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# The determinants of regional specialisation in business services: agglomeration economies, vertical linkages and innovation

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## Abstract

The article accounts for the determinants of sectoral specialisation in business services (BS) across the EU-27 regions as determined by: (i) agglomeration economies (ii) the region-specific structure of intermediate linkages (iii) technological innovation and knowledge intensity and (iv) the presence of these factors in neighbouring regions. The empirical analysis draws upon the REGIO panel database over the period 1999–2003. By estimating a Spatial Durbin Model, we find significant spatial effects in explaining regional specialisation in BS. Our findings show that, besides urbanisation economies, the spatial structure of intermediate sectoral linkages and innovation, in particular Information and Communication Technologies (ICTs), are important determinants of specialisation in BS. The article contributes to the debate on the global versus local determinants of regional specialisation in BS by restating the importance of the regional sectoral structure besides that of urbanisation. We draw policy implications by rejecting the ‘footloose hypothesis’ for BS.

**Keywords:** Business services, regional specialisation, agglomeration economies, services-manufacturing linkages, technological innovation, spatial Durbin model

**JEL classifications:** R12, L80, O3

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## 1. Introduction

Advanced economies—and increasingly some of the fast growing developing economies such as India (Dasgupta and Singh, 2005)—are experiencing processes of structural change that produce profound modifications in the sectoral structure of employment leading to specialisation in services (OECD, 2008). Processes of tertiarisation have been ongoing for several decades, resulting in an increasing number of attempts to identify, conceptually and empirically, its determinants and impact on aggregate economic growth (see Peneder, 2003; Peneder et al., 2003; Parrinello, 2004; Savona and Lorentz, 2005; Schettkat and Yocarini, 2006; Montresor and Vittucci, 2011, among the most recent studies).

A substantial part of the literature focuses on the impact of specialisation in a particularly dynamic branch of services—business services (BS in what follows)—on economic growth. BS have in fact exhibited higher rates of growth of employment, value added and productivity with respect to other branches of services and to the rest of the economy, contributing to cross-country differences of growth patterns (Francois, 1990; Rowthorn and Ramaswamy, 1999; Guerrieri et al., 2005; Kox and Rubalcaba, 2007a, 2007b).

An increasing emphasis has been put on the extent to which cross-country growth divergences in Europe are to be found in regional polarisation patterns of employment and productivity growth (Guerrieri et al., 2005; Fagerberg et al., 1997; Meliciani, 2006; Sterlacchini, 2008 among others). In this context, disentangling the factors that drive the increasing BS specialisation at a regional level is therefore of great importance to understand its impact, shed light on the on-going divergence of growth rates across regions in the EU and appropriately target industrial and innovation policy at the sub-national level (OECD, 2011).

It has been argued that information and communication technologies (ICTs) allow BS to increasingly access global and distant markets, favouring their location in an a-spatial context and leading to a ‘global flat world’ (Friedman, 2005).<sup>1</sup> This view supports the ‘footloose hypothesis’, according to which business and knowledge-intensive services would locate *independently* from proximity to urban areas, other industries and any region-specific characteristics. According to the ‘footloose hypothesis’, BS would therefore show high responsiveness to regional policy favouring their localisation in peripheral regions (for a discussion and rejection of the ‘footloose hypothesis’ see Muller and Zenker, 2001; Wernerheim and Sharpe, 2003).

However, geographers and regional scientists have pointed out that ICTs have rather led BS to locate toward the top of urban hierarchy, as large metropolitan areas allow BS to access both global and national dispersed markets (Shearmur and Doloreux, 2008). This view relies on the implicit assumption that geographical proximity between BS and their user sectors is not necessary or that BS mainly serve other high skilled and knowledge-intensive services, also concentrated in large urban areas.

In line with the regional science literature, emphasising the centripetal role of large metropolitan areas for BS location, this article challenges the ‘global flat world’ view (Friedman, 2005). However, unlike most regional scientists, we also argue that the *local* dimension of BS specialisation goes beyond the agglomeration in large urban areas. Both *spatial* and *sectoral contiguity* (van Oort, 2007; Raspe and van Oort, 2007), which need to be captured within a larger spatial unit of analysis than the city, explain much of the BS specialisation across European regions.

In particular, we argue and empirically show that both the presence of Hirschman forward linkages<sup>2</sup> between BS and their manufacturing user sectors and of an innovation-prone regional environment are important determinants of location of BS. These findings entail regional policy implications that substantially challenge the ‘footloose hypothesis’. Rather, they support the view that public policy should aim at guiding the processes leading regions into new growth paths through diversification and

1 See Rodriguez-Pose and Crescenzi (2008) for a review of the debate on the ‘flat world’ view.

2 The structure of intermediate linkages is often acknowledged in the regional literature as the presence of Hirschman forward and backward linkages affecting regional specialisation and growth polarisation (Hirschman, 1958; McCann and van Oort, 2009). This aspect is discussed more at length in Section 2.

technological upgrading in related sectors (Frenken et al., 2007; Asheim et al., 2011) which would entail an increasing demand for knowledge-based BS.

The location determinants of BS are to be found *both* in the centripetal forces of large metropolitan areas *and* in the centrifugal forces away from urban areas linked to the location of related manufacturing sectors within the larger region (and across them).

To support our claims, we consider BS specialisation of regions as an outcome of three different sets of determinants, themselves interlinked:

- The classical sources of *agglomeration economies*, in particular localisation and urbanisation externalities;
- The role of *intermediate demand*, in particular the structure of intermediate linkages between BS and their manufacturing users and the region-specific sectoral structure;<sup>3</sup>
- The region-specific innovation and knowledge infrastructure, particularly the ICT intensity.

We also claim that all the above determinants have a strong spatial dependence. We expect that BS specialised regions tend to cluster and we ask whether and how the presence of urbanisation economies, intermediate demand and an innovation-prone environment in neighbouring regions affect the BS specialisation of the typical region.

Unlike previous studies, we rely on the most advanced applications of spatial econometrics techniques, specifically designed to capture the spatial effects in the determinants of specialisation in BS across the EU-27 regions pooled over the period 1998–2003.

Overall, our contribution—as prompted by Shearmur and Doloreux (2008) and Doloreux and Shearmur (2012)—aims at integrating geography, regional science and the innovation literatures on BS.

The remainder of the article is organised as follows: Section 2 reviews the different sets of literature evoked above (agglomeration, linkages and innovation). Section 3 builds upon these literatures to formulate our main research questions, and identifies our contribution with respect to the existing relevant empirical literature. Section 4.1 summarises the theoretical constructs derived by the literature and translates them into empirical proxies; Section 4.2 provides a descriptive picture of BS specialisation across the EU regions; section 4.3 explains the econometric strategy while section 4.4 discusses the results of the Spatial Durbin model estimations. Section 5 draws the main conclusions and policy implications.

## **2. Regional specialisation in BS: agglomeration, intermediate demand and innovation determinants**

Before engaging into the conceptual determinants of regional specialisation, we briefly provide a review of the definitional boundaries of BS. The service activities that are intermediate in nature—that is, primarily serving other sectors rather than final

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3 We are aware that a substantial share of intermediate demand comes from business services themselves—as put forward by Wood (2006) among others. However, we are interested in the specific linkages between manufacturing and business services so to purposely address the new path of specialisation in BS of traditional manufacturing-based regions that might explain the localisation of BS outside urban areas (see also Section 4.1).

consumers—and /or characterised by a high technological and knowledge content have been variously addressed in different literatures. The geography and regional science literature have referred to them as HOPS—Higher Order Producer Services (Shearmur and Doloreux, 2008; Coffey and Shearmur, 1997), whereas the innovation literature has put forward the term KIBS—knowledge-intensive business services (Miles, 2005; den Hertog, 2000; Wood, 2006). The subsets of services that these labels refer to are in fact almost identical (computing and related activities, R&D, other BS including, among others, engineering and technical consultancy). A third, overarching issue has been put forward by Daniels and Bryson (2002) (see also Bryson et al. 2004) that is the increasing blur between manufacturing and BS. Daniels and Bryson suggest that the actual sectoral boundaries should be now based on the knowledge intensity rather than the statistical classification.<sup>4</sup> Bearing these stands in mind, and our aim of contributing to bridge the geography and innovation literature, we choose here to refer to the neutral denomination of BS, including R&D, Computing and other BS.<sup>5</sup>

### 2.1. The spatial dimension of BS specialisation: agglomeration economies

The classical theories of agglomeration economies date back to the contribution of Marshall in the late 19th century and have since sparked a substantial amount of theoretical and empirical work (for a historical review, see McCann and van Oort, 2009; see also van Oort, 2004, 2007; Burger et al., 2008).

Traditionally, the sources of agglomeration economies are to be found in:

- *localisation externalities* stemming from sectoral density, which favours internal and external economies of scale, though these depend on the specific sector (see for instance Combes, 2000; van Oort, 2007).
- *urbanisation externalities*, while independent from the sectoral structure, are due to urban and population density, which facilitate knowledge spillovers (Glaeser et al., 1992, 1995; Henderson et al., 1995).
- *Jacobs' externalities* deriving from the variety of activities within urban contexts (Jacobs, 1969; Duranton and Puga, 2000; Duranton and Puga, 2005). This type of externalities tends to be higher in regions with a relatively higher *related* rather than *unrelated* variety of urban activities (Frenken et al., 2007; McCann and van Oort, 2009).

Agglomeration economies have been analysed mainly with respect to their impact on regional growth and development and rarely accounted for as a determinant of sectoral specialisation, even when the sectoral dimension has been explicitly taken into account (Combes, 2000; van Oort, 2007). Raspe and van Oort (2007) argue that *geographic, dynamic* and *sectoral* context-dependency in the analysis of agglomeration effects has been overlooked and would deserve major attention.

