THE SPATIAL DETERMINANTS OF SPECIALISATION IN BUSINESS SERVICES IN THE EU REGIONS

Valentina Meliciani (University of Teramo)

and

Maria Savona (SPRU, University of Sussex)

ABSTRACT

The paper accounts for the spatial dimension of sectoral specialisation in the business services across the EU-27 regions as determined by: (1) the region-specific structure of intermediate linkages (2) the sectoral specialisation in the neighbouring regions and (3) technological intensity. The empirical analysis draws upon Input-Output tables and REGIO databases over the period 1999-2005. Using spatial econometric techniques, we find that both inter-sectoral linkages and technological intensity are important determinants of specialisation in business services. We also find significant spatial effects in explaining regional specialisation in business services, which supports the argument of the literature on clusters and agglomeration economies.

Keywords: Business Services, Regional Specialisation, Services-Manufacturing Linkages, Input-Output, Spatial Auto-correlation, Technological Innovation.
JEL Codes: R12, L80, O3

1. Introduction

The 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 are producing profound modifications to the sectoral structure of employment towards services. With some variation across countries, there is a general pattern of a monotonically increasing share of service employment and a reduction in the manufacturing employment base (OECD, 2008a). This process of tertiarisation has been ongoing for several decades in Europe and advanced OECD countries, resulting in an increasing number of attempts to identify, conceptually and empirically, its determinants and impact on aggregate economic growth (see Klodt, 2000; Peneder, 2003; Peneder et al., 2003; Parrinello, 2004; Savona and Lorentz, 2005; Schettkat and Yocarini, 2006; Montresor and Vittucci Marzetti, 2007 among the most recent studies).

A substantial part of the literature has focused on the impact of specialisation in business services (BS in what follows[1]) on economic growth and internationalisation (Markusen, 1989; Francois, 1990b; Marrewijk et al., 1997; Rowthorn and Ramaswamy, 1999; Guerrieri et al. 2005; Kox and Rubalcaba, 2007a and 2007b). Business services not only have exhibited higher rates of growth of employment, value added and international trade with respect to other branches of services and the rest of the economy, but have also contributed to a process of reorganisation of the ways in which goods and services are produced, delivered and traded both within and across countries.

Disentangling what are the factors that drive the increasing BS specialisation of countries is therefore of great importance to understand its impact, shed light on the ongoing divergence of growth rates across countries in the EU and appropriately target industrial and innovation policy.

The analysis of the factors behind the growth of BS has emphasised several, intertwined reasons. Particular attention has been devoted to the role played by the development and diffusion of Information and Communication Technologies (ICTs) that have affected the linkages between manufacturing and service industries, on the one hand by increasing the service content of many manufacturing activities, and on the other by facilitating the "splintering" away of activities once performed inside manufacturing firms. The increasing production and use of ICTs has therefore increased the BS content of many sectors, changing the coefficients of intermediate demand and structure of inter-sectoral linkages at the national and international level (Francois 1990, Francois et al., 1996; Freund and Weinhold, 2002; Guerrieri and Meliciani, 2005; Savona and Lorentz, 2005; Francois and Woerz, 2007).

[1] BS include R&D, computer and related services and other business services.

The innovation literature supports this view by showing that BS show higher innovation intensity and make higher use of ICTs, highly skilled labour and intangible know how with respect to other services (Miozzo and Miles, 2003; Miles, 2005; Cainelli et al., 2006; Evangelista, 2006; OECD, 2008b; Gallouj and Savona 2009), representing a substantial innovation leverage for the rest of the economy via the changing inter-sectoral linkages (Muller and Zenker, 2001; Castellacci, 2008; Castaldi, 2009).

The literature on the role of ICTs and intermediate demand for the growth of BS has mainly focused on countries. However, recently, an increasing emphasis has been put on the extent to which cross-country growth divergences in Europe are to be found in regional polarisation of employment and productivity growth (Guerrieri et al., 2005; Fagerberg et al. 1997; Meliciani, 2006; Sterlacchini, 2008 among others). EU regions - all the more so after the enlargement to the Eastern EU countries - are an important target of industrial and innovation policies, in the belief that the source of divergence go well beyond the national boundaries, residing at the level of regional clusters.

In this context, it is crucial to identify the sectoral specificities of sources of productivity and competitiveness at the regional level. To do so, it is important to disentangle the determinants of BS specialisation also at a sub-national level.

Part of the regional literature has focused exclusively on innovation clusters and regional 'clubs' of technological change to explain regional polarisation in Europe (Moreno et al., 2005; Crescenzi et al., 2007; Verspagen, 2007; Sterlacchini 2008), neglecting the two-way relationship between sectoral specialisation – particularly in BS - and technology and innovation diffusion.

Other contributions, based on economic geography models, have focused on the role of demand and agglomeration economies to explain the spatial distribution of industries (Fujita, Krugman and Venables, 1999; Midelfart-Knarvik et al., 2000). Fast growing industries tend to spatially concentrate depending on the structure of backward and forward linkages. Forward linkages, for instance, affect the location of BS, which are highly dependent on intermediate demand by specific industries.

It is important to account for both the role of demand and agglomeration economies and the regional distribution of 'innovation clusters' behind the regional specificities of specialisation in BS. To our knowledge, there are no studies investigating both these determinants within a unified empirical framework.

This paper aims to fill this gap and add to the regional economic literature by providing an in-depth view of the spatial dependence in the determinants of specialisation in BS. Also, it intends to contribute to the literature on services – and innovation in services - by providing a spatial picture of the technological and intermediate demand determinants of BS specialisation, which have so far been looked mainly at the country level (Savona and Lorentz, 2005; Kox and Rubalcaba, 2007a).

In particular we empirically address in a spatial econometric framework the determinants of specialisation - across the EU-27 regions - in BS over the period 1998-2005, looking at the role played by: (1) the region-specific structure of intermediate linkages; (2) human capital; (3) a series of indicators of technological intensity; (4) agglomeration and urban economies and (5) country effects.

The remainder of the paper is organised as follows: Section 2 reviews the literature that informs the choice of the variables related to specialisation in business services; Section 3 explains the econometric strategy (3.1); provides a descriptive picture of BS specialisation across the EU regions (3.2) and discusses the results of the spatial and non spatial specifications of the model (3.3); Section 4 summarises the findings and draws the main conclusions of the paper.

2. Business Services and the changing structure of economies: Demand and supply determinants

The growth of services and the persistent change in the sectoral structure of countries have been regarded as a 'service paradox' (Baumol, 2001). This paradox lies in the empirical fact that advanced economies are continuing to experience sustained growth in real output and employment in services, despite the trend towards increasing input costs and prices. In an attempt to explain this paradox, Ten Raa and Schettkat (2001) call for a general 'change in demand conditions' not related exclusively to the changing patterns of final consumption which are linked to pure prices and income effects. As mentioned earlier, these changes are linked to intermediate demand and the structure of intermediate linkages. Also, increasingly, technical change, the increasing diffusion of ICTs and innovation favour services – and business services in particular - specialisation.

