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Author(s): Horváth, Krisztina; Rabetino, Rodrigo

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Krisztina Horváth
Regional Innovation and Entrepreneurship Research Center (RIERC),
Faculty of Business and Economics, University of Pécs
Pécs Rákóczi út 80. 7622 Hungary
E-mail: horvathk@ktk.pte.hu

Rodrigo Rabetino
Department of Management, University of Vaasa
PO Box 700, FI-65101 Vaasa, Finland
E-mail: rodrigo.rabetino@uva.fi

Krisztina Horváth is the corresponding author and can be contacted at horvathk@ktk.pte.hu

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Abstract

This study analyses how regional manufacturing characteristics—i.e., specialisation and size of new manufacturers—and the entrepreneurial ecosystem—contextual factors driving entrepreneurial actions—impact the rate of new knowledge-intensive business service (KIBS) firms. Our spatial analysis of 121 European regions reveals that the entrepreneurial ecosystem plays a decisive role in supporting KIBS formation rates in territories with a solid industrial fabric. The economic potential of more attractive neighbouring regions can be detrimental to regional KIBS formation rates. The study offers valuable implications on how the entrepreneurial ecosystem can facilitate the interaction between manufacturing and KIBS firms.

Keywords: territorial servitisation; entrepreneurial ecosystem; Regional Entrepreneurship and Development Index (REDI); knowledge-intensive business services (KIBS)

JEL Codes: O14; L26; R58; O52

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1. Introduction

Knowledge-intensive business service (KIBS) firms have been recognised as key economic agents that are carriers of knowledge and facilitate development and innovation processes. In parallel with the call made by public administrations (European Commission [EC], 2011, 2012), scholars have suggested that introducing knowledge-based services into manufacturers' operation and offering advanced product-service systems (i.e., servitisation) may enhance their competitiveness (Baines & Lightfoot, 2014; Visnjic & Van Looy, 2013).

The recognition of the relevance of KIBS firms is becoming especially acute in the European Union. For example, the EU has set explicit goals to increase the contribution of manufacturing to the economy to at least 20% of its GDP by 2020 (EC, 2014), which may end up a sharp turnaround in the road to the innovation-driven status of the economy. Mostly related to R&D, management consulting, or IT outsourcing (Lafuente, Vaillant, & Serarols, 2010), KIBS firms may play a critical role in reaching territorial outcomes related to the channelling of value-adding services to manufacturers (Arnold, Javorcik, Lipscomb, & Mattoo, 2016; Lafuente, Vaillant, & Vendrell-Herrero, 2017).

Although the relevance of service transitions for manufacturers, few studies have assessed its territorial advantages (e.g., Arnold et al., 2016). Recently, a research stream addresses the potential impact of the connection between KIBS and manufacturing firms from a novel, territorial perspective. Lafuente et al. (2017) propose that territorial servitisation—more precisely knowledge-intensive territorial servitisation—represents ”the aggregate outcomes—e.g., economic, employment and other social outputs demanded by stakeholders—

resulting from the various types of mutually dependent associations that manufacturing and knowledge-intensive service businesses create and/or develop within a focal territory" (p. 20).

Nevertheless, territories do not realise the positive effects of the potential dynamics between KIBS and manufacturing sectors at the same intensity, regarding increased KIBS formation rates. Few studies have specifically dealt with the impact of servitisation strategies on KIBS formation rates at the territorial level (Lafuente et al., 2017; Meliciani & Savona, 2015). Besides the relevance of manufacturing sectors for promoting KIBS' formation rates, other sources of heterogeneity may explain the observed differences in the economic outcomes of territorial servitisation across territories. In this sense, it has been suggested that the effective channelling of entrepreneurial resources to the economy—a critical element for successful territorial servitisation—is conditioned by the characteristics of the entrepreneurial ecosystem (Acs, Autio, & Szerb, 2014). Entrepreneurship-enhancing policies—which are arguably conducive to greater rates of new KIBS firms—may turn sterile if territories do not enjoy a healthy entrepreneurial ecosystem (Acs et al., 2014; Lafuente, Szerb, & Acs, 2016).

This study extends the contribution by Lafuente et al. (2017) by adopting an approach to territorial servitisation that takes into consideration sources of territorial heterogeneity linked to the entrepreneurial ecosystem of European regions. More concretely, we evaluate how relevant features of manufacturing sectors—i.e., specialisation and the size of new manufacturers—affect KIBS formation rates, while acknowledging that the regional entrepreneurial ecosystem may affect this relationship. We argue that the entrepreneurial ecosystem plays a decisive role in explaining the knowledge-intensive territorial servitisation hypothesis that proposes that KIBS formation rates are more vigorous in territories with a solid industrial fabric. By employing spatial econometric methods, our analysis of 121 European regions during 2012-2014 allows to test the knowledge-intensive territorial servitisation hypothesis, and verify whether characteristics of neighbouring regions as well as of the entrepreneurial ecosystem explain differences in KIBS formation rates across regions.

The results support that regions with a solid manufacturing base attract new KIBS; however, this effect is conditioned by the prevalence of a healthy entrepreneurial ecosystem. This study has two main contributions to the literature. First, in line with the increased attention for the renaissance of manufacturing proposed by policymakers, this study is the first attempt to develop an extensive spatial analysis of the effects of the entrepreneurial ecosystem on the relationships between manufacturing and KIBS sectors. Second, by incorporating potential spatial effects between neighbouring European regions, this study provides reliable results as feedback on these strategies and, consequently, contributes to the debate on the design of future policy interventions.

2. Background theory and hypotheses development

Over the last three decades, the number of KIBS has drastically risen in Europe due to both increased inter-industry linkages and attempts of European economies for consolidating their knowledge-based economies (EC, 2011; Lafuente et al., 2017). The instrumental role played by KIBS in this process can be explained by their inherent function to offer specialised expertise to other businesses and by their capacity to use their accumulated knowledge to engage in innovation processes (Vendrell-Herrero, Bustinza, Parry, & Georgantzis, 2017).