In the case of BS, the theoretical agglomeration literature has mainly highlighted a specific role for large urban areas as attractors of BS (Jacobs, 1969; Duranton and

4 Although we are aware of the importance of this issue, in the context of our article we have no other choice than adopting the international standard industrial statistical classifications. We have to keep in mind that being increasingly difficult to separate service from production activities may lead to overestimate the spatial concentration of BS.

5 ISIC codes: 72 Computer and related activities; 73 Research and Development; 74 Other business services.

Puga, 2000). A further reason inducing BS to locate in regions with large urban areas is that they need to employ skilled labour and human capital (Kox and Rubalcaba, 2007a, 2007b),<sup>6</sup> which tend to be concentrated in cities (Glaeser, 1999; Karlsson et al., 2009).

The empirical regional agglomeration literature specifically focused on BS is not very large and mainly based on the case of Canada. Here it is worth mentioning the studies by Polèse and Shearmur (2006), Shearmur and Doloreux (2008) and Wernerheim and Sharpe (2003), who show interesting though somewhat heterogeneous findings. While Polèse and Shearmur (2006) find that *some* BS followed their *manufacturing* clients out of central urban areas, Shearmur and Doloreux (2008) show that KIBS that serve a manufacturing base may consider to be sufficiently close to their markets by being based in large urban areas and will not necessarily leave them. In line with Polèse and Shearmur (2006), Wernerheim and Sharpe (2003) provide very interesting insights, showing that locational advantages are not actually responsive to government policy aiming at favouring location of KIBS in peripheral areas, in the absence of a supporting manufacturing sector, or in general of close proximity to customers, rejecting therefore the ‘footloose hypothesis; (Wernerheim and Sharpe, 2003).

All in all, the arguments of agglomeration economies put forward by both the theoretical and empirical literature suggest that localisation and urbanisation externalities favour regional specialisation in BS, which tend to cluster in dense urban areas with a strong functional specialisation in knowledge-intensive and high-skilled activities. However, the issue of whether this tendency is outweighed by the centrifugal force to follow manufacturing clients (not necessarily based within large cities) remains open. Knowledge flows more fluidly where both *spatial* and *sectoral* contiguity are relatively high (Raspe and van Oort, 2007; Frenken et al., 2007). While the importance of spatial contiguity and urbanisation externalities has been largely acknowledged in the regional literature, less attention has been devoted to sectoral interdependencies. We turn to this in the next section.

## 2.2. Intermediate demand and inter-sectoral linkages

In a seminal contribution, Hirschman (1958) identifies different types of externalities, depending on whether activities are related to one another by forward or backward linkages, that is, whether certain sectors concentrate where their clients are located or, rather, migrate where new or growing supplier sectors are located. These aspects—along with the one more specifically related to the structure of intermediate linkages between BS and their users—are particularly important in the context of this work, as BS are characterised by strong supplier-user interactions (Muller and Zenker, 2001; Miles, 2005), making the geographical proximity of customer industries particularly relevant.

Aside from the regional literature, several authors have argued that the rise of services, particularly of BS, over the past 30 years is mostly due to changes in the production processes in many sectors and to the ensuing increase in the demand for services as intermediate goods (Francois, 1990; Rowthorn and Ramaswamy, 1999; Guerrieri and Melicani, 2005; Savona and Lorentz, 2005; Francois and Woerz, 2007).

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6 For a recent review on the role of human capital in regional development see Faggian and McCann (2009).

The growing complexity in the organisation, coordination and distribution of manufacturing production resulting from new technologies has raised the service content of many manufactured goods, which goes well beyond the simple ‘outsourcing’ or ‘contracting out’ of services (Ten Raa and Wolff, 2001; Miozzo and Soete, 2001).

Recent studies investigate the pattern of inter-sectoral linkages between BS and manufacturing. Guerrieri and Meliciani (2005), using Input–Output data, show cross-country regularities in the intensity of use of Financial, Communication and Business services (FCB). In particular they find that knowledge-intensive manufacturing industries make considerable use of FCB services, while labour- and scale-intensive industries are, on average, low or medium users of FCB services. Similar results are found by Francois and Woerz (2007), who show how BS serve especially knowledge-intensive industries. Empirical support to the key role of intermediate demand—rather than final consumption or trade—in explaining the growth of BS is also provided by Savona and Lorentz (2005) (see also Kox and Rubalcaba, 2007a, 2007b; Montresor and Vittucci, 2011). Moreover, Nefussi and Schweltnus (2010) show that the downstream demand by French manufacturing firms has a positive effect on the location choice probabilities of French business services firms.

Overall this literature suggests that the sectoral composition of regional economies and the nature of intermediate demand and inter-sectoral linkages are also important determinants of regional specialisation in BS. However, intermediate demand is ‘blind’ with respect to localisation. Sectoral contiguity may or may not need spatial contiguity, depending on the importance of face-to-face contacts between BS suppliers and manufacturing clients. When spatial proximity is essential and manufacturing clients are located outside urban areas, intermediate manufacturing demand might counter-balance the centripetal force of urbanisation in attracting BS.<sup>7</sup> The relevance of spatial contiguity also depends on the nature of technological innovation in BS, discussed in the next section.

### 2.3. Innovation in BS

There is increasing evidence that many service firms, and in particular BS, play important roles in innovation, not only in the use, but also in the creation and diffusion of new technologies and non-technological modes of innovation compared to their manufacturing sectors counterparts (Evangelista, 2000; den Hertog, 2000; Tether, 2005; Cainelli et al., 2006; Gallouj and Savona, 2009; Abreu et al., 2010). Here we focus on how the codified and tacit components of knowledge characterising innovation in BS are expected to affect the patterns of BS localisation.

On the one hand ICTs have increased the stockability and transportability of information, thus favouring the division of innovative labour and the emergence of knowledge-specialised functions (Ciarli et al., 2012). Also, ICTs have changed the way in which services are produced, organised and delivered allowing them to be produced in one place and consumed simultaneously in another one (Evangelista, 2000; Van Ark

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7 Although this effect might depend on the distance between urban areas and location of manufacturing plants outside cities, our conjecture is that there are regions specialised in high BS-intensive manufacturing sectors that are far enough from large urban areas to partially counter-balance the impact of urbanisation on BS location.

et al., 2003). To the extent that BS can be used and produced anywhere and traded on the global market through the use of ICTs, the importance local factors in general and of the local innovation environment in particular fades away, in line with the ‘global flat world’ view (Friedman, 2005).

However, on the other hand, we argue that the adoption and diffusion of innovation in BS requires a substantial share of tacit knowledge. In fact BS—and KIBS in particular—can be seen as a dynamic interface between codified and quasi-generic knowledge (produced and stored in universities and R&D laboratories) and tacit knowledge embedded within firms. The role of tacit knowledge in the relationship between BS and their clients increases the importance of spatial proximity (den Hertog, 2000; Muller and Zenker, 2001; Raspe and van Oort, 2007; Antonietti and Cainelli, 2008; Shearmur and Doloreux, 2008; Ciarli et al., 2012) and suggests that the location of BS might not be independent from the local innovation environment. Doloreux and Shearmur (2012) indirectly support this view by claiming that KIBS are a core actor in innovative regions, enhancing the network of collaborations for innovation, suggest that KIBS not only provide a one-directional transfer of specialised information, but are also co-producers of knowledge in a process that involves their clients intimately (see also Muller and Doloreux, 2009).

Alongside ICTs, complementary local assets, such as the availability of highly skilled human capital and public R&D infrastructures, contribute to the creation of an innovative ecosystem able to favour BS localisation. High public R&D expenditures at the regional level favour innovation in high-tech manufacturing sectors and are expected to (indirectly) positively affect regional specialisation in BS.<sup>8</sup>

Overall, the factors that *complement* the use of ICTs and knowledge for innovation in BS tend to be region-specific, leading BS to concentrate not only in large urban areas—where highly skilled human capital is relatively more available (see Section 2.1)—but also in specific regions, where ICTs and public R&D not only support innovation in BS, but also facilitate the location of their high-tech manufacturing sectors clients.

### **3. Regional specialisation, innovation and BS: key research issues**

The determinants of regional specialisation in BS, identified by the sets of literature reviewed in the previous section, have been (separately) accounted for by two different research communities. Here we summarise the emerging key research questions.

On the one hand geographers and regional scientists have mostly focussed on the role of urban economies in the concentration of BS and/or the existence of centripetal and centrifugal forces shaping the distribution of these activities towards and away from large urban areas (Shearmur and Alvergne, 2002; Polèse and Shearmur, 2004, 2006).

The empirical stylised facts emerging from these contributions show that *BS are concentrated in large urban areas and that, despite the ICT revolution, location patterns*

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8 Since BS include private R&D, a related issue is that of complementarity or substitutability between private and public R&D. Although there is slightly more evidence supporting the presence of positive spillovers of publicly funded R&D on private R&D investments, in some cases the opposite evidence has also been found, with a displacing effect within the two (for a detailed review see David et al., 2000).



are highly stable over time and distance still matters. However, this stream of literature rarely takes into account *the role of larger regional factors (and in particular the role of intermediate demand and innovation related variables) in the localisation of BS.*

On the other hand, research on innovation, once recognised the role of BS (in particular KIBS) as producers and diffusers of knowledge, has also investigated their interaction with local factors and contribution to regional development (den Hertog, 2000; Muller and Zenker, 2001; Raspe and van Oort, 2007; Antonietti and Cainelli, 2008). More recently, first steps in the direction of analysing spatial patterns of KIBS and innovation have been undertaken (Shearmur and Doloreux, 2009; Doloreux and Shearmur, 2012).