2.1 Intermediate demand and inter-sectoral linkages

Several authors have argued that the rise of services, particularly of producer and business services, in the last thirty years is mostly due to an increase in the demand for services as intermediate goods (Francois, 1990; Rowthorn and Ramaswamy, 1999; Klodt, 2000; Guerrieri and Meliciani, 2005; Savona and Lorentz, 2005; Francois and Woerz, 2007). The growing complexity in the organisation of manufacturing production and distribution resulting from the application and use of new technologies, and the significant increase in coordination problems has increased the service content of many manufactured goods (Miozzo and Soete, 2001). Bhagwati (1984) has suggested that producer services appear to be a growing sector in part because firms are externalising service activities that were formerly performed inside the firm. However the "splintering" away of activities once performed inside manufacturing firms does not fully explain the rise in producer services. In fact, producer services also represent an increasing share of the remaining activities still performed within manufacturing firms (Francois, 1990; Miozzo and Miles, 2003).

Recently, some studies have investigated the pattern of inter-sectoral linkages between producer services and manufacturing. Guerrieri and Meliciani (2005), using Input-Output data, have shown that there are some regularities across countries in the major users of Financial, Communication and Business services (FCB). In particular among the manufacturers that make considerable use of FCB services, they found mainly knowledge-intensive industries, while labour and scale-intensive industries appeared, on average, to be low or medium users of FCB services. Similar results are found by Francois and Woerz (2007) that show how business services are highly demanded especially by knowledge intensive industries. Empirical evidence supporting the growing role of intermediate demand for the growth of business services is also provided by Savona and Lorentz (2005) and Kox and Rubalcaba, (2007a and 2007b).

The change in demand conditions has also been tested in some formalised contributions. Lorentz and Savona (2008) propose a number of scenarios related to the process of tertiarisation on the basis of a micro-founded growth model, calibrated using actual data from OECD Input output tables. They test the validity of Baumol's cost disease[2] vs. a more Schumpeterian-like scenario and find that some of the most recent employment trends can be explained by innovation and changing patterns of intermediate demand within a Schumpeterian-like scenario.

Overall these results suggest that the structure of the economy (in particular its sectoral composition) and the nature of intermediate demand and inter-sectoral linkages affect the rise of Business services. In fact we expect countries/regions with a high share of activities in knowledge-intensive manufacturing (and services) industries to experience a higher demand for Business services and, therefore, to be more likely to specialise in these activities.

2.2 Technical change, ICTs and BS specialisation

Together with the role of intermediate demand, theory also suggests to look at technology and human capital. While services have long been considered laggard in terms of technology

[2] Baumol assumes that the demand for services and goods, measured at constant prices, does not depend on income levels and that, at the aggregate level, the share of services in total output is constant over time and across countries. However, as the increase in (labour) productivity levels is lower in services than in manufacturing, and combines with low productivity growth over time, high-income countries will experience higher shares of employment in services. The cost disease argument has for long been evoked to explain the employment performance of services from the gloomy perspective of technological stagnancy, which negatively affects productivity performance and, therefore, favors employment growth in services (for a recent reappraisal see Baumol, 2001).

development and adoption, there is increasing evidence that many service sector firms play important roles in innovation, and not only in the use, but also in the creation and diffusion of new technologies and non-technological forms of innovation. Most of the empirical literature in innovation in services is based on the Community Innovation Survey (CIS), a large-scale firm-level survey conducted across Europe. CIS allows accounting for a wider perspective on innovation: not only related to expenditures in R&D, but also non-R&D innovative input such as training, design, know how and marketing, besides expenditures in ICTs. This wider perspective on the nature of innovation activities is even more necessary for services where formalised R&D, and 'hard' technological activities play only a marginal role (Evangelista 2000; Tether, 2005; Cainelli et al., 2006; Gallouj and Savona, 2009; Abreu et al., 2010).

Some service sectors are not only among the major users of ICTs, but they also play a crucial role in diffusing technological improvements to others sectors: the diffusion of knowledge-intensive service industries is deeply affected by the parallel diffusion and implementation of the new information and communication technology systems (Soete, 1987; Antonelli, 1998; Miozzo and Miles, 2003). The intangible and information-based nature of services makes the generation and use of ICTs the central driver of firms' innovation activities. ICTs allow for increased stockability and transportability and they make it possible for services to be produced in one place and consumed simultaneously in another, affecting productivity performance (Evangelista, 2000; Van Ark et al., 2003; Cainelli et al., 2006, Crespi et al., 2006; Marrano et al., 2007,).

More recently, some authors have explicitly taken into account the different technological regimes and ICTs to revisit the famous Pavitt's sectoral taxonomy of technical change and include the role of services and BS in particular, which are found to be the 'specialised knowledge provider' of the advanced economies (Castellacci, 2008, see also Castaldi, 2009).

Together with the increasing role of innovation and ICTs in BS, human capital also appears as a crucial factor for these activities. Kox and Rubalcaba (2007b) find that the sector has a very strong orientation towards higher education, much more than most other industrial or service sectors. The European Labour Force Surveys as reported in Kox and Rubalcaba (2007b) indicate that in European countries in the aggregate manufacturing and services sectors the education profile of employees is dominated by the intermediate educational level. In manufacturing there is also a high share of workers with low education levels, while in services high levels of education prevail over low levels. When we look at the three categories of Business services considered in this study, both computer services and R&D services show very high shares of highly educated people. Moreover also in Other Business Services, despite the fact that this aggregate includes sub-sectors like cleaning or security services, which employ many low-skilled workers, the share of highly educated workers is high.

A further indication of the high educational profile in business services can be derived from the percentage of BS enterprises that provides their workers with any type of training. This indicator may reflect the extent to which workers are prepared to adapt to new requirements and manage to deal with increasing organisational and work complexity. Data for 2000 from the European Labour Force Survey indicate that in all EU15 countries, business services invest more in providing continuous vocational training (CVT) to their workers than the average for the total economy (Kox and Rubalcaba, 2007b). This evidence is supported in the case of single countries such as UK (see Abreu et al., 2010).

Summing up, it appears that Business services strongly rely on ICTs and innovation and make extensive use of highly educated people, therefore we expect that regional specialisation in these sectors is related to the regional availability of technology and human capital.

2.3 The spatial dimension of BS specialisation: Agglomeration economies

The changing structure of intermediate demand and inter-sectoral linkages and the increasing diffusion of technology and ICTs –responsible for the changing sectoral specialisation towards BS have been considered at the aggregate level, with some empirical contribution looking at the firm-level of analysis. However, to our knowledge, the spatial dependence and regional specificities of these phenomena have been much overlooked, exception made for traditional economic geography contributions looking at standard determinants of sectoral specialisation – agglomeration economies.

In the case of Business services the location of customer industries is particularly relevant, as we have seen that Business services are heavily demanded as intermediate inputs by specific manufacturing and service industries: agglomeration economies should also play a role in affecting the location of Business services.

These services (and in particular the sub-group of Knowledge Intensive Business Services, KIBS) are typically supplied to business through strong supplier user interactions (Muller and Zenker, 2001; Miles, 2005;), strongly relying on geographical proximity: “KIBS are confronted with the specific problems of their clients and thus they require most often direct contacts with them in order to conceive solutions by recombining existing knowledge and complementing it with new inputs if necessary. A high share of these interactions, especially in the starting phase of a consulting activity, is characterized by a strong tacit content, requiring personal contacts in particular: Proximity (geographical, social, cultural, etc.) is hence helpful to manage these phases”

(Muller and Zenker, 2001, p. 1506). Consistently with this, Antonietti and Cainelli (2007) find that spatial agglomeration, that is, the location of firms within a dense industrial area, where the probability of finding specialized external providers is high and which favours face-to-face contacts and close spatial interaction, is an important factor affecting the location of Business services.