KIBS have turned to be of crucial importance in the evolution of manufacturing businesses. For instance, contracting out part of their internal activity to KIBS firms—i.e., outsourcing—may result in superior cost efficiency, allows concentration on core competencies, and creates flexible business models (Hätönen & Eriksson, 2009). As a result, manufacturing firms are increasingly offering advanced product-service systems (PSS)—i.e., business servitisation models (Baines & Lightfoot, 2014)—to achieve new sources of profit, stable revenues, and a hard-to-replicate competitive advantage (Vendrell-Herrero et al., 2017).

Extrapolating from the servitisation literature, Lafuente et al. (2017) introduced the concept of territorial servitisation, which refers to the territorial value-creating processes resulting from increased interactions between manufacturers and KIBS. Yet, territorial servitisation is not limited to this particular case—that we call knowledge-intensive territorial servitisation (KITS)—or to local B2B relationships. The definition of territorial servitisation includes service innovations and outsourcing that are tacitly incorporated in manufacturers' offering and, thus, reasonable extensions of the original business servitisation concept. In this study, we will consistently use this extended definition of territorial servitisation.

The potential connection between manufacturers and KIBS firms constitutes a clear case in point, and this is the focus of this study. At the meso-level, territorial servitisation may result in a more consolidated manufacturing sector characterised by agglomeration economies (Meliciani & Savona, 2015). Thus, territorial servitisation contributes to regional development via positive externalities, knowledge spillovers and positive effects on input-output markets (Tavassoli & Jienwatcharamongkhol, 2016). This process creates the conditions for enhanced entrepreneurial activity, including knowledge-based sectors (Lafuente et al., 2010). For instance, manufacturing firms with the suitable absorptive capacity as a market for KIBS may attract new KIBS to the territory (Visnjic, Neely, Cennamo, &Visnjic, 2016).

2.1. Knowledge-intensive territorial servitisation (KITS) and the regional manufacturing characteristics

KITS represents the potential interlocking of economic activity between KIBS and manufacturing sectors that can be seen as an output of related variety (Frenken, Van Oort, & Verburg, 2007, p. 688). Related variety not only means diversity of activities but also implies that industries partially share their knowledge and skills (Frenken et al., 2007). Research shows that higher levels of related variety may yield superior territorial growth rates (Glaeser, Kallal, Scheinkman, & Shleifer, 1992). Thus, KITS becomes a case of interest when analysing the role of territorial servitisation on the regional economy.

A growing number of studies (e.g., Crozet & Milet, 2017; Czarnitzki & Spielkamp, 2003) support the interrelatedness of KIBS and manufacturing industries. For instance, in the Netherlands, manufacturers are the most important clients of KIBS firms specialised in computer services/IT and R&D—as opposed to other KIBS' clients in construction and agriculture sectors (den Hertog, 2000). In addition, a remarkable share—in 2015, 40%—of jobs in the manufacturing sector in Europe is related to value-added services (Bienkowska, 2015). This situation is in line with previous work showing that the demand of manufacturers could affect the location decision of KIBS (Gallego & Maroto, 2015; Lafuente et al., 2010).

However, enhanced value generation also depends on the characteristics of the territory's manufacturing industry. Fritsch and Changoluisa (2017) find that the formation of new service businesses affects the productivity of incumbent manufacturers more positively than regional firm formation rates in general. Thus, the proposed knowledge-based territorial servitisation is a special case of service interactions that result from the complementarities between manufacturers and KIBS. Lafuente et al. (2017) propose a mutually reinforcing loop between new KIBS—that stimulates employment in new manufacturers—and the regions' manufacturing sector whose activity is conducive to greater rates of new KIBS. Following this theory and evidence, it seems plausible that existing manufacturers can stimulate the formation of KIBS or attract new KIBS to the region. Therefore, the first hypothesis emerges:

H1: A positive relationship exists between the manufacturing specialization of a region and the rate of new KIBS firms.

European markets are primarily populated by small businesses and manufacturing sectors are not the exception. Because of the positive effects of the increased provision of knowledge-based services on manufacturers' performance, it is relevant to question whether the benefits of territorial servitisation are evenly accessible for all manufacturers. We argue that small manufacturers will demand knowledge-based services only if they add value.

Servitisation can be seen as a reaction to market pressures, and two scenarios emerge for manufacturing SMEs pursuing enhanced competitiveness through this strategy. First, small manufacturers could integrate a portfolio of services into their offering (e.g. after-sale maintenance). However, most SMEs are exposed to operational, financial and organizational constraints that limit their capacity to implement servitisation strategies internally (Huikkola, Kohtamäki, & Rabetino, 2016). Second, manufacturing SMEs could servitise via outsourcing the service to an external provider (Visnjic & Van Looy, 2013). Here, collaborations with local KIBS are critical to sustain the competitive advantage of manufacturing SMEs and to support territorial servitisation by restructuring the local industry (Lafuente et al., 2017).

The adoption of servitisation strategies may well be conditioned by the intra-or inter-industry interactions between businesses in a focal region. Fritsch and Changoluisa (2017) find that incumbent manufacturers benefit more from interactions—i.e., input market competition—with businesses in other industries, which constitutes an example of Jacobian externalities. Servitisation strategies may be especially attractive for new and small manufacturers often subject to severe resource constraints (Lafuente et al., 2017; Szerb, Acs, Autio, Ortega-Argilés, & Komlósi, 2014). In this scenario, the positive effects of territorial servitisation will become evident if new manufacturing SMEs have a greater possibility to introduce value-adding services provided by local KIBS. Thus, we hypothesise:

H2: A negative relationship exists between the average size of new manufacturing businesses in a region and the rate of new KIBS firms.

2.2. Knowledge-intensive territorial servitisation and the role of the entrepreneurial ecosystem

So far, our arguments suggest that territories can achieve superior rates of new KIBS by supporting the renaissance of manufacturing sectors, regardless their development level. Yet, support policies that prove themselves effective in some regions may not be so in other contexts. Research shows that the complex interactions between entrepreneurial actions and place-based characteristics shape territorial performance (Acs et al., 2014). Thus, between-industry interactions do not result solely from the presence of more businesses, and territories are heterogeneous in their capacity to attract KIBS. We argue that, among the different sources of territorial heterogeneity, the quality of the entrepreneurial ecosystem is an important region-specific factor with relevant implications for KITS.