However, Shearmur and Doloreux (2008) observe that these two streams of literature, although partly overlapping in the study of the determinants and the effects of BS localisation, have remained largely distinct to the extent that the same branch of activities has been referred to as HOPS in the geography literature and as KIBS in the innovation literature.

Finally, the third stream of literature reviewed above (Section 2.2), on the specific roles of intermediate demand and forward linkages, has, to our knowledge, rarely been accounted for in either the regional science or the innovation literature.

Our conceptual contribution is not only in the joint account of all the theoretical blocks above, but also in the explicit consideration of the role of Hirschman linkages, which further supports the theoretical stand of the importance of *both* spatial and sectoral proximity and challenges the view that ‘the world is flat’ (Friedman, 2005; Crescenzi et al., 2007; Rodriguez-Pose and Crescenzi, 2008).

More specifically, we address the following research questions:

- What are the main determinants of regional specialisation in a particular set of sectors, BS, among those traditionally considered by the regional science and innovation literatures?
- To what extent do *geographical* distance (i.e. concentration in large metropolitan areas), *sectoral* contiguity and innovation ecosystem matter in the location of BS?
- In particular, does the presence of Hirschman-type of linkages between BS and high BS-users manufacturing sectors *require* spatial proximity and therefore affect BS regional location?
- Does the presence of urbanisation economies, intermediate demand and an innovation-prone environment in *neighbouring* regions affect BS specialisation in the typical region and how?

Should our findings corroborate our hypotheses, this article would allow a solid empirical support to crucial policy implications, namely the rejection of the ‘footloose hypothesis’ mentioned above and the formulation of regional and innovation policies which are sensible to the spatial sectoral structure.

## 4. The spatial determinants of specialisation in BS. Empirical analysis

### 4.1. A summary of the variables included in the econometric analysis

Table 1 provides a synthesis of the hypotheses derived from the literature reviewed in the previous sections. These are translated into operational variables and empirical

**Table 1.** A summary of the variables included in the econometric model

Theoretical constructs	Operational variables	Proxy
Agglomeration economies (Section 2.1)	<i>Localisation externalities</i>	BS: specialisation in BS
	<i>Urbanisation externalities</i>	AGGL: POP: population density CAPITALS: regions with capital cities
Intermediate demand (Section 2.2)	<i>Hirschman's forward linkages</i>	INTDEM: weighted share of employment in manufacturing industries that are high users of BS over total employment
Innovation in services (Section 2.3)	<i>Information and communication technology</i>	ICT: patents in ICT over population
	<i>Public expenditures in R&amp;D</i>	RD: public R&D expenditures over regional GDP
	<i>Human capital</i>	HC: share of population with tertiary education

proxies included as dependent variable and regressors in the econometric analysis (see Section 4.3).

Existing theories reviewed in Section 2 identify three sets of determinants that might affect BS regional specialisation: agglomeration economies; intermediate demand and Hirschman linkages between BS and their users; innovation. Each one of these theoretical approaches leads to identify operational variables (localisation and urbanisation economies; input-output linkages; ICT, public R&D intensity and human capital), which can be more easily translated into proxies for our empirical analysis.

Urbanisation economies (AGGL) were found in the literature to favour specialisation in BS, which tend to cluster in regions with urban areas and in general more densely populated. Therefore proxies of these economies are:

POP: the share of population over the regional area (population density);

CAPITAL: dummies for regions where capital cities are located.

Hirschman linkages in terms of intermediate demand for BS (INTDEM) are proxied by the weighted share of employment in manufacturing industries that are intensive users of BS over total employment. Intensive users are identified on the basis of the Eurostat symmetric Input Output tables in 2000, by considering the average use across the European countries included in the analysis. In particular, we take a vector measuring the use of services on output<sup>9</sup> for manufacturing sectors that are above average BS users and, for each region and year, we multiply it by total employment in

9 We normalise the use of BS for total sectoral output in order to take into account the size of the sector. Another possible normalization is for total sectoral inputs. In Evangelista et al. (2013) use both normalizations and find that they are highly correlated (the ranking of the sectors is similar).

each respective manufacturing sector; this number is then divided by the region's  $i$  total employment in year  $t$ :

$$INTDEM_{it} = \frac{\sum_{j=1}^m W_j E_{ijt}}{\sum_{j=1}^n E_{ijt}}$$

where:  $i$  is the region,  $j$  the sector,  $t$  the time,  $m$  the number of above average BS users manufacturing sectors,  $n$  the total number of sectors,  $E$  the employment,  $W$  the weight given by the average (across European countries) share of BS in total industry output as computed from Eurostat symmetric Input Output tables in 2000. The indicator is higher the higher is regional employment in manufacturing sectors that are intensive users of BS with respect to total regional employment for each year.

Table 2 reports the coefficients that are used as weights to construct our indicator. These are obtained by regressing the share of BS in total output on industry dummies for all European countries included in the analysis in the year 2000.

Consistently with Wood (2006), the table shows a high use of BS by other BS. Once we exclude intra BS demand, the other services that are major users of our aggregate of BS are insurance and financial services, post and telecommunication and wholesale and retail trade. Despite the importance of the use of BS by other services, as mentioned in the introduction, in this article we choose to focus on Hirschman linkages between BS and manufacturing sectors, for several reasons. First, this choice allows us to specifically look at the new path of specialisation in BS occurring in traditional manufacturing-based regions. This has important policy implications within the debate on developing a competitive service economy independently from the strength of the manufacturing base and challenging the 'footloose hypothesis' on the location of BS (see also discussion in Section 5). Second, since our BS sector includes various sub-sectors (R&D, computer and related activities and other BS), the intra-BS demand as a determinant of the typical region's BS specialisation can be empirically accounted for only when it comes from neighbouring regions, that is, it is captured by the spatial lag of the dependent variable. Finally, many inter-sectoral linkages between BS and other service sectors occur in large urban areas and are captured by the proxy of urbanisation economies.

Focussing on manufacturing sectors, Table 2 shows that those that make considerable use of BS are all (with the exception of Tobacco products) knowledge-intensive industries (printed matter and recorded media; chemicals and chemical products; office machinery and computers, radio, television and communication equipment and apparatus; medical, precision and optical instruments, watches and clocks), while labour- and scale-intensive industries appear, on average, to be low or medium users of BS. This pattern shows clear regularities across countries:<sup>10</sup> this allows us to expect that our indicator, that uses as weights the mean coefficients for above-average BS user industries reported in Table 2, is a good proxy for 'potential' intermediate demand.

10 The regression has shown that there are significant industry effects in explaining the use of BS across countries:  $R^2=0.67$ ,  $F=41.52$  significant at 1%. For more details, see Guerrieri and Meliciani (2005).

**Table 2.** Share of BS in total industry output in 2000, average across European countries

Above-average manufacturing industries	Share	Above-average service industries	Share
Printed matter and recorded media	8.2%	Computer and related services	19.5%
Chemicals and chemical products	8.1%	Other BS	17.5%
Office machinery and computers	8.0%	Research and development services	13.9%
Tobacco products	7.6%		
Radio, television and communication equipment and apparatus	7.3%		
Medical, precision and optical instruments, watches and clocks	6.4%		
Average manufacturing industries	Share	Average service industries	Share
Machinery and equipment n.e.c.	5.0%	Insurance and pension funding services, except compulsory social security services	10.5%
Electrical machinery and apparatus n.e.c.	4.8%	Services auxiliary to financial intermediation	9.0%
Other transport equipment	4.8%	Wholesale trade and commission trade, except of motor vehicles and motorcycles	8.9%
Rubber and plastic products	4.5%	Post and telecommunications services	8.1%
Food products and beverages	4.4%	Renting of machinery and equipment without operator and of personal and household goods	8.0%
Furniture; other manufactured goods n.e.c.	4.2%	Financial intermediation services, except insurance and pension funding services	7.7%
Wearing apparel; furs	4.1%	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	7.6%
Other non-metallic mineral products	4.0%	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods	6.7%
Below-average manufacturing industries	Share	Below-average service industries	Share
Motor vehicles, trailers and semi-trailers	3.9%	Supporting and auxiliary transport services; travel agency services	5.3%
Pulp, paper and paper products	3.7%	Water transport services	5.2%
Recovered secondary raw materials	3.5%	Air transport services	4.5%
Fabricated metal products, except machinery and equipment	3.4%	Hotels and restaurants services	4.1%
Textiles	3.3%	Real estate services	3.5%
Leather and leather products	3.0%	Land transport; transport via pipelines services	3.3%
Basic metals	2.8%		
Wood and of products of wood and cork (except furniture); articles of straw and plaiting materials	2.3%		
Coke, refined petroleum products and nuclear fuels	2.0%		
<i>Average</i>	4.7		8.4
<i>Standard Deviation</i>	1.9		4.5

Source: Eurostat Regio database.

Notes: Industries are defined as above (below) average when the share is higher (lower) than the average plus (minus)  $(1/2) \times$  standard deviation.

The operational variables capturing innovation (ICTs, public expenditure in R&D and human capital) are proxied respectively by:

ICT: patents in ICT over population;

RD: public R&D expenditures over GDP;

HC: human capital, measured as the share of population with tertiary education.