An interesting study has been carried out on the US counties over the period 1972-2000 (Desmet and Fafchamps, 2005) to test the spatial distribution of service vs. non-service jobs. The results show that non-service jobs have been spreading out whereas service employment has been clustering in areas of high aggregate employment, supporting the conjecture that agglomeration economies works strongly for service employment.

Finally a specific role for large urban areas as attractors of business services has been highlighted in the literature. Duranton & Puga (2005) present a model of functional specialisation where multinational firms locate their "headquarter functions" in large urban regions. Such a location makes it possible for the headquarters to locally buy inputs from specialised business service firms in areas such as R&D, marketing, financing, law, exporting, logistics, etc. Moreover, the location of headquarters favours the co-location of specialised intermediate business service firms from which the headquarters can buy locally when they want to outsource various services. Another reason inducing the location of knowledge-intensive services in large urban areas is that they need to employ skilled labour and human capital tends to be concentrated in cities (Karlsson et al., 2009).

All in all, the argument of agglomeration economies put forward by the literature supports the intermediate demand determinant mentioned above insofar BS tend to cluster in urban areas with a strong functional specialisation in knowledge-intensive and high skilled activities.

3. The spatial determinants of specialisation in BS. Empirical analysis

As discussed in the previous sections, sectoral specialisation may depend on both supply determinants (factor endowments, technology), and, in the presence of transport costs, on the cross-country and/or cross-regional distribution of intermediate and final demand for each sector's output. Moreover agglomeration factors have been put forward by economic geography contributions and within the literature on urbanisation of particular regions. However, we have argued that none of these contributions has empirically tested the joint impact of all these factors on EU regional specialisation in BS taking into account possible spatial effects. This is the aim of the econometric analysis carried out in this section.

3.1 Econometric strategy

The estimated equation includes intermediate demand and technology determinants of BS specialisation also controlling for the role of agglomeration economies within the regions as well as for country-specific and time-specific factors. We, therefore, estimate the following equation for specialisation in Business services:

$$BS_{it}=\alpha_1 INTDEM_{it}+\alpha_2 TEC_{it}+\alpha_3 HC_{it}+\alpha_4 AGGL_{it+}e_{it} \qquad (1)$$

where:

- The dependent variable BS_{it} is the share of employment is business services over total employment of region i at time t[3];

- The regressor INTDEM captures the effect of regions' specialisation in BS user industries. This is proxied by the weighted share of employment in manufacturing industries that are high users of Business services over total employment. In order to construct the index of specialisation in manufacturing sectors that are high users of Business services for each region we take the weighted sum of employment in above average users manufacturing industries divided by total regional employment, where weights are given by the average (across countries) share of Business services in total industry output as computed from Eurostat symmetric Input Output tables (see Table 1 in the next section).

- The regressor TEC includes the supply/technological determinants of BS regional specialisation. The variables included are:

(i): public R&D expenditures over GDP;

(ii): Patents in ICT over population;

In order to construct the above variables, data on specialisation in business services have been integrated with data on regional technological intensity, human capital and population density. These data are also drawn from the Regio database. We use public R&D/GDP and the number of patents in ICT over population, as proxy of the technology intensity of a region.

- HC is the human capital, measured as the share of population with tertiary education;
- AGGL is a proxy of agglomeration economies, for which we include:

(i) the share of population over the regional area (population density);

(ii) dummies for regions where capital cities are located.

Country and time dummies are also included.

[3] From now on we omit the explanation of the suffix i and t which refer respectively to the region and to the time period. All the regressors included in the equation specification refer to region i at time t.

In line with the literature reviewed above, we conjecture that business services' firms are more likely to locate in regions with high levels of technological intensity and human capital availability and a sectoral specialisation that favours high demand for BS. We also argue that both our dependent variable and our explanatory variables are likely to be spatially related. Equation (1) is therefore estimated using both non-spatial and spatial econometric specifications, in order to test for the presence of spatial effects in the determinants of BS regional specialisation. In particular, we first estimate Equation (1) using a pooled Generalised Least Squares (GLS) for a panel of 168 NUTS2 EU27 regions over the period 1999-2003[4].

After providing descriptive evidence of the existence of spatial correlation in BS regional specialisation (Moran's coefficient and scatter plot), we then test the same equation using a Spatial Durbin model (SDM). This is a general model that includes amongst 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[5]:

$$Y_t = \rho W Y_t + X_t \beta_1 + W X_t \beta_2 + \lambda_t e_N + v_t \qquad (2)$$

where Y_t denotes a Nx1 vector consisting of one observation for every spatial unit of the dependent variable in the th time period, X_t is a NxK matrix of independent variables, W is an NxN non negative spatial weights matrix with zeros on the diagonal. A vector or matrix premultiplied by W denotes its spatially lagged value, ρ, β_1 and β_2 are response parameters, and λ_t denotes a time specific effect, which is multiplied with a Nx1 vector of units elements and v_t is a Nx1 vector of residuals for every spatial unit with zero mean and variance σ^2. We use a row standardised inverse distance spatial weights matrix choosing the bandwidth so that each region has at least one neighbour[6]. With row standardisation spatially weighted variables represent an average across neighbouring regions.

LeSage and Fischer (2008) show that this model is appropriate, independently from economic considerations, when two circumstances are verified: i) spatial dependence in the disturbances of a regression model and ii) 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

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

[5] Elhorst (2005) presents a more general panel model including also fixed effects and a dynamic specification. Due to the short time series available 1999-2003, we decided to treat data as a repeated cross-section (pooled estimation).

[6] Results are robust to the choice of different bandwidths.

the regional literature. In particular imposing the restriction that $\beta_2=0$ leads to a spatial autoregressive (SAR) 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 (SEM) that allows only for spatial dependence in the disturbances, imposing the restriction that $\rho=0$ leads to a spatially lagged X regression model (SLX) 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.

For completeness we report estimates of all the above-mentioned models. The spatial specifications are estimated by Maximum Likelihood (ML) which allows to obtain efficient, unbiased and consistent coefficients, with respect to a traditional OLS framework, which neglects both the spatial dependence in the causal relationship and the spatial dependence in the error term. In this work estimates are based on a pooled model of European regions over time (Elhorst, 2003). We also rely on the work and MATLAB routines developed by LeSage (2004a and 2004b) and LeSage and Pace (2009).

3.2 Data and descriptive evidence

Data on employment specialisation in BS, human capital, R&D and patents in ICT are drawn from the Eurostat REGIO database. Moreover, in order to construct the linkages between BS and manufacturing industries, we used Eurostat symmetric input-output tables for the year 2000 across a large sample of European countries[7].

We will first show the structure of inter-sectoral linkages (table 1), then provide evidence on which regions are specialised in BS and how specialisation has changed over time (table 2 and figures 1, 2 and 3), and finally report summary statistics for all the variables used in the regression analysis (table 3).