Since Schumpeter (1934), the role of entrepreneurship as a vital component of territorial development has increasingly drawn scholarly attention, and it has evolved in two main directions. On the one hand, the emphasis on the quality of new enterprises has started prevailing against the traditional quantity-based analysis of the role of entrepreneurship on territorial development (Qian, Acs, & Stough, 2013). On the other hand, scholars acknowledge that environmental embeddedness influences the quality of entrepreneurship and have proposed a systemic view of entrepreneurship (Spigel, 2017). This systemic approach has led to developing the concepts of industrial districts (Marshall, 1890), clusters (Porter, 1998) and regional innovation systems (Cooke, Gomez, & Etxebarria, 1997).

According to Acs et al. (2014), the entrepreneurial ecosystem is "the dynamic, institutionally embedded interaction between entrepreneurial attitudes, abilities, and aspirations by individuals, which drives the allocation of resources through the creation and operation of new ventures" (p. 479). Recent work emphasises that a healthy entrepreneurial ecosystem yields to superior territorial performance (Acs et al., 2014; Lafuente et al., 2016).

The entrepreneurial ecosystem approach shares the characteristics of complexity and multidimensionality (Acs et al., 2014), and focuses on the systemic interactions between entrepreneurs and institutions. Entrepreneurs play an organic part in maintaining a healthy ecosystem, while the ecosystem catalyses successful entrepreneurship to the economy in the form of new businesses (Acs et al., 2014). According to Szerb et al. (2014), some territorial impulses come from a broader, national level (e.g., regulation), while other factors (e.g., the quality of human capital and networking) carry specific characteristics below the country level. Additionally, entrepreneurial ecosystems are territorially bounded, being the Silicon Valley, Copenhagen, and Cambridge among the most well-known examples.

Nevertheless, how can the entrepreneurial ecosystem contribute to the KITS process via KIBS formation rates? From a systemic perspective, entrepreneurship implies a resource mobilization process in which individuals pursue economic opportunities through entrepreneurial actions. At the territorial level, resource mobilization creates a process of entrepreneurial churn that drives resource allocation to more productive activities (Reynolds et al., 2005). The capacity of an entrepreneurial ecosystem to facilitate resource allocation processes is evidence of its quality. A high-quality ecosystem is characterised by superior factors that are conducive to enhanced territorial performance, such as well-developed social networks and digital infrastructures. However, judgments about the potential feasibility of entrepreneurial actions can be influenced by contextual factors, such as support structures and local network availability (e.g., suppliers, customers). Thus, the institutional framework acts as a regulator of the feasibility of entrepreneurial projects and the outcomes of entrepreneurial ventures (Acs et al., 2014). We, therefore, hypothesise:

H3: A positive relationship exists between the quality of the regional entrepreneurial ecosystem and the rate of new KIBS firms.

In the context of the proposed KITS process, a healthy entrepreneurial ecosystem will likely strengthen the connection between local manufacturers and KIBS businesses by nurturing the system with the appropriate mechanisms to create/develop this relationship. For example, developed network structures that facilitate the connection between manufacturers and KIBS are part of a solid entrepreneurial ecosystem that, in turn, may yield a stronger KITS (Arnold et al., 2016; Lafuente et al., 2017). In addition, the entrepreneurial ecosystem may improve resource allocation processes by channelling new entrepreneurial ventures to productive areas, which will translate into increased incentives for entrepreneurs to create KIBS businesses in settings where manufacturing firms are mostly new and small, and demand knowledge-based services. Existing evidence justifies specific location advantages that manufacturers may seek in a territory, such as energy costs, concentration of employment and access to public infrastructures (Carlton, 1983). In this scenario, the entrepreneurial ecosystem provides the conditions to realise the economic potential of new KIBS businesses. Following this line of thought, we propose the following hypotheses:

H4: At the regional level, the entrepreneurial ecosystem moderates the positive relationship between the manufacturing specialization and the rate of new KIBS firms.

H5: At the regional level, the entrepreneurial ecosystem moderates the negative relationship between the average size of new manufacturing businesses and the rate of new KIBS firms.

3. Data and method

3.1. Sample

The data used in this study come from three sources. First, regional information on the rate of manufacturers, GDP per capita, and population density was obtained from Eurostat. Second, data related to KIBS formation rates and the size of new manufacturers was collected from the annual population surveys available at the Global Entrepreneurship Monitor (GEM) Regional databases. GEM is one of the world's most extensive entrepreneurship surveys with a database that covers more than 100 countries. Scholars and policymakers increasingly acknowledge the value of GEM data, and the robustness and quality of GEM's data collection process has been confirmed through the publication of several studies in leading scholarly journals (e.g., Lafuente, Vaillant, & Rialp, 2007; Lafuente et al., 2017; Sternberg, 2012).

Third, data on the regional entrepreneurial ecosystem across Europe was obtained from the Regional Entrepreneurship and Development Index (REDI) databases. In the context of this project—also called as the regional GEDI (Global Entrepreneurship and Development Index) (Lafuente et al., 2016)—the REDI score is an index number based on multiple data sources, including GEM's data, Eurostat, World Bank, World Economic Forum, and the Heritage Foundation. The REDI index constitutes an accurate proxy to measure the quality of the regional entrepreneurial ecosystem (Acs, Szerb, Ortega-Argilés, Aidis, & Coduras, 2015).

In this study, the unit of analysis is the region and the final sample includes 121 regions (67 NUTS 1 regions and 54 NUTS 2 regions), based on the EU's official territorial classification system (nomenclature of territorial units for statistics). For all variables, values refer to averages between 2012 and 2014. The representativeness of the sample is ensured insofar as it covers 24 European countries. Table A1 presents the list of the study regions.

3.2. Variable definition

Dependent variable. The dependent variable is the rate of new KIBS businesses (R_NKIBS), measured as the number of new KIBS divided by the total number of new businesses in the region. This variable helps to capture business formation rates and other relevant economic processes in highly heterogeneous regions, in terms of size. Prior work has used similar variables to analyse various regional phenomena (Mason, Carter, & Tagg, 2011) and territorial servitisation processes (Lafuente et al., 2017).