The choice of the proxies is determined by the theoretical and empirical findings reviewed in Sections 2 and summarised in Table 1 and by data availability. In particular, in the case of ICT, the share of patents was the only variable available at the regional level. While ICT spending could also be a meaningful proxy for the amount of ICT available at the regional level, the patenting activity is a better measure of the innovation output of ICT (Acs et al., 2002).

One of the overarching questions behind the selection of variables within a spatial econometric framework is the choice of the most appropriate spatial unit of analysis (Burger et al., 2008), known as the Modifiable Areal Unit Problem (MAUP). This refers to the different magnitude of the effects of agglomeration economies, depending on the spatial unit of analysis considered. The MAUP is both a theoretical and methodological problem (Burger et al., 2008; van Oort, 2007) and a priori hypotheses on the spatial extent of the phenomenon investigated should be specified. We are aware that the NUTS2 spatial level of aggregation is relatively large compared to the one traditionally used in spatial models and that regional contiguity may have different meanings depending on the size of the regions and the location of the centroids from which distances are measured (we will go back to this issue in the discussion of results). However, the choice of a NUTS2 level of spatial aggregation has also some advantages. First, we are interested in the regional spatial level of aggregation as we aim to contribute to the literature on the ‘construction of a regional advantage’ (Cooke and Leydesdorff, 2006). Second, it allows the inclusion of all the EU 27 regions rather than limiting the analysis to a single country. All in all, the lack of availability of spatial data at finer level of disaggregation with respect to NUTS2 does not allow us to consider MAUP-related aspects in this article. However, in the next section we will use spatial descriptive statistics that will allow a preliminary idea of the extent of spatial correlation of BS specialisation at the NUTS2 level. Specifying different distance matrices for all our variables will also help interpreting the results of the spatial econometric analysis. Further investigation of the MAUP with more disaggregated data will certainly be a part of our research agenda.

#### 4.2. Patterns of spatial correlation

In order to measure spatial correlation in BS and its determinants we have to specify the pattern of spatial interactions among regions as captured by the spatial weight matrix. The choice of the spatial weight matrix is important since it defines the boundaries within which spatial interactions occur and the intensity of these interactions. In the literature two main criteria are used to evaluate geographical connections: a *contiguity* indicator or a *distance* indicator.

In the first case, it is assumed that interactions can only exist if two regions share a common border (the contiguity indicator can be refined by taking into account the length of this common border). The problem with the contiguity matrix is that some regions might not share borders with any other region (this is the case of islands). Therefore this does not seem to be the best choice in our sample of European regions. We therefore rely on a distance-based matrix.

In the case of a distance matrix, it is assumed that the intensity of interactions depends on the distance between the regions. In defining a distance matrix various indicators can be used depending on the definition of the distance (great circle distance, distance by roads, etc.) and depending on the functional form we choose (the inverse of the distance, the inverse of the squared distance, etc.). Finally, a distance-cut-off above which spatial interactions are negligible must be chosen. Following, among others, [Dall'Erba and Le Gallo \(2008\)](#), we use the great circle distance between regional centroids. In particular each element of the spatial weight matrix is defined as follows:

$$w_{ij} = 0 \text{ if } i = j; w_{ij} = 1/(d_{ij}^k) \text{ if } d_{ij} \leq D \text{ and } w_{ij} = 0 \text{ if } d_{ij} > D$$

where  $w_{ij}$  is an element of the row standardised weight matrix  $\mathbf{W}$  (with row standardisation spatially weighted variables representing an average across neighbouring regions);  $d_{ij}$  is the great circle distance between centroids of regions  $i$  and  $j$ ;  $k$  defines the functional form and  $D$  is the cut-off parameter above which spatial interactions are assumed to be negligible.

In order to choose the functional form and the cut-off distance we rely on a-priori considerations on the scope of spatial interactions in our sample and on comparisons of the overall explanatory power of the model (as measured by the  $R$ -squared and log-likelihood) estimated with different spatial matrices as suggested by [Lee \(2009\)](#). Since our regions are already large (NUTS2), we choose the minimum bandwidth allowing each region to have at least one neighbour and we take the inverse of the distance (this is the matrix that maximises the  $R$ -squared and log-likelihood in regression analysis). The problem of the use of a cut-off is that it introduces discontinuities. However, we argue that the spatial spillovers that we are looking for occur within smaller distances and our unit of analysis (NUTS2) is already 'too large' to capture some of them. In any case we also test for robustness using larger distance bands and using the inverse of the squared distance ( $k = 2$ ).<sup>11</sup>

Spatial correlation is assessed by means of the Moran's  $I$  statistic (a measure of global spatial correlation), by the Moran scatterplot ([Anselin, 1996](#)), and the Moran local indicator of spatial association 'LISA' ([Anselin, 1995](#)). Moran's  $I$  statistic gives a formal indication of the degree of linear association between the vector  $z_t$  of observed values and the vector  $Wz_t$  of spatially weighted averages of neighbouring values, called the spatially lagged vector. Values of  $I$  larger (smaller) than the expected value  $E(I) = -1/(n - 1)$  indicate positive (negative) spatial autocorrelation. Statistical inference is based

11 We are aware that the joint use of NUTS2 spatial unit of analysis and the basic Euclidean distance with a cut-off point is based on the implicit (strong) assumption that the heterogeneous geographical dimensions of EU regions and the effectiveness of transport networks within them are not deemed to substantially affect our results, which remain therefore exploratory in nature. Future work with more disaggregated data and precise information on transport costs will allow dealing with problems linked to differences in the size of the regions and in their accessibility.

on the permutation approach with 10,000 permutations (Anselin, 1995). Moran's *I* statistic is a global statistic and does not allow us to assess the local structure of spatial autocorrelation. The local Moran helps assessing whether there are local spatial clusters of high or low values (a positive value indicates spatial clustering of similar values (high or low) whereas a negative value indicates spatial clustering of dissimilar values between a region and its neighbours).<sup>12</sup> All statistics are computed in the final year of analysis (2003).

Figure 1 shows Moran's scatter and reports the associated global Moran's coefficient based on the distance matrix defined above for all the variables used in the regression analysis. The Moran function attempts to illustrate the strength of spatial autocorrelation using a scatterplot of the relation between a variable vector (measured in deviations from the mean) and the spatial lag of this variable.

The highest degree of spatial correlation (as measured by the global Moran coefficient) is found for patents in ICT over population and for manufacturing intermediate demand (respectively 0.545 and 0.424 both significant at 1%), followed by specialisation in BS and population density (with Moran values of respectively 0.344 and 0.330 both significant at 1%), while relatively low values are found for tertiary education (0.092) and public R&D (0.042).<sup>13</sup> In the case of R&D, the lack of spatial correlation is not surprising considering the importance of government choices (strengthening local advantages but also helping to reduce regional gaps). Also in the case of tertiary education, institutional and political factors might play an important role in the regional distribution of the variable as shown by the fact that many Greek and Polish regions have high values of the indicator while in Italy, UK and Germany there are very differentiated patterns not matching with geographical clusters (see Figure 1).

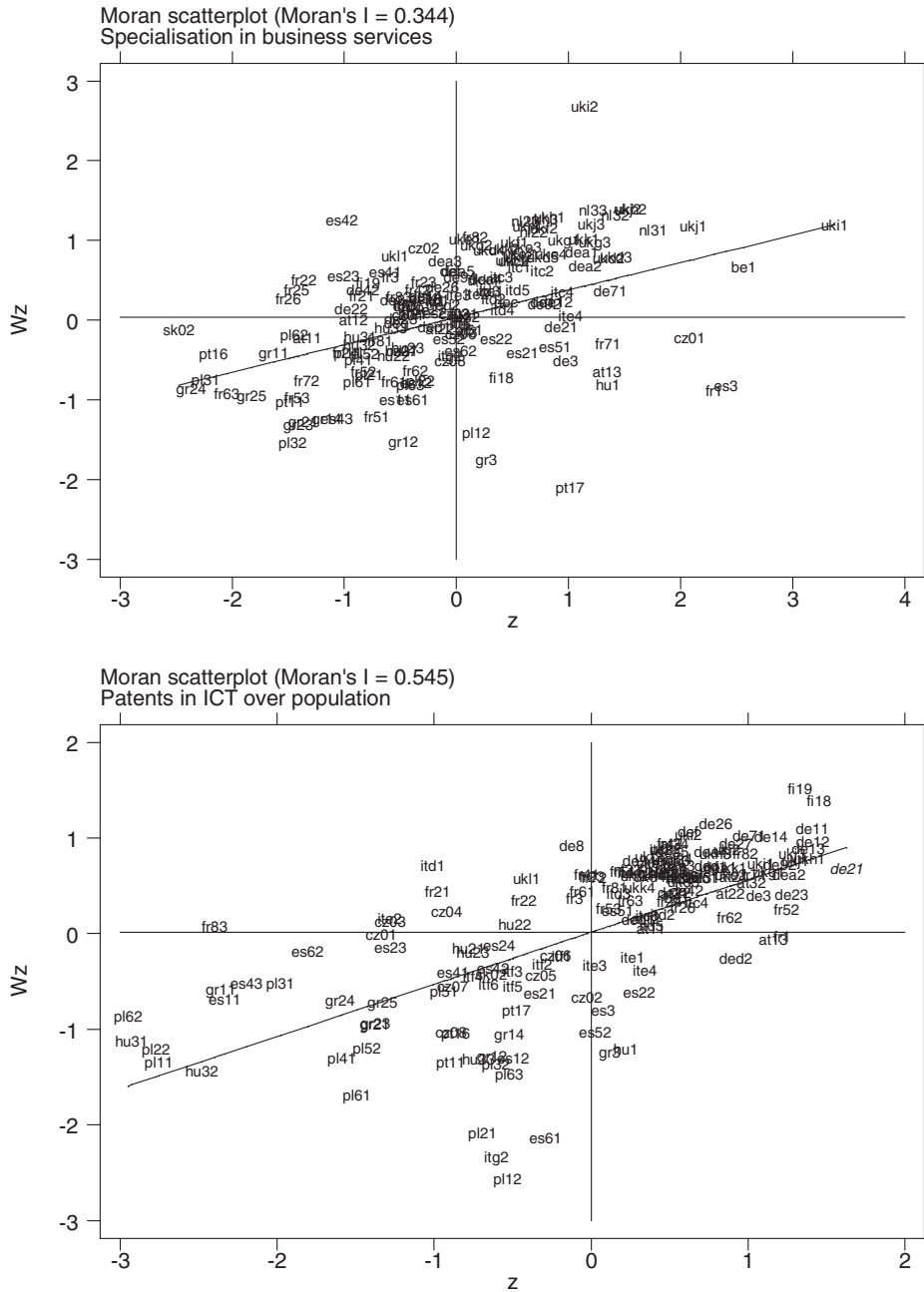
In the case of the ICT variable, there appears to be important clustering effects with most regions located in the upper-right or bottom-left quadrants (indicating positive spatial correlation respectively of high and low values), while only a few regions are located in the upper left or bottom right quadrants (indicating negative spatial correlation of respectively low (high) ICT regions surrounded by high (low) ICT regions). As shown by the local Moran statistics,<sup>14</sup> clusters of high ICT regions include South East and Central UK regions; the two Finnish regions; most German regions belonging to Nordrhein-Westfalen, Baden Wurttemberg (surrounded by the French region of Alsace) and Bayern (surrounded by the Austrian regions Salzburg and Vorarlberg). Clusters of low ICT regions include almost all Polish regions (with the two surrounding Eastern regions of Check Republic, Central Moravia and Moravskoslezsko); Eastern Hungary; Greek regions with the exception of Attiki and the cluster of two Portuguese regions (Norte and Centro) with two Spanish regions (Galicia and Extremadura).