Table 1 reports the coefficients in the regression of the share of Business services in total output on industry dummies, distinguishing between manufacturing and service sectors[8]. Among the manufacturers that make considerable use of Business services, we find knowledge-intensive industries with the exception of Tobacco products (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

7 The countries included are: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

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

labour and scale-intensive industries appear, on average, to be low or medium users of Business services.

At the same time we can observe that, of the service sectors, as expected, the highest users are the same Business services sectors (Computer and related services, Other services and R&D services) followed by other “knowledge intensive services” (such as those linked to Insurance and Financial intermediation and Post and telecommunications, together with Wholesale and retail trade) while the lowest shares are found in Transport services, Hotel and Restaurants and Real Estate.

[Insert Table 1 about here]

Table 2 shows the list of regions specialised in Business services in the year 2005. Comparative advantage is computed as the share of employment in business services over total employment in region i divided by the average share of employment in business services across all regions.

Many of the regions with the highest values are regions where capital cities are located. This is the case not only in high income countries, but also in Spain, Portugal, Greece and in some new entrant eastern countries (Kozép-Magyarorszàg: the region of Budapest; Bucuresti; Bratislavsky kraj; Mazowieckie: the region of Warszawa).

When we exclude regions with capital cities, there appear to be important “country effects” in the spatial map of specialisation in business services. In fact all the Dutch regions and the great majority of the UK 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, Norway and Finland (with the exception of regions with capital cities, as mentioned above) show a comparative advantage in Business services. Regions in Spain, France and Italy show a more variegated pattern although on average they appear not to be specialised in Business services, while among the 11 Belgian regions, four have a comparative advantage in Business services.

[Insert Table 2 about here]

The comparative advantage index has been further used to map the EU regions in terms of BS specialisation, respectively in 1999, in 2003 and the changes in BS specialisation over the period 1999-2003. The maps visually help revealing the presence of an agglomeration pattern in the regional distribution of BS specialisation.

[Insert Figure 1 and 2 about here]

The evidence emerging from Figures 1 and 2 also shows a sort of north-south divide in the (trend of) regional specialisation in BS. The only case in Northern Europe which has experienced a de-specialisation process in BS over the period considered is France, except, as usual, for the Ile de France (Paris) region. In the majority of Northern country regions, and mainly the UK, the Netherlands, Belgium, North of Italy, the emerging pattern is one of higher specialisation in BS over the period 1999-2003, despite starting from an initial high share of BS on total employment. This seems to be also the case of those Eastern Europe regions for which the data are available. The opposite seems to occur in the Southern regions – mainly Spain, South of Italy, and Greece where the share of employment in BS remains at best unchanged.

[Insert Figure 3 about here]

There is certainly a country effect in the patterns of BS specialisation emerging from our indicator of comparative advantage mapped in the Figures 1 to 3. A clear clustering effect in the dimension and change of the comparative advantage indicator also emerges.

There are factors explaining the sectoral composition of regional employment in BS which seem to involve the neighbouring regions. We test the effects of these factors in the next section.

3.3 Econometric results

3.3.1 The determinants of BS specialisation: GLS estimates

We first discuss the results of a non-spatial econometric estimation of the determinants of BS specialisation across the 168 EU NUTS2 regions over the 1999-2003 period. We then compare these results with those of the spatial specifications - reported and discussed in Section 3.3.2 – when we allow for the presence of a spatial dependence behind the BS specialisation. The results of the different estimations are all reported in Table 4.

[Insert Table 4 about here]

The first column in Table 4 reports the results of the GLS. All the coefficients have the expected signs and are significant. Both supply and demand factors are robust in explaining the specialisation in business services. As expected, both ICT, proxied by the ICT-related patents over population across regions, and public R&D are positive and significant. Also Human capital exerts a positive and significant effect on BS specialisation, as expected, leading to conclude that the reservoir of human capital *within the region* is a necessary condition for the region to specialise in BS. It remains to be analysed whether the availability of such a reservoir in the neighbouring regions also favour BS specialisation, assuming that a certain degree of mobility of human capital between close regions occurs.

Intermediate demand factors (as captured by the index of potential intermediate demand from manufacturing industries) represent a major determinant of BS specialisation across regions, in line with most of the literature recalled in the previous sections. Again, we expect that intermediate demand coming from neighbouring regions plays a role on one regions' BS specialisation.

Finally, proxies of agglomeration economies also turn out to play the expected role. The dummy for regions with capital cities is highly positively related to BS specialisation as well as the variable of population density. It is also interesting to observe that, also when included simultaneously, both population density and the dummy for regions with capital cities positively affect regional specialisation in Business services, highlighting a specific role played by urban economies for the development of these services. High population density as well as the specific role of the urban economies can also be interpreted as a (final) demand determinant of BS specialisation. There appear to be strong complementarities between intermediate and final demand in fostering the increasing specialisation in BS across EU regions. This result is in line with the aggregate empirical evidence mentioned above (Savona and Lorentz, 2005; Kox and Rubalcaba, 2007a).

Overall, the factors behind the growth of BS and the presence of a structural composition of regional economies with high intensity of BS are well captured by our first model specification. The Pooled GLS estimation resulting coefficients show the expected signs. What is left to be tested is whether a spatial dependence exists behind these factors. We turn to a further set of results from the use of different spatial econometric specifications of Equation (1) in the next section.

3.2.2 The spatial dependence in BS specialisation: SAR, SEM and spatial Durbin estimates

Figure 4 shows the Moran's scatter and reports the associated Moran's coefficient[9] which indicates a positive and significant spatial autocorrelation in the regional specialisation in BS of about 0.4.

The Moran function attempts to illustrate the strength of spatial autocorrelation using a scatter plot of the relation between a variable vector (y-y^*) measured in deviations from the mean form y* and the spatial lag of this variable, $W(y\text{-}y^*)$.[10]

[9] At a descriptive level, the presence of a spatial structure behind a certain variables can be detected by an extension of the Pearson's correlation coefficient, applied to a binary spatial weight matrix C, where elements cij = 1 to denote that region j is relatively close to region i. This extended correlation coefficient known as the Moran Coefficient (I).

The positive value of the Moran's shows a clear positive relationship between BS specialization and its spatial lagged value. In particular, in the Moran scatter plot, the largest number of regions is concentrated in quadrant III, where regions de-specialised in BS are clustered together. Also regions specialized in BS tend to spatially agglomerate, as the scatter plot shows the presence of a consistent number of regions in quadrant I. However, there is also a certain number of regions clustered in quadrant IV, where regions de-specialised in BS have neighbours slightly more specialized in BS (points are concentrated around the zero). Finally few regions (such as Cataluna and Pais Vasco) appear to be specialized in BS but surrounded with de-specialised regions.

It is interesting to observe that a positive spatial correlation does not seem to be a country-specific phenomenon. This is particularly relevant for the UK, where we find regions highly specialized in BS significantly clustered to similarly highly BS specialized, as well as to regions de-specialised. In other words, some of the countries included in our sample show more a variegated pattern in terms of spatial dependence in BS specialization.

Table 4 reports the results of – respectively – the ML SAR, ML SEM and ML Spatial Durbin estimates of Equation (1).

The estimated coefficients consistently show the expected signs in all the specifications– with the exception of public R&D – confirming also the results of the GLS specification discussed in the previous section. Also, the figures reported for the spatial specifications do confirm the presence of a spatial dependence behind the determinants of BS specialisation.