The construction of this variable requires refinement in two aspects: the definition of KIBS firms and new businesses. First, to accurately identify KIBS sectors, we used the classification of knowledge-intensive services (KIS) provided by the EC (2016) as our starting point, and we narrowed it down to specifically B2B (business-to-business) sectors. As a result[1], we include the following sectors in our analysis: water transport (NACE Rev-2: 50), air transport (NACE Rev-2: 51), telecommunications (NACE Rev-2: 61), computer programming, consultancy and related services (NACE Rev-2: 62), information service activities (NACE Rev-2: 63), legal and accounting activities (NACE Rev-2: 69), activities of head offices; management consultancy activities (NACE Rev-2: 70), architectural and engineering activities; technical testing and analysis (NACE Rev-2: 71), scientific research and development (NACE Rev-2: 72), advertising and market research (NACE Rev-2: 73), other professional, scientific and technical activities (NACE Rev-2: 74), employment activities (NACE Rev-2: 78), and security and investigation activities (NACE Rev-2: 80).

Second, and following the GEM standards, we identified new businesses as firms up to 42 months of market experience (3.5 years). This borderline can be a good choice, as the market position of firms in their first 3-4 years is usually uncertain and most of them even stop their operations those years (Reynolds et al., 2005).[2]

Entrepreneurial ecosystem. We employ the REDI index developed by Szerb et al. (2014) to measure the quality of the entrepreneurial ecosystem. Above the complexity that entrepreneurial ecosystem measures embrace, two reasons validate the choice of the REDI to measure this concept. First, a strong theoretical background supports the structure of the index (Szerb et al., 2014). The most important brick of the REDI is the notion of entrepreneurship as a systemic issue (Acs et al., 2014) that manifests in the interaction of individual efforts with their institutional context, and the pillars of a region's ecosystem itself. More concretely, the REDI index captures key elements of the entrepreneurial ecosystem in six levels: 1) 76 sub-indicators, 2) 36 indicators, 3) 28 variables, 4) 14 pillars, 5) 3 sub-indices and finally, the 6) REDI index. The structure of the index is depicted in Table A2. The computation of the REDI is aligned with the OECD's Handbook on constructing composite indicators (Giovannini et al., 2008). A detailed description of the REDI and its computation is presented in Szerb et al. (2017). For illustrative purposes, Figure 1 displays the quartile distribution of the REDI index across the analysed European regions. The figure shows that Helsinki-Uusimaa constitutes an example of a region with high-quality entrepreneurial ecosystem, while a region with one of the lowest-quality ecosystems is Voreia Ellada (Greece).

--- Insert Figure 1 about here ---

Industry characteristics. We use two variables related to the regional industrial base. First, following the same logic behind the construction of the rate of new KIBS in regions, we introduce the rate of manufacturers (R_MAN), calculated as the number of manufacturing units divided by the total business units in the region. This variable captures the regional specialization in manufacturing activities. Second, and similar to Lafuente et al. (2017), we include the average size of new manufacturers (SIZE_NMAN) in the region, in terms of employees. In all models, this variable was logged to reduce skewness. We use the term new business consistently with the definition of new for the KIBS firms detailed above.

Table 1 provides descriptive statistics for the study variables. In case of new KIBS' rate (the average size of new manufacturers), the minimum value of zero means the lack of new KIBS firms (new manufacturers) in a focal region. In case of new KIBS six regions—Brandenburg, Bremen and Sachsen-Anhalt in Germany, Est and Sud-Ouest in France, and Central-Italy—and in terms of new manufacturers 25 regions—among others, eight German regions and five Swedish regions—fall into this category. Note that these values do not refer to the whole population of businesses in the category, as they come from the GEM APS survey. On the other hand, the region with the highest KIBS formation rate is Upper Norrland in Sweden, and the region with the largest new manufacturers is Berlin. The region with the lowest rate of manufacturers is London, while the highest rate can be found in Continental Croatia. The Macroregion two (Romania) reports the least developed ecosystem, while the most developed entrepreneurial ecosystem was found in Stockholm.

--- Insert Table 1 about here ---

Control variables. We control for economic development and urbanisation economies in the model specifications. Similar to Lafuente et al. (2017), Gross Domestic Product per capita (GDP_PC) is the indicator of regional economic development and it is expressed in purchasing power parity (PPP). Urbanisation economies are a type of agglomeration externality that explains territorial outcomes by promoting local demand (Bottazzi & Gragnolati, 2015), access to skilled labour (Meliciani & Savona, 2015), and knowledge spillovers (Glaeser et al., 1992). However, other regional forces can divert new KIBS firms from densely populated areas. Bottazzi and Gragnolati (2015) confirm empirically that urbanisation externalities are important but they may play a secondary role after industrial linkages. Similar to Gallego and Maroto (2015) and Meliciani and Savona (2015), we use regional population density (POPDENS)—measured as the number of inhabitants per square km—and a dummy that identifies regions with a capital city (D_CAPCITY) as urbanisation measures. To account for the potential differences in terms of KIBS formation rates between Central Eastern European and Western European regions, we introduced a CEE dummy (D_CEE) that at the same time is an efficient measure of potential country-specific effects. Note that the GDP per capita and population density were logged to reduce skewness.

3.3. Method

This study analyses how relevant regional characteristics affect KIBS formation rates in 121 EU regions. However, from a methodological perspective the potential interactions within and between regions bring about important considerations with relevant estimation implications. In models where spatial interactions do not influence KIBS formation rates—e.g., the rate of new KIBS in Île-de-France is not affected by the characteristics of its surrounding regions—canonical OLS models can be used to test the study hypotheses. Yet, the presence of spatial interactions—which become evident via, for example, economic relationships, positive or negative externalities or knowledge spillovers—render OLS estimates inefficient and may obscure the true effects of the analysed regional characteristics on KIBS formation rates (Anselin, 1988; Elhorst, 2014).

As a result, we employ spatial econometric techniques to account for the geographic embeddedness of the analysed European regions. This method allows us to differentiate regional (local) and external effects (linked to adjacent territories), and accurately test the proposed hypotheses dealing with internal effects of interest for policymakers. More concretely, we apply spatial Durbin cross-section models (SDM) that quantify spillover effects stemming from neighbouring regions (diversity effects), and relationships between the rates of new KIBS firms in the specific region and its adjacent regions. In our models, these spatial effects do not only spill over to the neighbouring regions but also to the neighbours of the neighbours, and so on, that is global spatial spillovers prevail (LeSage & Pace, 2009).