With respect to intermediate manufacturing demand, clusters of high intermediate demand regions again include UK South Eastern (but not central) regions, not distant from the two French regions of Haute Normandie and Île-de-France; three Hungarian regions including the region of the capital and the two Western regions of Transdanubia; clusters of low manufacturing intermediate demand include again the cluster of Portuguese and Spanish regions (with again Norte and Centro of Portugal

12 For a thorough use of measures of LISA on European regions, see Ertur and Koch (2006).

13 In the case of public R&D the local Moran is not significant at conventional levels, while in the case of tertiary education it is low but significant.

14 Local Moran coefficients and their significance levels are available on request.



**Figure 1.** Moran scatter plot of dependent and explanatory variables. Distance band between 0.0 and 2.5;  $z$  = vector of each the variable in deviation from the regional mean;  $Wz$  = vector of spatial lags.

Source: EUROSTAT Regio database.

(continued)



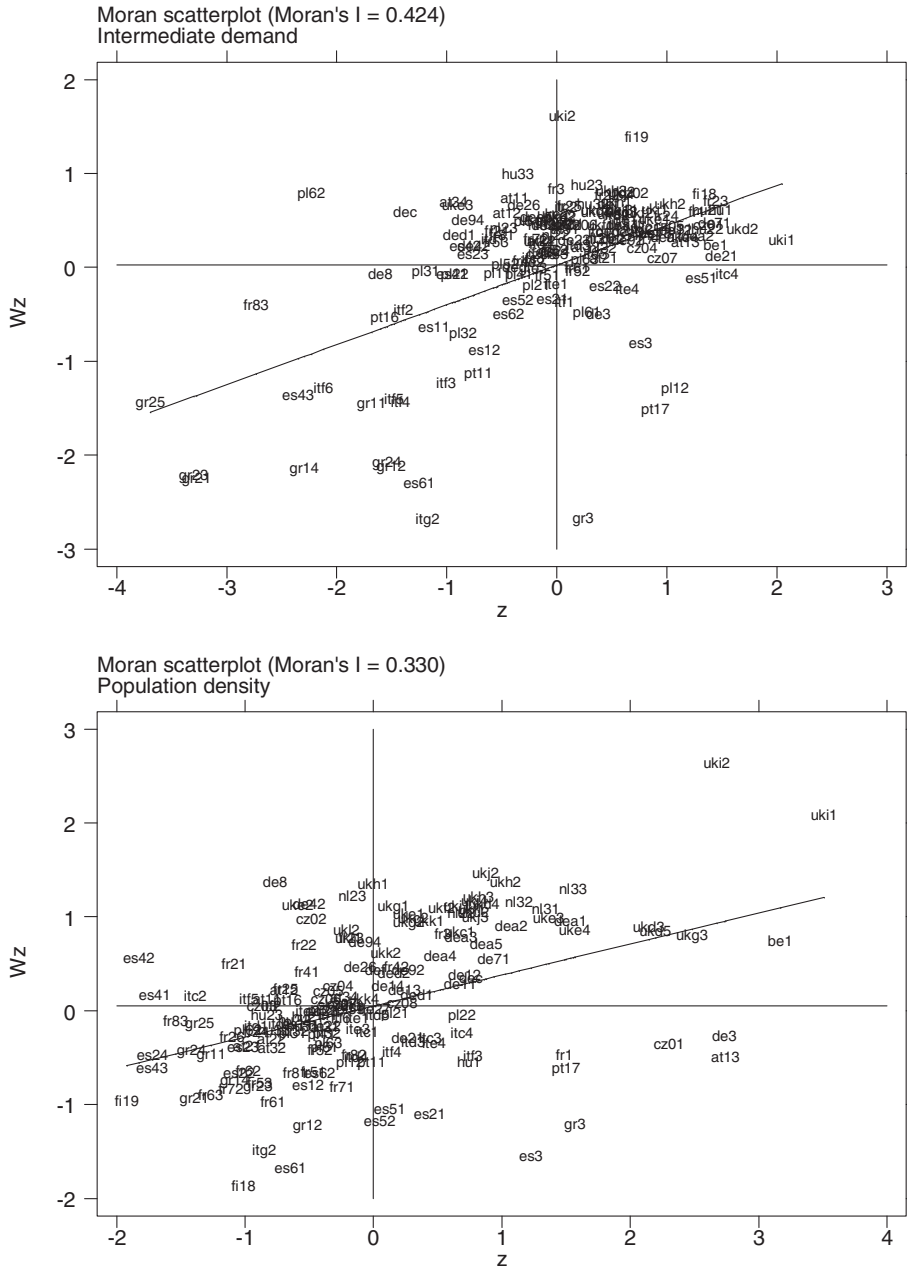


Figure 1. Continued.

and Extremadura but also Andalucia); the cluster of Greek regions and also a cluster of Southern Italian regions.

In the case of population density, negative values of local Moran (negative local spatial correlation) are found mainly for highly populated urban areas surrounded by

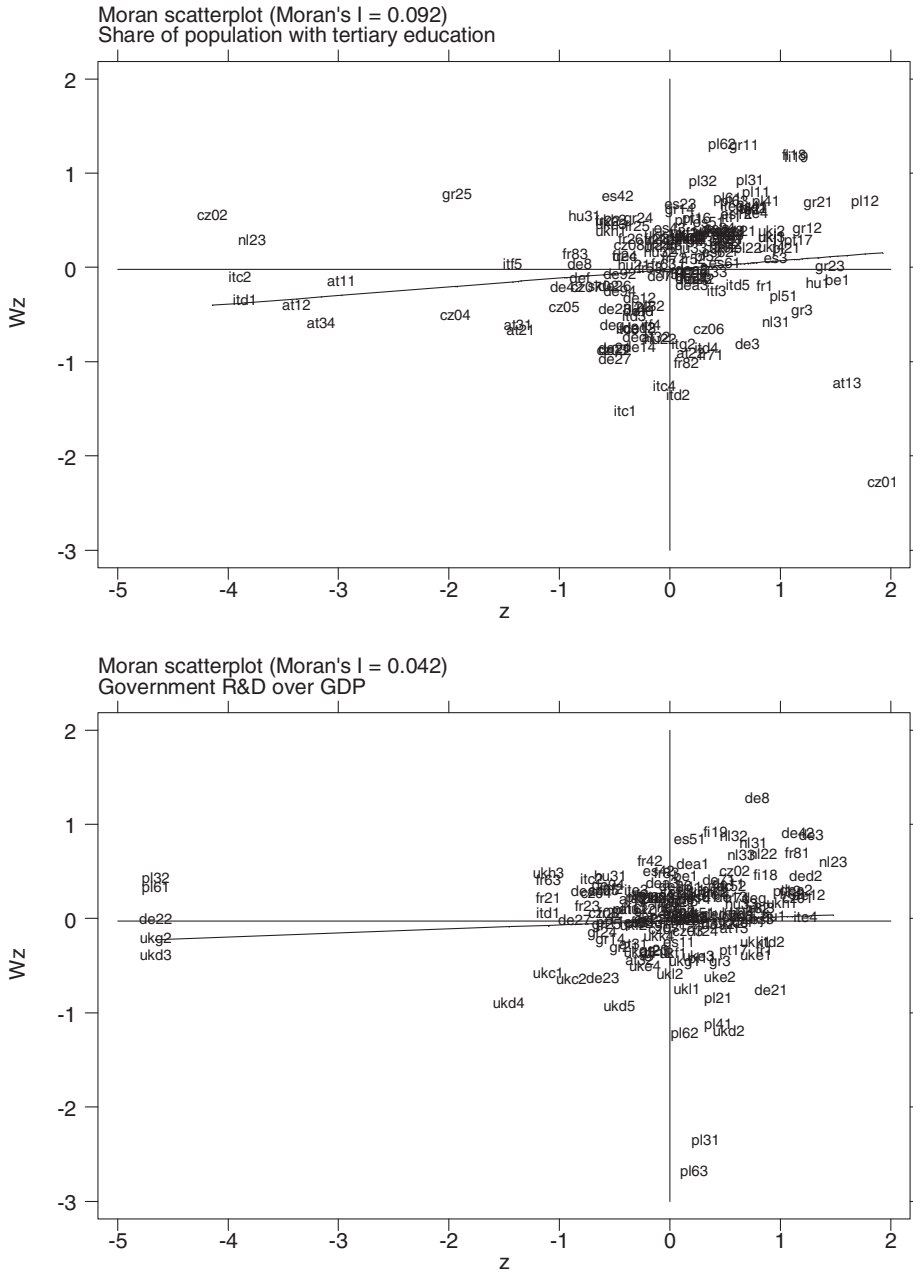


Figure 1. Continued.