In the ML SAR estimation, the coefficient of the spatial lag is positive and significant, meaning that the BS specialisation of one region is affected by the BS specialisation of its neighbour regions. This also confirms the descriptive picture provided by the Moran scatter plot discussed above and establishes the spatial dependence in BS specialisation. This does not offset the role of the intermediate demand and technology determinants captured by the other regressors, as the coefficients of the other regressors remain positive and significant.

The coefficients of the SEM - reported in the third column of Table 4 – also confirm that a spatial dependence is behind the error distribution, as the coefficient of the spatial error autocorrelation is positive and significant.

Overall, the results of the SAR and SEM specifications confirm our conjecture of the presence of a spatial dependence in BS specialisation across NUTS2 regions in EU27. The only variable that

---

[10] The slope of the Moran scatter plot would be represented by the scalar parameter Moran's I so that values near unity indicate high levels of positive spatial autocorrelation. This would correspond to a Moran scatter plot having a large number of points in quadrant I, where high values of (y-y^*) are associated with high values for neighbors $W(y\text{-}y^*)$, and quadrant III, where low values are also associated with low values for the neighbors (LeSage, 2004a).

loses significance in both the spatial specifications is the R&D share of GDP. When controlling for spatial dependence, the role of R&D seems to be wholly explained by the across- regions effect rather than the within-region one. There are a few possible explanations for this result. It might well be that there are knowledge spillovers across neighbouring regions so that the impact of public R&D is not localised within the regions. Also, the fact that when controlling for the spatial dependence public R&D expenditures do not exert a significant impact on BS specialisation might also mean that the complementarities/substitutability relation between public and private R&D (which is a branch included in the BS) changes depending on whether spatial dependence is accounted for. When we do not consider spatial dependence, public R&D is positively related to BS specialisation and therefore shows complementarities with private R&D. However, when we account for the spatial dependence behind the determinants of BS specialisation, these complementarities seem to lose statistical significance, though we cannot conclude that high public R&D intensity in the neighbouring regions tends to crowd out private R&D at the regional level. One possible explanation for the different results with and without spatial lags is that complementarities between own region private R&D (that is included in BS) and neighbouring regions' private R&D prevail over within region complementarities between private and public R&D.

In this respect, the empirical literature has not provided a conclusive answer. To our knowledge there is no evidence testing the spatial dependence of the relationship between public and private R&D, where all the empirical literature has focused either on the firms or the country level of analysis. Having said this, 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, where a displacing effect has occurred (for a detailed review on the issue of complementarities/substitutability between public and private R&D see David et al., 2000).

The shortcoming of the SAR and SEM model specifications, behind the econometric considerations reported in Section 3.1, is related to the fact that, once the presence of a spatial dependence is verified, it is less obvious to disentangle which of the determinants of BS specialisation has the strongest spatial dependence. In other words, it would be important to provide a regional/spatial declination - the within and across-region dimension - of the causal relationships between technology and intermediate demand factors behind BS specialisation and structural change, in line with the main conjecture in this work.

To this aim, we have tested the presence of a spatial dependence also in the variables identified as determinants of BS specialisation, by including the spatial lagged regressors in the estimation, along with the spatial lagged dependent variable (Spatial Durbin estimation, reported in the last column of Table 4). This allows us to quantify the spatial dependence in each of the determinants of regional BS specialisation, so to check whether the sectoral intermediate linkages – that is the sectoral specialisation and the presence of high-intensive BS user sectors in the neighbour regions – play more an important role in explaining regional BS specialisation than the technology-related determinants. Alternatively, it could be the case that technology-related determinants – for instance a reservoir of skilled human capital in the neighbouring regions – play a leading role in the regional BS specialisation.

The sign and significance of the coefficients in the spatial Durbin specification confirm the robustness of the conclusions based on the results of the SAR and SEM specifications but also provide interesting insights into the different role of spatially lagged independent variables. In particular, the role of technology in neighbouring regions supports (and reinforces) the effects on BS specialisation within the region: the intensity of ICTs use in the close-by regions – proxied by the lagged patents in ICT over population – has a positive and significant impact on BS specialisation but the same does not occur for public R&D. This suggests the existence of ICT clusters (or ICT-related spillovers) that go beyond the regional boundaries..

While lagged ICT positively affects BS specialisation, this is not the case for lagged human capital, showing that the positive role of a high qualified labour force remains confined within the region. Unfortunately, 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.

When we look at the role of intermediate demand coming from neighbouring regions – i.e. the sign and significance of the coefficient of the lagged intermediate demand - however, we find a negative impact of intermediate demand coming from neighbouring regions on the BS specialisation. One possible interpretation of this result is that the presence of high intensive users of BS in the neighbouring regions tends to ‘displace’ the BS specialisation, as if a substitution mechanism was at work. This would mean that the sectoral vertical structure matters only when associated to closeness. However, it is important to highlight that the indirect effect of neighbouring regions’ intermediate demand, as captured by the lagged dependent variable, is positive. Therefore it is difficult to draw final conclusions on the total effect of neighbouring regions intermediate demand on BS specialisation[11]. What the results show is that, once the positive role of neighbouring

[11] 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 an ‘indirect impact’ on other regions (see LeSage and Fischer (2008) for a discussion). This result arises from the spatial connectivity relationships that are incorporated in spatial regression models and increases the difficulty of interpreting the resulting estimates. LeSage and

regions' BS specialisation (also determined by the intermediate demand coming from high BS-user sectors) is taken into account, higher levels of high BS-user sectors specialisation in neighbouring regions negatively affect one region's BS specialisation.

Finally, the clustering effect, given by the sign of the spatial lagged dependent variable is also confirmed to have a positive impact on BS specialisation, even when – as in the case of spatial Durbin specification - part of the variance is captured by the spatial lagged independent variables.

4. Summary of the findings and conclusions

4.1 Technology and intermediate demand determinants of BS specialisation

Our study aimed at investigating the structural and spatial determinants of specialisation in Business services at the regional level. We identified sectoral intermediate linkages and intermediate demand from the manufacturing and other sectors, human capital, technology and agglomeration economies as strategic variables. That the manufacturing base affects performance in business services has important implications since it suggests that a region's ability to develop an efficient and dynamic service economy is linked to the structure of its manufacturing sector. In particular, we found that knowledge-intensive industries are the main users of business services. As a consequence, regions specialised in these industries are in a favourable position for developing a comparative advantage in business services.

We also found that technology (proxied by patents in ICT) has a positive and significant impact on specialisation in business services. Also, the intensity of regional public spending in R&D has a positive and significant effect on BS, though this loses significance within a spatial specification (see discussion below). This supports those theories that emphasise the role of technology in affecting specialisation and is consistent with the view that ICT plays a special role in the case of business services. It also suggests that technology policy focussing on the development and use of new technologies can impact positively on regional specialisation in business services, an area that is becoming strategic for its high rate of growth and its linkages with the manufacturing sector. We found a positive impact also of human capital. This is not surprising since business services employ people with high levels of skills, therefore the availability of a highly skilled workforce is a prerequisite for regions to become specialised in these knowledge-intensive services.

