dicha región. La evidencia disponible muestra una relación positive ~~de~~ la actividad emprendedora y la productividad regional. Este artículo argumenta que dicha evidencia puede ser explicada por las mencionadas externalidades, pero también por la presencia de rendimientos decrecientes a escala en las tecnologías de producción de las empresas. El artículo desarrolla un sencillo marco metodológico para medir y poder distinguir entre ambos efectos. Su aplicación a una muestra de 52 provincias españolas durante once años confirma la presencia de rendimientos decrecientes a escala. En consecuencia, la literatura previa podría estar sobre estimando las externalidades de la actividad emprendedora ~~sobre~~ la productividad de las empresas.

Palabras clave: capital emprendedor, productividad regional, economías de escala.

Clasificación JEL: R11, L26, O4.