The meaning of adjacent territories and their effects on a focal region depend on the assumed connections between regions. In the spatial econometric literature, two main connections are differentiated based on spatial proximity: contiguity- and distance-based (Meliciani & Savona, 2015; Varga & Sebestyén, 2017). A good example for contiguity-based connections is queen contiguity (two regions are neighbours if they share common borders), while inverse distance is an example for distance-based connections (localised knowledge spills over to a certain distance, supposing decreasing effect with growing distance). Spatial connections between regions are defined by a spatial weight matrix (W). In this study, we run the following two spatial models, where equation (1) is the baseline model and equation (2) incorporates interaction terms between REDI and the key independent variables:

Base model: (1)

$$\begin{aligned}\text{R\_NKIBS}_r &= \rho \text{W R\_NKIBS}_r + \beta_0 + \beta_1 \text{REDI}_r + \beta_2 \text{R\_MAN}_r + \beta_3 \text{SIZE\_NMAN}_r + \beta_4 \text{Controls}_r \\ &+ \theta_1 \text{W REDI}_r + \theta_2 \text{W R\_MAN}_r + \theta_3 \text{W SIZE\_NMAN}_r + \theta_4 \text{W Controls}_r + \varepsilon_r\end{aligned}$$

Full model: (2)

$$\begin{aligned}\text{R\_NKIBS}_r &= \rho \text{W R\_NKIBS}_r + \beta_0 + \beta_1 \text{REDI}_r + \beta_2 \text{R\_MAN}_r + \beta_3 \text{SIZE\_NMAN}_r \\ &+ \beta_{12} \text{R\_MAN}_r \times \text{REDI}_r + \beta_{13} \text{SIZE\_NMAN}_r \times \text{REDI}_r + \beta_4 \text{Controls}_r + \theta_1 \text{W REDI}_r \\ &+ \theta_2 \text{W R\_MAN}_r + \theta_3 \text{W SIZE\_NMAN}_r + \theta_{12} \text{W R\_MAN}_r \times \text{REDI}_r + \theta_{13} \text{W SIZE\_NMAN}_r \times \text{REDI}_r \\ &+ \theta_4 \text{W Controls}_r + \varepsilon_r\end{aligned}$$

In both models, β_0 is the constant term, while β_j are coefficients for the *jth* independent variables in region *r*. Variables with W—meaning weighted—are the spatially lagged terms of the dependent (with ρ parameter) and independent (with Θ parameter) variables, that is, the average values in the adjacent regions of region *r* (Anselin & Rey, 2014). The term ε is the normally distributed error.

To corroborate the robustness of our models, we first apply a specific-to-general-approach and test whether a spatial model yields efficient estimators (Elhorst, 2014). In the first round, two spatial models are considered: a spatial autoregressive model (SAR), where the only spatial dependence between regions is in the dependent variable, and a spatial error model (SEM), where the spatial dependence appears in the error terms. Following Anselin and Rey (2014), we use Lagrange Multiplier (LM) and robust LM tests to verify whether a non-spatial, a spatial autoregressive or a spatial error model describes best the data. In case the presence of spatial effects cannot be rejected, we estimate a spatial Durbin model and test whether it is a better choice than the SAR and SEM models (general-to-specific approach) (Elhorst, 2014). As SAR and SEM are nested in the SDM, we apply a common factor analysis that supports decision between nested models. If H0: $\theta = 0$ we should simplify our model to SAR, while a SEM model should be applied if H0: $\theta+\rho\beta = 0$ (Burridge, 1981; Anselin, 1988).

We employed four spatial weight matrices to define the type of regional connection (queen contiguity, binary distance, inverse distance, and squared inverse distance). Wald tests were used to corroborate the hypotheses (Elhorst, 2014). The squared inverse matrix yields the highest result for the robust LM test; however, and similar to Melicani and Savona (2015), we employ the inverse distance weight matrix in the analysis based on both the results of the LM test (Table A3) and the superior goodness of fit statistics of the regression models. To verify that the SDM best describes the analysed spatial relationship, we look at the Wald test statistic for both SAR and SEM models. The significance levels of the tests (Table A3) indicate that SAR and SEM should be rejected in favour of the SDM.

4. Results

Table 2 presents the results of the baseline (equation (1)) and the full model (equation (2)). Also, Table A4 shows that correlations among the study variables are generally in the low to moderate range. To evaluate collinearity we computed the average variance inflation factor (VIF) for all variables. The average VIF value for the full model is 7.73 and the only VIFs that exceed 10—a generally accepted rule of thumb for assessing collinearity—were observed for the interaction terms. By construction, these terms are correlated and—even if computationally correct—this explains the VIF results (Greene, 2003). We computed VIFs for the variables used in model 1, and the resulting average VIF is 2.14 (range: 1.14–3.89). Consequently, the results of this diagnostic test do not raise collinearity concerns.

We also ran the Jarque-Bera test to verify whether the errors computed from the different regression models are normally distributed (Jarque & Bera, 1987). Based on the results for both models (Model 1: $\chi 2=12.77$, $p<0.01$, Model 2: $\chi 2=15.11$, $p<0.01$), we estimated equations (1) and (2) using the more general Weibull distribution.

--- Insert Table 2 about here ---

Results in model 1 of Table 2 show that, at the regional level, the rate of new KIBS is associated with both a higher specialization in manufacturing and smaller manufacturing businesses. Therefore, we give support to our hypothesis 1 that proposes a positive relationship between manufacturing specialization and the rate of new KIBS, and to our second hypothesis that proposes a negative relationship between the average size of new manufacturing businesses in a region and the business formation rate of KIBS firms.

The findings in Table 2 reveal that the rate of new KIBS is higher in regions with lower levels of GDP per capita. This result is in line with Gallego and Maroto (2015) who point out that the rapid improvements in less developed European regions contribute to explain the higher employment growth rate of KIBS. Also, results in Table 2 indicate that the REDI is consistently positive and significant in both models (Model 1: $p<0.01$, Model 2: $p<0.05$). This result underlines the relevance of the entrepreneurial ecosystem as an engine to increase KIBS formation rates. These results confirm our hypothesis 3 that states that KIBS formation rates are greater in regions with more developed entrepreneurial ecosystems.