Finally, urban agglomeration – proxied by population density and the capital cities regional dummies – exerts on BS specialisation the expected effect as emerging from the literature on agglomeration and urban economies (Duranton and Puga, 2005, among others). High value services

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. However they only discuss and provide routines for cross-section estimates and not for panel data estimates.

tend to concentrate in capitals and urbanised areas, where also the presence of high levels of final demand is ensured.

4.2 The spatial dependence of BS specialisation

Our results support the conjecture of the presence of spatial dependence in the determinants of BS specialisation. At a descriptive level, a positive and significant Moran coefficient is found, which indicates that a regional sectoral specialisation (and de-specialisation) is affected – among other determinants – by that of neighbour regions.

The estimation of the spatial specifications of equation (1) has confirmed that BS specialisation and some of its determinants are spatially dependent.

Interestingly, the only variable that loses significance once spatial dependence is accounted for is public R&D. This is somewhat in line with the absence of any conclusive evidence on the sign of the relation between publicly funded and private R&D – included as a branch of BS – emerged in the literature (David et al., 2000). Although the within-region result confirms the existence of complementarities – as from the pooled GLS estimates – the across-regions results do not allow us to conclude neither in favour of a persistence of the existence of spillovers of public R&D expenditures on the level of BS, nor it supports the presence of a crowding out effect on the presence of private R&D among other BS.

When looking at the role of spatially lagged explanatory variables we find interesting results: while lagged ICT exerts a positive significant impact on BS specialisation, this is not the case for human capital. This result suggests that while regions benefit from being surrounded by other regions with high levels of ICT (supporting the findings on the importance of ICT clusters or ICT spillovers), human capital must be concentrated within the region in order to favour BS specialisation. As mentioned, this does not capture any aspect of potential migration from neighbouring regions, which would be worth investigating with a different data set.

A further interesting result emerging from the spatial Durbin estimation is the changing sign of the (spatial lagged) intermediate demand. Although vertical structure still matters to the extent that its (positive) role is accounted for in the spatially lagged dependent variable, when we look at the specific effect of the presence of high BS users sectors in the neighbouring regions, this seems to crowd out the BS specialisation in one regions. This result seems to support the literature on clusters and industrial agglomerations and the importance of physical proximity, though more research is needed to investigate this relation more in depth.

All in all, this paper has aimed to add to both the regional economic literature and the literature on structural change and tertiarisation, which has so far lacked a regional perspective. Providing a spatial picture of the determinants of BS specialisation contributes to the understanding of the underlying reasons behind the employment productivity and growth divergences at the regional level, in line with recent contributions concerned with these issues (Fagerberg et al., 1997; Guerrieri et al., 2005; Meliciani, 2006; Verspagen, 2007; Sterlacchini, 2008 among others), which are likely to become more important after the enlargement to the Eastern EU countries.

Although a detailed discussion on this issue is outside the scope of this paper, the analysis presented is also aimed to informing the European industrial and innovation policies, which are increasingly (and rightly so) designed at the regional level, where the imperative is to ensure both efficiency and equity at the (large) European level (Verspagen, 2007).

Our research agenda includes accounting for the dynamic specifications of the spatial econometric model presented in this work and a more refined set of variables synthesising the innovation intensity, beyond the patents in ICTs and the share of population with tertiary education.

References

Abreu M, Grinevich V, Kitson M, Savona M (2010) Policies to Enhance the 'Hidden' Innovation in Services: Evidences and Lessons from the UK. *The Service Industries Journal - Special Issue on 'Governance Policies and Services'* 30(1) January 2010: 99-118.

Antonelli C (1998) Localised technological change, new information technology and the knowledge-based economy: the European evidence. *Journal of Evolutionary Economics* 8: 177-198.

Antonietti R, Cainelli G (2007) Spatial agglomeration, technology and outsourcing of knowledge intensive business services. Empirical insights from Italy. *Fondazione ENI Enrico Mattei Working Papers*: 141.

Bhagwati J N (1984) Splintering and disembodiment of services and developing nations. *The World Economy* 7: 133-143.

Baumol W J (2001) Paradox of the services: Exploding costs, persistent demand. In: T ten Raa, Schettkat R (eds.), *The growth of service industries. The paradox of exploding costs and persistent demand*. Edward Elgar Cheltenham: 3-28.

Cainelli G, Evangelista R, Savona M (2006) Innovation and economic performance in services. A firm level analysis. *Cambridge Journal of Economics* 30: 435-458.

Castaldi C (2009) The relative weight of manufacturing and services in Europe: An innovation perspective. *Technological Forecasting and Social Change* 76: 709-722.

Castellacci F (2008) Technological paradigms, regimes and trajectories: Manufacturing and service industries in a new taxonomy of sectoral patterns of innovation. *Research Policy* 37: 978-994.

Crescenzi R, Rodriguez-Pose A, Storper M (2007) The territorial dynamics of innovation: a Europe-United States comparative analysis. *Journal of Economic Geography* 7: 673-709.

Crespi G, Criscuolo C, Haskel J, Hawkes D (2006) Measuring and Understanding Productivity in UK Market Services. *Oxford Review of Economic Policy* 22(4):560-572.

Dasgupta S, Singh A (2005) Will Services be the New Engine of Economic Growth in India? Discussion paper, *Working Paper Series, n. 310 Centre for Business Research, University of Cambridge*.

David PA, Hall BH, Toole AA (2000) Is public R&D a complement or substitute for private R&D? A review of the econometric evidence. *Research Policy* 29: 497-529.

Desmet K, Fafchamps M, (2005) Changes in the spatial concentration of employment across US counties: a sectoral analysis 1972-2000. *Journal of Economic Geography* 5: 261-284.

Duranton G, Puga D (2005) From sectoral to functional urban specialisation. *Journal of Urban Economics* 57: 343-370.

Elhorst JP (2003) Specification and Estimation of Spatial Panel Data Models. *International Regional Science Review* 26: 244-268.

Elhorst JP (2005) Models for dynamic panels in space and time: An application to regional unemployment in the EU. Paper presented at the European Regional Science Association, Amsterdam.

Elhorst JP (2009) Spatial Panel data models, in: Fischer MM, Getis A (eds.) *Handbook of Applied Spatial Analysis*. Springer, Berlin.

Evangelista R (2000) Sectoral patterns of technological change in services. *Economics of Innovation and New Technology* 9:183-221.

Evangelista R (2006) Innovation in the European Service Industries*, Science and Public Policy* 3, No. 9:

Fagerberg J, Verspagen B, Caniëls M (1997) Technology, Growth and Unemployment across European Regions. *Regional Studies* 31(5): 457-466.

Francois JF (1990) Producer services, scale, and the division of labor. *Oxford Economic Papers* 42: 715-729.

Francois JF, Reinert KA, (1996) The role of services in the structure of production and trade: stylized facts from a cross-country analysis. *Asia-Pacific Economic Review* 2.

Francois JF, Woerz J (2007) Producer services, manufacturing linkages, and trade. *Tinbergen Institute Discussion Paper*, TI 2007-045/2.

Freund C, Weinhold D (2002) The Internet and international trade in services. *American Economic Review Papers and Proceedings* 92: 236-240.

Fujita M, Krugman P, Venables AJ (1999) *The Spatial Economy. Cities, Regions, and International Trade.* Cambridge, MA. MIT Press.