less populated regions (this is the case, e.g. of Wien, Attiki, Comunidad de Madrid, Praha, Île-de-France, Berlin). Clusters of regions with high population density include several UK regions (mainly located in the South East, the area of London, South-West Yorkshire, East Midlands and North West); a group of Dutch (Western) and German (in the border area of Nordrhein-Westfalen) regions and Bruxelles.

populated areas include some Central and South Western regions of France (some of them, Aquitaine and Midi Pyrenées, sharing borders with low-populated Spanish regions: Comunidad Foral de Navarra and Aragon); Finnish and Greek regions.

As for specialisation in BS, we find many capital regions with negative local Moran coefficients; again there is a cluster of highly specialised regions including Dutch, Belgian and German regions and another cluster of UK regions; clusters with low values include also Polish regions and a group of Portuguese and Spanish regions (Norte and Centro of Portugal and the Spanish region of Extremadura).

Overall we not only observe some similarities, but also differences in the geographical clustering of our dependent and explanatory variables. These are summarised in Table 3 that reports the correlation coefficients for all variables and their spatial lags.

From the table we see that specialisation in BS is highly correlated with population density (0.75) and also with potential manufacturing demand (0.57), ICT (0.52) and capital cities (0.46). Lower, but still significant, correlation coefficients are found with public R&D (0.26) and tertiary education (0.21). Looking at the lagged variables, the highest correlation of specialisation in BS is found with its own lag (0.45). Significant positive correlation is also found with lagged ICT, lagged population density and lagged potential manufacturing demand, while negative correlation is found with lagged tertiary education and lagged capital cities<sup>15</sup> (this last significant only at 10%); finally no relationship is found with lagged R&D. Looking at correlation among the explanatory variables, the highest values are found between ICT and manufacturing demand (0.53) and between population density and regions with capital cities (0.51). Tertiary education is positively correlated only with population density, regions with capital cities and its own lag (with correlation coefficients respectively of 0.30, 0.34 and 0.16), while the only positive significant correlation coefficients for public R&D are found with regions with capital cities (0.23) and ICT (0.17, significant at 5%).

Overall, it appears that tertiary education and public R&D have low or not significant spatial correlation and are loosely (and in some cases even negatively) correlated with the other variables and their spatial lags. This is probably due to the relevance of institutional and political factors in affecting the spatial distribution of these variables.

Since specialisation in BS is the main variable of interest in the paper, the location quotient measuring specialisation in BS at the regional level<sup>16</sup> has been further used to map the EU regions in terms of BS specialisation in 2003 (Figure 2). Consistently with the Moran scatterplot, the map visually helps revealing the presence of an agglomeration pattern in the regional distribution of BS specialisation, with the main exceptions of the capital cities.

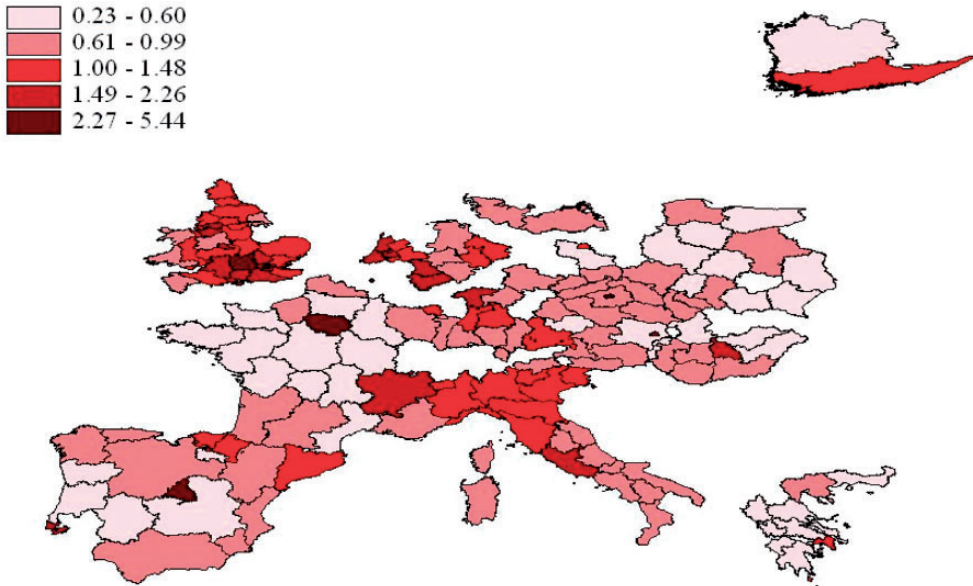
15 While the variable 'regions with capital cities' is a dummy variable, its spatial lag is not anymore a dummy variable but assumes values between zero and one depending on the distance with regions where capital cities are located (higher values indicating lower distance).

16 This is computed as employment in business services in region  $i$  over total employment of region  $i$  divided by employment in business services for all regions over total employment for all regions.

Table 3. Correlation coefficients among all variables and their spatial lags

	BS	INTDEM	POP	ICT	HC	RD	CAPITAL	LBS	LINTDEM	LPOP	LICT	LHC	LRD	LCAPITAL
BS	1													
INTDEM	0.572 (0.000)	1												
POP	0.749 (0.000)	0.483 (0.000)	1											
ICT	0.521 (0.000)	0.532 (0.000)	0.395 (0.000)	1										
HC	0.213 (0.006)	0.108 (0.168)	0.302 (0.000)	-0.054 (0.489)	1									
RD	0.260 (0.001)	0.125 (0.111)	0.099 (0.206)	0.172 (0.027)	0.107 (0.174)	1								
CAPITAL	0.462 (0.000)	0.309 (0.000)	0.510 (0.000)	0.130 (0.097)	0.345 (0.000)	0.233 (0.003)	1							
LBS	0.451 (0.000)	0.312 (0.000)	0.344 (0.000)	0.442 (0.000)	-0.197 (0.011)	0.056 (0.475)	-0.154 (0.049)	1						
LINTDEM	0.262 (0.001)	0.553 (0.000)	0.206 (0.008)	0.403 (0.000)	-0.203 (0.009)	0.033 (0.675)	-0.086 (0.271)	0.636 (0.000)	1					
LPOP	0.361 (0.000)	0.246 (0.001)	0.443 (0.000)	0.303 (0.000)	-0.177 (0.023)	-0.018 (0.818)	-0.090 (0.226)	0.815 (0.000)	0.549 (0.000)	1				
LICT	0.367 (0.000)	0.374 (0.000)	0.252 (0.001)	0.672 (0.000)	-0.225 (0.004)	0.093 (0.235)	-0.095 (0.226)	0.658 (0.000)	0.640 (0.000)	0.518 (0.000)	1			
LHC	-0.247 (0.001)	-0.231 (0.003)	-0.208 (0.007)	-0.319 (0.000)	0.161 (0.039)	-0.148 (0.058)	-0.075 (0.341)	-0.031 (0.690)	-0.085 (0.278)	0.082 (0.294)	-0.231 (0.003)	1		
LRD	0.098 (0.212)	0.060 (0.442)	-0.006 (0.934)	0.178 (0.022)	-0.188 (0.016)	0.086 (0.274)	0.092 (0.240)	0.167 (0.032)	0.090 (0.252)	0.064 (0.404)	0.223 (0.004)	-0.170 (0.029)	1	
LCAPITAL	-0.131 (0.096)	-0.058 (0.463)	-0.085 (0.280)	-0.097 (0.216)	-0.102 (0.196)	0.083 (0.286)	0.001 (0.987)	0.288 (0.000)	0.255 (0.001)	0.338 (0.000)	0.066 (0.404)	0.314 (0.000)	0.208 (0.007)	1

Note: p values in brackets.



**Figure 2.** Specialisation in BS in EU regions—location quotient in 2003.  
*Source:* EUROSTAT Regio database.

Many of the regions highly specialised in BS are regions where capital cities are located, in line with the urbanisation literature reviewed above (Glaeser et al., 1992; Glaeser, 1999 among others). This is the case not only in high-income countries, but also in Spain, Portugal and Greece and in some new entrant eastern countries (Közép-Magyarország: the region of Budapest; Praha).

When we exclude regions with capital cities, there appear to be some ‘country effects’ in the spatial map of specialisation in BS. In fact, all the Dutch regions and many UK (with some exception especially in the Western part of the country) and German regions appear to be highly specialised in these branches. On the other hand, none of the regions from new entrant countries, Portugal, Greece and Finland (with the exception of regions with capital cities, as mentioned above) show a comparative advantage in BS. Regions in Spain, France and Italy show a more mixed pattern. In particular Italy shows a North–South divide, while French and Spanish regions, while being on average de-specialised, show relatively higher values of specialisation at their borders.