The analysis of the interaction between industry features and the entrepreneurial ecosystem offers different results. Results in model 1 show that manufacturing specialization attracts higher rates of new KIBS (H1). However, in model 2 we see that territorial servitisation processes are conditioned by the quality of the entrepreneurial ecosystem, that is, regions with a higher rate of manufacturers show higher rates of new KIBS firms only if the region enjoys a healthy entrepreneurial ecosystem ($p<0.01$). Therefore, we give support to our hypothesis 4 that states that, at the regional level, the entrepreneurial ecosystem moderates the positive relationship between manufacturing specialization and KIBS formation rates.

The interaction term between the average size of new manufacturers and the REDI is not significant. This result indicates that the REDI variable does not moderate the relationship between new manufacturers' size and the rate of new KIBS. We, therefore, cannot support our hypothesis 5 that states that the entrepreneurial ecosystem moderates the negative relationship between the average size of new manufacturing businesses and KIBS formation rates.

We also observe effects stemming from the spatial structure of regions and their adjacent territories. The findings in models 1 and 2 show that the only spillover effect related to KITS processes comes from the manufacturing specialization in neighbouring regions that positively influences KIBS formation rates. Finally, results for the spatially lagged dependent variable (Rho) corroborate that significant differences exist in the rate of new KIBS between a region and its neighbours, that is, the rate of new KIBS in a focal region is negatively affected by the capacity of neighbouring regions to attract new KIBS firms.

5. Discussion, implications and concluding remarks

This paper proposes a spatial analysis of the connection between manufacturing and KIBS businesses; a process recently called territorial servitisation. More concretely, we study how territorial heterogeneity associated with differences in the quality of the entrepreneurial ecosystem conditions the relationship between the characteristics of regions' manufacturing base and the creation of KIBS firms. The proposed spatial econometric model offers a compelling view of how the entrepreneurial ecosystem affects KIBS formation rates.

The results suggest that the quality of the entrepreneurial ecosystem positively influences KIBS formation rates, and positively moderates the relationship between manufacturing specialization and the rate of new KIBS. This result reinforces the territorial servitisation loop proposed by Lafuente et al. (2017), which emphasises that a resilient local industrial base may stimulate the development of KIBS sectors and contribute to revitalising both manufacturing sectors and territorial outcomes. However, manufacturing specialization by itself is not enough to attract more KIBS, and a healthy entrepreneurial ecosystem seems essential for an effective territorial servitisation. Thus, efforts to develop a competitive KIBS sector in regions with a high manufacturing specialization may turn sterile if they do not have a healthy entrepreneurial ecosystem that channels entrepreneurial resources to the economy.

The results of this study have important scholarly and policy implications. From an academic standpoint, we found that the entrepreneurial ecosystem is a relevant source of territorial heterogeneity that plays a decisive role in explaining the relationship between manufacturers and KIBS. This study also discusses how the economic potential of more attractive neighbouring regions can be detrimental to regional KIBS formation rates.

Although regions with a solid manufacturing base may attract new KIBS, this effect is conditioned by the quality of the entrepreneurial ecosystem. Thus, this study contributes to the nascent literature on territorial servitisation by developing the concept of knowledge-intensive territorial servitisation through a model that incorporates both the role of the entrepreneurial ecosystem, and a more accurate identification of the spatial factors affecting the relationships at the core of the virtuous circle underlying the territorial servitisation framework.

This study offers various implications for policymakers interested in enhancing the performance of manufacturing sectors. As a precondition for territorial servitisation to occur, the creation of a flourishing KIBS sector seems to call for the development of both resilient manufacturing firms and high quality entrepreneurial ecosystems. Thus, besides bringing manufacturers and KIBS together, policymakers must focus on the design of specific actions that facilitate the quality enhancement of local conditions. In particular, specific elements that are important for manufacturers might foster the creation of new KIBS firms and, in turn, enhance territorial servitisation. In line with Gallego and Maroto (2015), these policies should focus on the promotion of both traditional technological developments—e.g., digital infrastructures—and other forms of innovation linked to organisational change—e.g, integration of digital technologies into production processes, crowdsourcing—that may contribute to generate effective networks with implications for territorial servitisation.

Regarding the entrepreneurial ecosystem, few central attributes have shown to be relevant to explain KIBS formation rates. Besides the key role of agglomeration externalities (e.g., the presence of MNEs and other KIBS) and market size, the opportunities for networking (Makun & MacPherson, 1997) and gaining access to relevant knowledge from different local actors seem key determinants of KIBS formation rates. Also, knowledge resources and soft factors that attract talent have shown a positive effect on the rate of new KIBS. Public policy must support the introduction of mechanisms for attracting talent (human capital), as well as for promoting networking (social capital) and connectivity to increase the proximity advantage for KIBS in activities where client-provider face-to-face interactions are still relevant and occur within localised business networks (Makun & MacPherson, 1997).

However, policies should accommodate regional development level and receptivity (Visnjic et al., 2016). For example, some regions may require a higher level of industry-specific support, while for other regions the development of strong networks and enhanced local connectivity seem relevant to bring manufacturing and KIBS businesses together. The REDI index constitutes an interesting tool to start the improvement process by identifying and handling the existing bottlenecks that hinder other, more relevant, ecosystem factors that contribute to improving territorial development (Szerb et al., 2017).

Our work is not exempt from limitations that, in turn, offer space for further research. First, due to data availability issues we worked with NUTS 1 and NUTS 2 level regions; however, spatial interactions may take place at a smaller scale. Future studies should address this issue by evaluating the drivers of KIBS formation rates at a smaller regional scale. Also, the identification of manufacturing clusters is a promising route to take. Guerrieri and Meliciani (2005) found that knowledge-intensive manufacturers turn to certain types of services. The focus on these manufacturers could offer further insights into KITS practices. Incorporating additional sources of territorial heterogeneity such as the distribution of sectors unrelated to KIBS' operation or regional policy priorities may also yield further understanding of the relevance of KITS. Second, a longitudinal analysis jointly with the use of larger samples that permit separating KIBS firms in terms of their potential value added to manufacturers and their location constitutes an issue that should be addressed in future work.