Gallouj F, Savona M. (2009) Innovation in Services. A Review of the Debate and a Research Agenda. *Journal of Evolutionary Economics* 19: 149-172.

Guerrieri P, Meliciani V (2005) Technology and international competitiveness: The interdependence between manufacturing and producer services. *Structural Change and Economic Dynamics* 16: 489-502.

Guerrieri P, Maggi B, Meliciani V, Padoan PC (2005) Technology diffusion, services and endogenous growth in Europe. Is the Lisbon strategy useful?. *Rivista di Politica Economica* 95: 271-317 and International Monetary Fund Working Paper (WP/05/103).

Karlsson C, Johansson B, Stough RR (2009) Human Capital, Talent and Regional Growth. *CESIS Electronic working paper series 191*, The Royal Institute of Technology, Sweden.

Klodt H (2000) Structural change towards services: the German experience. *University of Birmingham IGS Discussion paper* 2000/07.

Kox HLM, Rubalcaba L (2007a) Analysing the contribution of business services to European economic growth. MPRA Paper n. 2003.

Kox HLM, Rubalcaba L (2007b) Business services and the changing structure of European economic growth. MPRA Paper n. 3750.

LeSage JP (2004a) *Spatial Econometrics Course*. Department of Economics, University of Toledo, Toledo, US, March 2004.

LeSage JP (2004b) A Family of Geographically Weighted Regression Models. In: *Advances in Spatial Econometrics*, Anselin L, Florax JGM, Rey SJ (eds.) Springer-Verlag.

LeSage JP, Pace RK (2009) *Introduction to spatial econometrics*. Taylor & Francis CRC Press, Boca Raton.

LeSage JP, Fischer MM (2008) Spatial Growth Regressions. Model Specification, Estimation and Interpretation. *Spatial Economic Analysis*, 3(3): 1742-1780.

Lorentz A, Savona M (2008) Evolutionary Micro-dynamics and Changes in the Economic Structure. *Journal of Evolutionary Economics*. 18(3-4): 389-412.

Marrano MG, Haskel J, Wallis G (2007) What happened to the Knowledge Economy? ICT, Intangible Investment and Britain's Productivity Record Revisited. *Working Paper n. 603, June 2007, Dpt. Economics, Queen Mary University of London*.

Markusen JR (1989) Trade in producer services and in other specialised intermediate inputs. *American Economic Review* 79: 85-95.

Marrewijk C van, Stibora J, de Vaal A, Viaene J (1997) Producer services, comparative advantage, and international trade patterns. *Journal of International Economics* 42: 195-220.

Meliciani V (2006) Income and Employment Disparities across European Regions. The Role of National and Spatial Factors. *Regional Studies* 40(1): 75-91.

Midelfart-Knarvik KH, Overman HG, Redding SJ, Venables AJ (2000) The location of European industry. Report prepared for the Directorate General for Economic and Financial Affairs, European Commission.

Miles I (2005) Innovation in services. In: Fagerberg J, Mowery D, Nelson R (eds.) *The Oxford Handbook of Innovation*. Oxford University Press, Oxford.

Miozzo M, Soete L (2001) Internationalization of services: a technological perspective. *Technological Forecasting and Social Change* 67: 159-185.

Miozzo M, Miles I (2003) (eds.). *Internationalisation, Technology and Services*. Elgar, Cheltenham.

Montresor S, Vittucci Marzetti G (2007) The deindustrialization/tertiarisation hypothesis reconsidered. A sub-system application to the OECD7. Mimeo, University of Bologna.

Moreno R, Paci R, Usai S (2005) Innovation Clusters in the European Regions. Mimeo, CRENos, University of Cagliari.

Muller E, Zenker A (2001) Business services as actors of knowledge transformation: the role of KIBS in regional and national innovation systems. *Research Policy* 30: 1501-1516.

Ord JK (1975) Estimation Methods for Models of Spatial Interaction. *Journal of the American Statistical Association* 70: 120-126.

OECD (2008a) *Employment outlook 2008*, OECD, Paris.

OECD (2008b) *Science, technology and industry outlook* – 2008 edition, OECD, Paris.

Parrinello S (2004) The service economy revisited. *Structural Change and Economic Dynamics* 15:381-400.

Peneder M (2003) Industrial structure and aggregate growth. *Structural change and economic dynamics* 14: 427-448.

Peneder M, Kaniovsky S, Dachs B (2003) What follows tertiarisation? Structural change and the role of knowledge-based services. *The Service Industry Journal* 23: 47-66.

Rowthorn. R, Ramaswamy R (1999) Growth, Trade and Deindustrialisation. *IMF Staff Papers* 46, 18-41.

Savona M, Lorentz A (2005) Demand and Technological Contribution to Structural Change and Tertiarisation. An Input-Output Structural Decomposition Analysis. *LEM Working Paper Series*, 2005/25 (December 2005).

Schettkat R, Yocarini L (2006) The shift to services employment: A review of the literature. *Structural Change and Economic Dynamics* 17: 127-147.

Soete LLG (1987) The newly emerging information technology sector. In: Freeman C, Soete, L.L.G. (eds.) *Technical Change and Full Employment*. Oxford, Blackwell.

Sterlacchini A (2008) R&D, Higher Education and Regional Growth. Uneven Linkages among European Regions. *Research Policy* 37: 1096-1107.

Tether B (2005) Do services innovate (differently)? Insights from the European Innobarometer Survey. *Industry and Innovation*, **12**, 153–184.

Vaal A, de van den Berg (1999) Producer services, economic geography and services tradability. *Journal of Regional Science* 39: 539-572.

Van Ark B, Inklaar R, McGuckin R (2003) Changing gear – productivity, ICT and service industries in Europe and the United States. in: Christensen F, Maskell P (eds.), *The Industrial Dynamics of the New Digital Economy*. Cheltenham, UK and Northampton, MA, USA: Edward

Elgar: 56–99.

Verspagen B (2007) The Spatial Hierarchy of Technological Change and Economic Development in Europe. *UNU-MERIT Working Paper Series*, #2007 – 012.

Appendix: Tables and Figures

Table 1 - Share of Business Services in total industry output

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 business services	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 service 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%		
Average	*4.7*		*8.4*
Standard Deviation	*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)*standard deviation.