A clear clustering effect in the location quotient mapped in Figure 2 emerges, confirming that the factors explaining the sectoral composition of regional employment in BS seem to spread to neighbouring regions. We test this in a spatial econometric framework in the next section.

### 4.3. Econometric strategy

Due to the existence of spatial correlation in most of our variables, specialisation in BS is estimated using a Spatial Durbin model (SDM). This is a general model that includes among the regressors not only the spatial lagged dependent variable, but also the spatial

lagged set of independent variables. In the context of panel data, it can be represented as follows<sup>17</sup>:

$$Y_t = \rho WY_t + X_t\beta_1 + WX_t\beta_2 + \lambda_t e_N + v_t \quad (1)$$

where  $Y_t$  denotes a  $N \times 1$  vector consisting of one observation for every spatial unit of the dependent variable in the  $t$ -th time period,  $X_t$  is a  $N \times K$  matrix of independent variables, with  $N$  = number of regions and  $K$  = number of explanatory variables;  $W$  is an  $N \times N$  non-negative spatial weights matrix with zeros on the diagonal. A vector or matrix pre-multiplied by  $W$  denotes its spatially lagged value,  $\rho$ ,  $\beta_1$  and  $\beta_2$  are response parameters and  $\lambda_t$  denotes a time specific effect, which is multiplied by a  $N \times 1$  vector of units elements and  $v_t$  is a  $N \times 1$  vector of residuals for every spatial unit with zero mean and variance  $\sigma^2$ .

Based on the hypotheses discussed in Section 4.1,  $Y$  is the regional share of employment in business services (BUS) and  $X$  is a matrix of explanatory variables including: the share of population over the regional area (POP), dummies for regions where capital cities are located (CAPITAL), the weighted share of employment in manufacturing industries that are intensive users of BS over total employment (INTDEM), patents in ICT over population (ICT), public R&D expenditures over GDP (RD) and the share of population with tertiary education (HC). All variables are in logarithms and the model is estimated for a panel of 164 NUTS2 EU27 regions drawn from the Regio database pooled over the period 1999–2003.<sup>18</sup>

LeSage and Fischer (2008) show that the SDM is appropriate, independently from economic considerations, when two circumstances are verified: (i) spatial dependence occurs in the disturbances of a regression model and (ii) there is an omitted explanatory variable (variables) that exhibits non-zero covariance with a variable (variables) included in the model. Moreover, it nests most models used in the regional literature. In particular, imposing the restriction that  $\beta_2 = 0$  leads to a spatial autoregressive model that includes a spatial lag of the dependent variable from related regions, but excludes these regions' characteristics. Imposing the restriction that  $\beta_2 = \rho\beta_1$  yields the spatial error model that allows only for spatial dependence in the disturbances. Imposing the restriction that  $\rho = 0$  leads to a spatially lagged X regression model that assumes independence between the regional dependent variables, but includes characteristics from related regions in the form of explanatory variables. Finally, imposing the restriction that  $\rho = 0$  and  $\beta_2 = 0$  leads to a non-spatial regression model. We choose the appropriate model on the basis of hypotheses testing.<sup>19</sup>

In our spatial regression that includes a spatial lag of the dependent and independent variables, a change in a single explanatory variable in region  $i$  has a *direct impact* on region  $i$  as well as an *indirect impact* on other regions (see LeSage and Fischer, 2008 for

17 Elhorst (2003, 2009) presents a more general panel model including also fixed effects and a dynamic specification. Due to the short time series available (1999–2003), we treat data as a repeated cross-section (pooled estimation).

18 The regions belong to the following countries: Austria, Belgium, Czech Republic, Germany, Spain, Finland, France, Greece, Hungary, Italy, Netherlands, Poland, Portugal, Slovakia and United Kingdom. Only regions for which there were enough data in order to construct a balanced sample by interpolating missing values were included.

19 Lagrange Multiplier tests and their robust versions are used to test the OLS versus the SAR and SEM; Wald tests are used for testing the SAR and SEM versus the SDM while the test of the SLX versus the SDM is a t-test on the coefficient of the spatial lag of the dependent variable.

a discussion). This result arises from the spatial connectivity relationships that are incorporated in spatial regression models; it raises the difficulty of interpreting the resulting estimates. [LeSage and Pace \(2009\)](#) provide computationally feasible means of calculating scalar summary measures of these two types of impacts that arise from changes in the explanatory variables. These routines have been extended by [Elhorst \(2010\)](#) to panel data model. In this article we use [Elhorst's \(2010\)](#) Matlab routines that allow to compute and direct and indirect effects.

#### 4.4. Discussion of econometric results

Since all the restrictions were rejected (see tests at the end of the table) we report results based on the more general model (spatial Durbin). Coefficients, direct, indirect and total effects of each variable with their asymptotic *t*-values are reported in [Table 4](#).

Looking at the direct effects, all the coefficients have the expected signs and are significant with the exception of tertiary education. Agglomeration economies, manufacturing intermediate demand and technology are all relevant factors in explaining specialisation in BS, as suggested by the literature.

Looking at the agglomeration variables, the dummy for regions with capital cities and population density are highly positively related to BS specialisation, confirming that urbanisation externalities are key determinants of regional specialisation in BS. It is interesting to observe that, even when included simultaneously, both population density and the dummy for regions with capital cities positively affect regional specialisation in BS, highlighting a specific role played by urban centres as attractors of these services. These results confirm the importance of geo-structural factors in the location of BS ([Polèse and Shearmur, 2004, 2006](#); [Shearmur and Doloreux, 2008](#)). High population density as well as the specific role of urban economies can also be interpreted as a (final) demand determinant of BS specialisation.

Intermediate demand from manufacturing industries also represents a major determinant of BS specialisation across regions. This result has important implications: on the one hand it suggests that urbanisation externalities are counter-balanced by the effect of centrifugal forces leading BS to locate outside urban areas; on the other hand it shows that the location of BS also depends on prior regional sectoral specialisation.

Our findings differ from those by [Shearmur and Doloreux \(2008\)](#), who observe that KIBS serving a manufacturing base in Canada may not necessarily leave metropolitan areas and consider to be sufficiently close to their markets. The different results may depend on differences in the scale of the analyses (European NUTS2 regions versus smaller regions in Canada)<sup>20</sup> or by differences in the time period considered ([Shearmur and Doloreux](#) find strong concentration of KIBS in 2001 but also observe that over the

20 As pointed out in Section 4.1, the questions addressed in our article are different from those addressed in studies conducted at the level of the city. In particular we ask whether regional specialisation in manufacturing sectors that are high users of BS favours BS location, that is, whether we observe regional agglomerates of BS and high BS user manufacturing industries that are independent from proximity to urban areas. The spatial unit of analysis in [Shearmur and Doloreux \(2008\)](#) might be too small to capture these effects. In particular when observing location in the neighbourhood of urban areas the centripetal forces of BS localisation in cities might prevail over the centrifugal ones (being surrounded by urban areas might have a displacing effect). However, this does not mean that there cannot be autonomous processes of location of BS far away from large urban centres in regions specialised in high-tech or traditional manufacturing sectors.

**Table 4.** The Determinants of specialisation in BS 1999–2003—SDM estimates

Variables	Coefficient	Direct effect	Indirect effect	Total effect
Intermediate demand	0.181 <sup>c</sup> (7.238)	0.178 <sup>c</sup> (7.194)	-0.063 (-1.075)	0.115 <sup>a</sup> (1.910)
Share of population with tertiary education	-0.000 (-0.036)	0.001 (0.112)	0.026 (0.634)	0.028 (0.569)
Patents in ICT over population	0.017 <sup>b</sup> (2.248)	0.019 <sup>c</sup> (2.592)	0.029 <sup>a</sup> (1.683)	0.048 <sup>c</sup> (2.682)
Government R&D over GDP	0.034 <sup>c</sup> (5.563)	0.035 <sup>c</sup> (5.375)	0.012 (0.468)	0.047 (1.634)
Population density	0.178 <sup>c</sup> (10.671)	0.185 <sup>c</sup> (11.663)	0.088 <sup>c</sup> (2.680)	0.273 <sup>c</sup> (7.784)
Regions with capital cities	0.390 <sup>c</sup> (7.362)	0.360 <sup>c</sup> (6.509)	-0.435 <sup>c</sup> (-2.770)	-0.074 (-0.415)
BS Specialisation in neighbours regions	0.487 <sup>c</sup> (12.896)			
Lagged intermediate demand	-0.121 <sup>c</sup> (-3.250)			
Lagged Share of population with tertiary education	0.015 (0.675)			
Lagged Patents in ICT over population	0.007 (0.690)			
Lagged government R&D over GDP	-0.010 (-0.742)			
Lagged population density	-0.038 (-1.585)			
Lagged regions with capital cities	-0.435 <sup>c</sup> (-4.979)			
LM spatial lag	148.12 <sup>c</sup>			
Robust LM spatial lag	6.268 <sup>c</sup>			
LM spatial error	226.22 <sup>c</sup>			
Robust LM spatial error	84.364 <sup>c</sup>			
Wald spatial lag = 70.23***				
Wald spatial error = 21.30***				
R <sup>2</sup> = 0.697				
Log-likelihood = -237.72				
Observations = 820				

Note: <sup>a</sup>, <sup>b</sup>, <sup>c</sup> indicate significant at the 10%, 5% and 1% levels, respectively. Time dummies are included.

period 1991–2001 KIBS grew faster in cities with good access to manufacturers and that this may be indicative of a growing local synergy).