Endnotes

1. We also considered NACE Rev-2 codes, regional data in the Eurostat Regional Database, and included only those industries that had available data for the overall number of KIBS businesses in the analysed regions.

2. The timing of the GEM annual population survey allows at distinguishing between businesses created in the same year of the survey (firms with less than 6 months of market experience) and firms created years prior to the survey. This criterion leads to define new businesses as those firms with less than 42 months of market experience.

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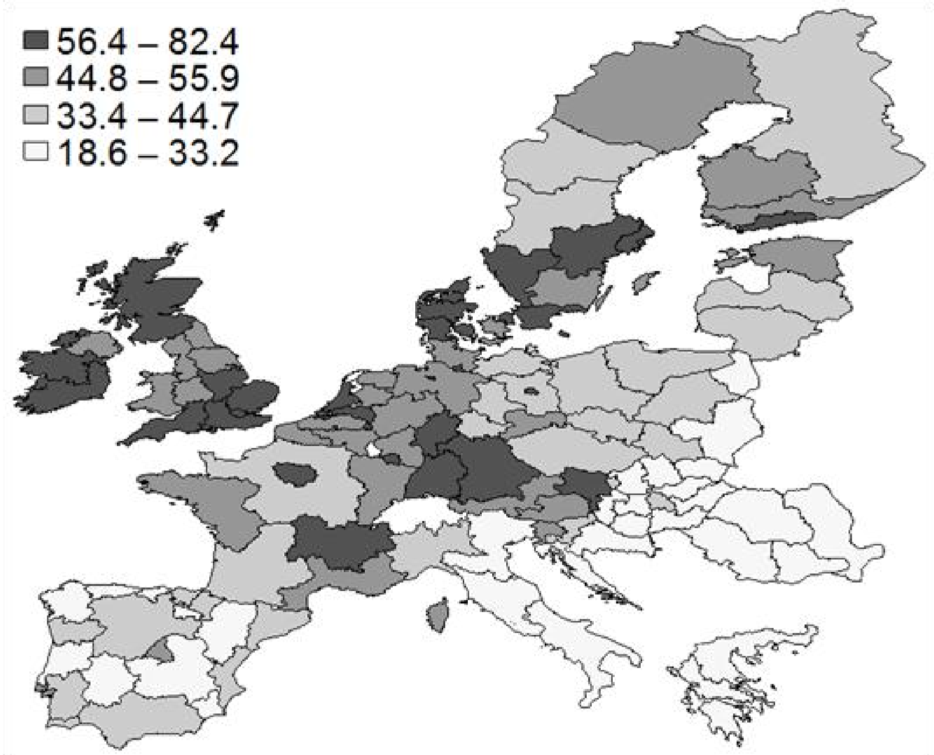
List of Figures

Figure 1. Entrepreneurial ecosystem (REDI) in the analysed European regions



List of Tables

Table 1. Descriptive statistics

Variable name	Mean	Standard deviation	Minimum	Maximum
R_NKIBS	0.1876	0.0981	0	0.5
REDI	44.5727	14.8444	18.6	82.4
R_MAN	0.0981	0.0458	0.0354	0.3935
SIZE_NMAN	4.3142	9.5308	0	94
GDP_PC	25,957.85	9,154.13	10,350	56,775
POPDENS	349.80	907.56	3.37	7,322.17
D_CAPCITY	0.1983	0.4004	0	1
D_CEE	0.2397	0.4287	0	1

Sample size: 121 observations.

Table 2. Spatial Durbin Model: Regression results

	Model 1	Model 2
Dependent variable: R_NKIBS	Coefficient (Std error)	Coefficient (Std error)
REDI	0.0060 (0.0015)***	0.0034 (0.0016)**
R_MAN	0.4847 (0.2890)*	–1.1705 (0.4871)**
R_MAN X REDI		0.0508 (0.0172)***
SIZE_NMAN (ln)	–0.0248 (0.0091)***	0.0183 (0.0244)
SIZE_NMAN (ln) X REDI		–0.0008 (0.0005)
GDP_PC (ln)	–0.1093 (0.0431)***	–0.1446 (0.0404)***
POPDENS (ln)	0.0030 (0.0112)	0.0110 (0.0099)
D_CAPCITY	0.0231 (0.0327)	0.0480 (0.0296)
D_CEE	–0.0565 (0.0659)	–0.0788 (0.0682)
W * REDI	–0.0032 (0.0023)	–0.0015 (0.0047)
W * R_MAN	1.4387 (0.6412)**	3.3375 (1.6866)**
W * R_MAN X REDI		–0.0545 (0.0405)
W * SIZE_NMAN (ln)	0.0084 (0.0332)	–0.0743 (0.0911)
W * SIZE_NMAN (ln) X REDI		0.0015 (0.0017)
W * GDP_PC (ln)	0.2104 (0.1027)**	0.2713 (0.0954)***
W * POPDENS (ln)	–0.0153 (0.0136)	–0.0224 (0.0132)*
W * D_CAPCITY	–0.1108 (0.0458)**	–0.1270 (0.0412)***
W * D_CEE	0.0003 (0.0692)	0.0268 (0.0811)
W * R_NKIBS (Spatial Rho)	–0.4340 (0.1595)***	–0.4678 (0.1571)***
Constant	0.0700 (0.0043)	–1.1327 (0.7742)
R2	0.5946	0.7171
Adjusted R2	0.5453	0.6705
Log likelihood value	131.2514	139.2700
F test	11.2076***	14.5074***
Observations	121	121

Note: Robust standard errors adjusted by heteroskedasticity are presented in brackets. W * indicates the spatially lagged (dependent and independent) variables, calculated with row-standardized inverse distance weight matrix. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.