Finally, as suggested by the literature on innovation in services (Antonelli, 1998; Muller and Zenker, 2001; Antonietti and Cainelli, 2008; Gallouj and Savona, 2009), ICT, proxied by the ICT-related patents over population across regions, has a large impact on BS specialisation. Also, the innovation environment and knowledge infrastructure of the region, proxied by public R&D, have a positive and significant impact on BS specialisation.<sup>21</sup>

21 Since we do not have a long enough time-series we cannot test for the direction of causality. We assume that the innovation environment is an 'attractor' of BS but we cannot exclude that the location of BS will in turn lead to a better innovation environment, through a self-reinforcing mechanism.



The lack of significance of the human capital variable is not expected on the basis of the empirical evidence found in the literature (Wernerheim and Sharpe, 2003; Shearmur and Doloreux, 2008). One possible explanation is that the impact of human capital on BS location is captured by other included regressors.<sup>22</sup> Also, the share of people with tertiary education might be a poor proxy of employees' abilities when we compare regions of different countries since the meaning of the variable can be different depending on the educational system. Moreover, due to lack of data on migration, we cannot assess in this context whether migration of high-skilled workers represents a factor of attractiveness for BS to localise in a particular region. Future studies might investigate whether other proxies measuring the availability of skilled workforce at the regional level might better explain regional specialisation in BS, as one would expect.

Overall, our findings on the role of technology for BS specialisation suggest that the cross-fertilisation between the literature on innovation in services (including the definition of a more refined set of variables measuring the innovation intensity and human capital) and the one on services' localisation is a promising avenue for further research.

Agglomeration, demand and technology factors favouring specialisation in BS within the region are well captured by the direct effects. Turning to spatial dependence, the highly significant coefficient of the lagged dependent variable (and some lagged independent variables) suggests the presence of clustering effects behind the determinants of BS specialisation. The positive coefficient of the spatial lag confirms the descriptive picture provided by the Moran scatter plot discussed above and establishes the spatial dependence in BS specialisation.

However, in order to disentangle the contribution of each explanatory variable to spatial dependence we have to look at indirect effects.

The signs and significance of indirect effects in the spatial Durbin specification provide interesting insight into the different roles of spatially lagged independent variables. There are two possible (equivalent) interpretations of these effects. One interpretation (the one that we adopt in our discussion) focuses on the effects that changes by some constant amount of each explanatory variable in all neighbouring regions have on the dependent variable of the typical region. LeSage and Pace (2009) label this as the *average total impact on an observation*. The second interpretation measures the cumulative impact of a change in each explanatory variable in region  $i$  over all neighbouring regions, which LeSage and Pace (2009) label the *average total impact from an observation* (see also Le Sage and Fischer, 2008).

Interesting results emerge from the indirect effects of agglomeration variables (capital cities and population density). In fact, while being surrounded by highly populated regions results into positive spillovers (positive and significant indirect effect), being surrounded by regions with capital cities exerts a negative indirect effect on specialisation in BS. It appears that in the case of capital cities there is a strong

22 Table 3 shows that human capital is significantly correlated only with the dummy for capital cities and population density, with correlation coefficients that are only slightly above 0.3, which is likely to exclude the presence of multicollinearity. We then checked for multicollinearity by computing variance inflation factors (VIF). These are between 1 and 2 for all variables (mean value 1.45), with the lowest value for human capital (1.11), suggesting that multicollinearity should not be a problem.

‘displacing’ effect with services-based activities moving away from surrounding areas to concentrate in urban centres. This result is consistent with the finding of Polèse and Shearmur (2006) that the most dynamic service industries are centrality-seeking and has important implications for the evolution of income disparities at the regional level: while the concentration of valued-added and knowledge intensive activities in large cities may foster regional growth, it could also cause negative externalities in surrounding areas.

When we look at the role of intermediate demand coming from neighbouring regions on BS in the typical region we find a negative but not significant indirect effect. This contrasts with the negative and highly significant coefficient of the lagged intermediate demand. It must be noted that the indirect effect takes into account the whole set of spatial interactions among regions as captured also by the positive spatial dependence in BS specialisation. A possible explanation of the lack of significance of the indirect effect is that the positive spillovers coming from intermediate demand in neighbouring regions are counter-balanced by a possible crowding out effect (the presence of high intensive users of BS in neighbouring regions might tend to ‘displace’ the BS specialisation in the typical region). Alternatively, it is also possible that the extent of forward linkages and related externalities are geographically more concentrated and cannot be captured at our level of aggregation (the NUTS2 level).<sup>23</sup> Overall, this result is in line with the theoretical and empirical literature stressing that, despite the ICT revolution, the adoption and diffusion of innovation in BS and user sectors still require a substantial share of tacit knowledge flows, which rely on spatial proximity and face-to-face contacts between suppliers and clients (Coffey, 1996; Antonietti and Cainelli, 2008).

Looking at the indirect effect of technology, we find mixed results. While the intensity of ICT in the close-by regions—proxied by the lagged patents in ICT over population—has a positive and significant impact on regional BS specialisation, the same does not occur for public R&D. This suggests the existence of ICT clusters (or ICT-related spillovers) that go beyond regional boundaries, while, surprisingly, these spillovers are not found for government R&D. A possible explanation could be the fact that knowledge spillovers of public R&D are not geographically confined. The finding of a positive direct effect but a non-significant indirect effect also suggests the existence of complementarities between a region’s public and private R&D (that is included in BS) but not between the same region’s private R&D and neighbouring regions’ public R&D. In this respect, the empirical literature has not provided a conclusive answer. Although the evidence supporting the presence of positive spillovers of publicly funded R&D on private R&D investments is larger, in some cases a displacing effect has also been found (see David et al., 2000).

Finally, it is interesting to underline that while the estimated coefficients of the SDM do not substantially differ from the direct effects, the coefficients of spatially lagged variables are misleading (they point to a negative impact of lagged intermediate demand

23 The results reported in Table 4 are based on a distance matrix with a cut-off distance of 2.5 (the minimum bandwidth allowing each region to have at least one neighbour) and where we take the inverse of the distance (see Section 3.2). Results are qualitatively the same if we take the inverse of the square distance. All results are stable to doubling the cut-off with the exception of lack of significance of the ICT indirect effect. This is not surprising since our unit of analysis is already large (NUTS2 regions) and, therefore, it is important to choose small distances if we want to capture spillovers effects.

and to a lack of significance of lagged population density and ICT) because they do not take into account the whole set of connectivity relationships that are incorporated in the spatial regression model.

## 5. Conclusions and policy implications

Our findings bear implications that not only challenge traditional regional development policies, but also inform European industrial and innovation policies, which are increasingly (and rightly so) designed at the regional level (Verspagen, 2007). In this section we go back to the relevant findings, and convey a few key messages to inform regional policy.

The first one relates to the polarisation in regional development that might result from the spatial concentration of BS. The second one challenges the actual effectiveness of traditional regional development policies relying on the hypothesis of ‘footloose’ service location (Wernerheim and Sharpe, 2003). The third one attempts to provide an alternative message for regional policy based on what can be inferred from our findings in terms of ‘construction of regional advantage’ (Asheim et al., 2011).

The spatial concentration of BS tends to reinforce the asymmetry between heartland and hinterland: while the location of valued-added and knowledge-intensive activities in large metropolitan areas may foster regional development, it could also cause negative externalities in surrounding areas. The emerging European picture, and forecast, is that of large metropolitan areas—even in new entrants, catching-up countries—leading the rank of regional development, as opposed to peripheral rural and ‘old manufacturing’ areas (Rodríguez-Pose, 1999; Chapman and Meliciani, 2012) which are left behind. This asymmetrical development pattern leads therefore new entrant countries to converge at the level of metropolitan areas and at the same time to diverge when considering the ‘old manufacturing areas’.

These findings, as mentioned above, are in line with those in Wernerheim and Sharpe (2003), who reject the ‘footloose hypothesis’, that the pervasive diffusion of ICT had led some scholars to put forward. According to this hypothesis, business and knowledge-intensive services would locate independently from proximity to other industries and from any region-specific characteristics. This would imply a higher responsiveness to regional policy supporting BS localisation in peripheral regions, aiming to generate localisation externalities and start a virtuous process of development. Instead, our findings have shown that BS tend to concentrate not only in large metropolitan areas, but also in regions where high-tech manufacturing and in general intensive manufacturing BS user are located, reducing *de facto* the effectiveness of subsidisation interventions aiming at facilitating location in regions not specialised in BS user sectors.

This leads us to our third point, which builds upon the contributions by Cooke and Leydesdorff (2006) and Asheim et al. (2011), on the ‘construction of regional advantage’. The debate on whether regional policy should aim to support regional specialisation or, rather, regional diversification (Glaeser et al., 1992) might be misleading: according to Asheim et al. (2011) public policy should aim at ‘guiding’ the processes leading regions to diversify into new growth paths, based on sectoral structural changes into ‘related’ sectors (see also Frenken et al., 2007). What is important from a policy perspective is the ability to build on regions’ existing specialisation, ensure technological rejuvenation of traditional sectors and move

towards knowledge-related sectors, which in turn enhance knowledge spillovers and reinforce the innovation ecosystem. Within this context, an appropriate mix of innovation and industrial policy might favour such technological rejuvenation of 'old manufacturing' and rural areas, which would entail an increasing demand for knowledge-based services and an 'up-grading' of existing sectoral specialisation toward innovative related activities.

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