Appendix

Table A1. List of sampled regions

Country	**NUTS level**	**Regions**
Austria	NUTS 1	Eastern Austria, Southern Austria, Western Austria
Belgium	NUTS 1	Brussels-Capital Region, Flemish Region, Walloon Region
Croatia	NUTS 2	Continental Croatia, Adriatic Croatia
Czech Republic	NUTS 1	Czech Republic
Denmark	NUTS 2	Hovedstaden, Sjælland, Southern Denmark, Midtjylland, Nordjylland
Estonia	NUTS 1	Estonia
France	NUTS 1	Île-de-France, Bassin parisien, Nord, Est, Ouest, Sud-Ouest, Centre-Est, Méditerranée
Finland	NUTS 2	West Finland, Helsinki-Uusimaa, South Finland, North & East Finland
Germany	NUTS 1	Baden-Württemberg, Bayern, Berlin, Brandenburg, Bremen, Hamburg, Hessen, Mecklenburg-Vorpommern, Niedersachsen, Nordrhein-Westfalen, Rheinland-Pfalz, Saarland, Sachsen, Sachsen-Anhalt, Schleswig-Holstein, Thuringen
Greece	NUTS 1	Voreia Ellada, Kentriki Ellada, Attiki
Hungary	NUTS 2	Central Hungary, Central Transdanubia, Western Transdanubia, Southern Transdanubia, Northern Hungary, Northern Great Plain, Southern Great Plain
Ireland	NUTS 2	Border, Midland and Western NUTS-II Region, Southern and Eastern NUTS-II Region
Italy	NUTS 1	Northwest Italy, Northeast Italy, Central Italy, South Italy
Latvia	NUTS 1	Latvia
Lithuania	NUTS 1	Lithuania

Table A1. Continued

Country	**NUTS level**	**Regions**
Netherlands	NUTS 1	Northern Netherlands, Eastern Netherlands, Western Netherlands, Southern Netherlands
Poland	NUTS 1	Region Centralny, Region Południowy, Region Wschodni, Region Północno-Zachodni, Region Południowo-Zachodni, Region Północny
Portugal	NUTS 2	Norte Region, Algarve, Centro Region, Lisboa Region, Alentejo Region
Romania	NUTS 1	Macroregion one, Macroregion two, Macroregion three, Macroregion four
Slovak Republic	NUTS 2	Bratislava Region, Western Slovakia, Central Slovakia, Eastern Slovakia
Slovenia	NUTS 2	Eastern Slovenia, Western Slovenia
Spain	NUTS 2	Galicia, Asturias, Cantabria, Basque Community, Navarre, La Rioja, Aragon, Madrid, Castile-Leon, Castile-La Mancha, Extremadura, Catalonia, Valencian Community, Andalusia, Region of Murcia
Sweden	NUTS 2	Stockholm, East Middle Sweden, Småland and the islands, South Sweden, West Sweden, North Middle Sweden, Middle Norrland, Upper Norrland
United Kingdom	NUTS 1	North East, North West, Yorkshire and the Humber, East Midlands, West Midlands, East of England, London, South East, South West, Wales, Scotland, Northern Ireland

Table A2. Structure of the Regional Entrepreneurship and Development Index (REDI)

	Sub-indices	Pillars	Variables (individual/**institutional**)
Regional Entrepreneurship and Development Index (REDI)	Entrepreneurial Attitudes Sub-index	Opportunity perception	Opportunity recognition
			Market agglomeration
		Startup skills	Skill perception
			Quality of education
		Risk acceptance	Risk perception
			Business risk
		Networking	Knows entrepreneur
			Social capital
		Cultural support	Carrier status
			Open society
	Entrepreneurial Abilities Sub-index	Opportunity startup	Opportunity motivation
			Business environment
		Technology adoption	Technology level
			Absorptive capacity
		Human capital	Educational level
			Education and training
		Competition	Competitors
			Business strategy
	Entrepreneurial Aspirations Sub-index	Product innovation	New product
			Technology transfer
		Process innovation	New technology
			Technology development
		High growth	Gazelle
			Clustering
		Globalization	Export
			Connectivity
		Financing	Informal investment
			Financial institutions

Table A3. Test for model selection

	Equation (1)		Equation (2)	
	χ^2	p-value	χ^2	p-value
LM lag (QUEEN)	5.048	0.025	4.740	0.029
Robust LM lag (QUEEN)	12.079	0.001	13.211	0.000
LM error (QUEEN)	1.434	0.231	1.062	0.303
Robust LM error (QUEEN)	8.466	0.004	9.533	0.002
LM lag (BIN)	7.438	0.006	7.386	0.007
Robust LM lag (BIN)	8.472	0.004	9.770	0.002
LM error (BIN)	2.916	0.088	2.516	0.113
Robust LM error (BIN)	3.951	0.047	4.900	0.027
LM lag (INV)	**10.408**	**0.001**	**10.747**	**0.001**
Robust LM lag (INV)	**14.234**	**0.000**	**16.237**	**0.000**
LM error (INV)	3.527	0.060	3.341	0.068
Robust LM error (INV)	7.353	0.007	8.831	0.003
LM lag (INV2)	7.391	0.007	7.707	0.006
Robust LM lag (INV2)	15.54	0.000	18.275	0.000
LM error (INV2)	1.804	0.179	1.668	0.197
Robust LM error (INV2)	9.954	0.002	12.236	0.000
Wald test: SDM vs SAR	37.51	0.0000	47.94	0.0000
Wald test: SDM vs SEM	44.34	0.0000	55.52	0.0000

Note: Spatial weight matrices are row-standardized. QUEEN- queen contiguity matrix; BIN-binary distance matrix, threshold distance: 377.95 km; INV- inverse distance matrix, threshold distance: 377.95 km; INV2- inverse distance squared matrix, threshold distance: 377.95 km.

Table A4. Correlation matrix

		1	2	3	4	5	6	7	8
1	R_NKIBS	1							
2	REDI	0.4666***	1						
3	R_MAN	–0.0798	–0.4547***	1					
4	SIZE_NMAN (ln)	0.0147	–0.1635*	0.0806	1				
5	GDP_PC (ln)	0.3503***	0.7919***	–0.4492***	–0.0922	1			
6	POPDENS (ln)	0.2127**	0.4308***	–0.3123***	0.0600	0.4620***	1		
7	D_CAPCITY	0.1945**	0.2572***	–0.0960	0.2400***	0.3287***	0.3602***	1	
8	D_CEE	–0.1651*	–0.5046***	0.4959***	0.0537	–0.4937***	–0.1456	0.2062**	1

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