Table 2: Regions specialised in Business Services in 2005

Code	Regio	CA	Code	Regio	CA
Uki1	Inner London	5.81	nl23	Flevoland	1.42
be1	Région de Bruxelles-Capitale	3.54	Ukh1	East Anglia	1.38
es3	Comunidad de Madrid	3.14	Ukk2	Dorset and Somerset	1.37
fr1	Ile de France	2.98	de21	Oberbayern	1.36
Ukj1	Berkshire, Bucks and Oxfordshire	2.68	ukl2	East Wales	1.35
nl31	Utrecht	2.48	ukj4	Kent	1.35
pt17	Lisboa	2.41	uke3	South Yorkshire	1.33
nl32	Noord-Holland	2.21	ukf1	Derbyshire and Nottinghamshire	1.32
Ukh2	Bedfordshire, Hertfordshire	2.19	nl42	Limburg (NL)	1.32
de6	Hamburg	2.11	de92	Hannover	1.32
Ukj2	Surrey, East and West Sussex	2.05	be21	Prov. Antwerpen	1.29
de71	Darmstadt	2.03	de25	Mittelfranken	1.27
fr71	Rhone-Alpes	1.98	de73	Kassel	1.26
No01	Oslo og Akershus	1.95	Ukd5	Merseyside	1.26
Hu1	Kozép-Magyarorszàg	1.95	fr82	Provence-Alpes-Cote d'Azur	1.26
Ukj3	Hampshire and Isle of Wight	1.95	itc3	Liguria	1.25
at13	Wien	1.94	Ukh3	Essex	1.25
Ukd2	Cheshire	1.91	itc1	Piemonte	1.24
nl33	Zuid-Holland	1.89	Ukm2	Eastern Scotland	1.20
de5	Bremen	1.88	Ukd4	Lancashire	1.20
ro08	Bucuresti (SRE 2002)	1.84	be31	Prov. Brabant Wallon	1.20
Ukd3	Greater Manchester	1.79	es21	Pais Vasco	1.19
itc4	Lombardia	1.78	itd5	Emilia-Romagna	1.18
Ukk1	Gloucestershire, Wiltshire and Bristol/Bath area	1.71	Dec	Saarland	1.16
Uki2	Outer London	1.70	itd2	Provincia Autonoma Trento	1.15
Dea2	Koln	1.69	itc2	Valle d'Aosta	1.15
Ukg3	West Midlands	1.67	nl12	Friesland (NL)	1.14
ite4	Lazio	1.65	uke2	North Yorkshire	1.11
nl41	Noord-Brabant	1.64	ite1	Toscana	1.10
Ukg1	Herefordshire, Worcestershire and Warks	1.64	itd4	Friuli-Venezia Giulia	1.09
De12	Karlsruhe	1.62	Ukk4	Devon	1.09
Dea1	Dusseldorf	1.62	gr3	Attiki	1.08
De3	Berlin	1.59	Ded3	Leipzig	1.07
Be24	Prov. Vlaams Brabant	1.59	ukc1	Tees Valley and Durham	1.06
Sk01	Bratislavsky kraj	1.59	pl12	Mazowieckie	1.06
Ukf2	Leicestershire, Rutland and Northants	1.55	fi18	Etela Suomi	1.05
De11	Stuttgart	1.55	Ukg2	Shropshire and Staffordshire	1.05
nl22	Gelderland	1.49	nl34	Zeeland	1.04
ukm3	South Western Scotland	1.49	at31	Oberosterreich	1.04
es51	Catalana	1.48	itd3	Veneto	1.02
nl21	Overijssel	1.48	dea4	Detmold	1.02
Ukc2	Northumberland, Tyne and Wear	1.48	ite2	Umbria	1.01
Uke4	West Yorkshire	1.44	pt3	Region Autonoma da Madeira (PT)	1.00

Source: EUROSTAT Regio Database
Note: comparative advantage is computed on employment data

Table 3 – Summary of the variables used in the econometric estimations

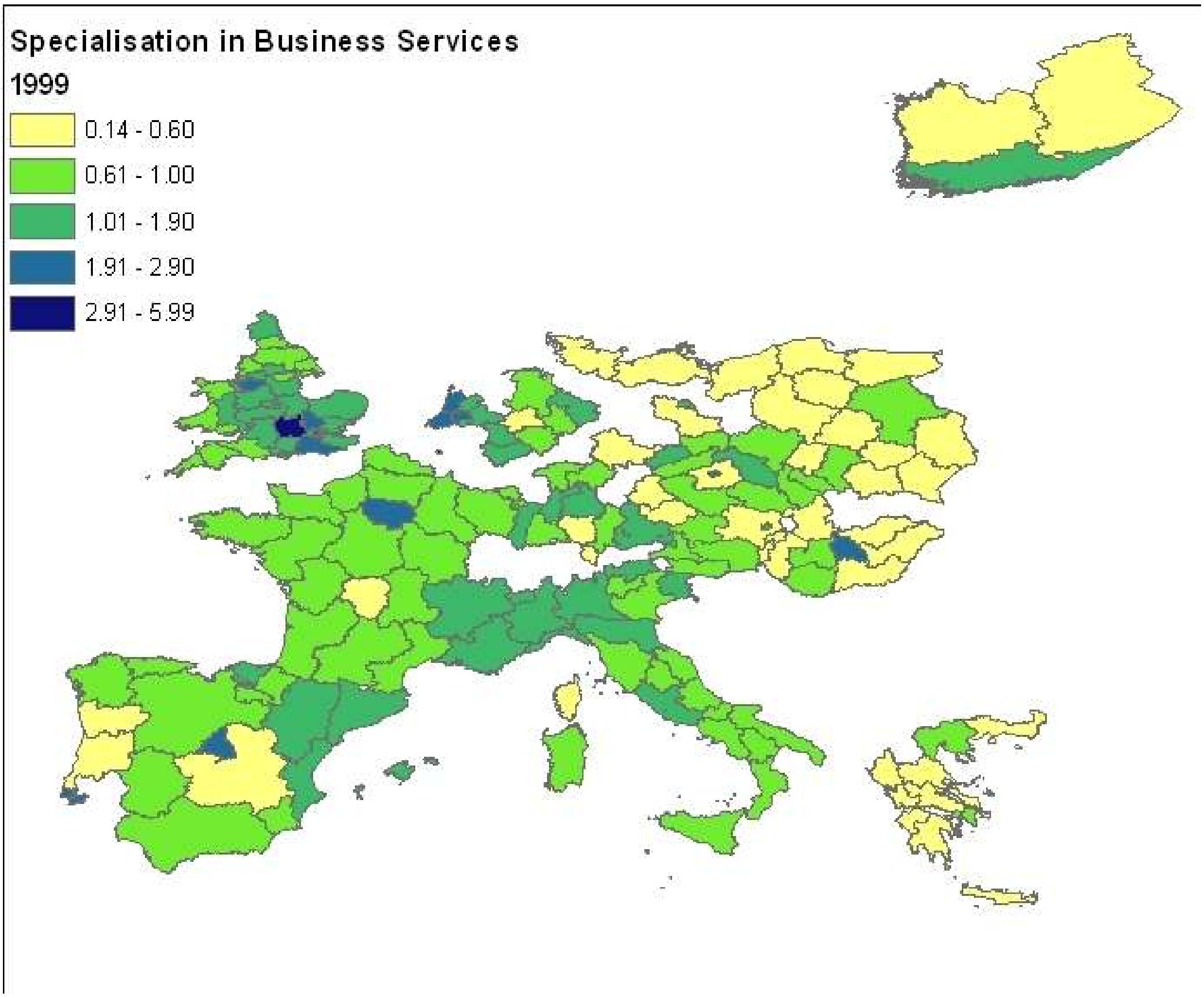
Variable	Mean	Std. Dev	Min	Max
BS Specialisation	0.85	0.60	0.10	7.32
Intermediate demand	0.02	0.01	0.00	0.06
Share of population with tertiary education	0.32	0.15	0.00	0.94
Patents in ICT over population	0.23	0.41	0.00	3.69
R&D over GDP	0.00	0.00	0.00	0.02
Population density	4.14	9.89	0.08	90.73

Table 4 – The spatial dependence in specialisation in business services 1999-2003 - Econometric Results

Estimation Method	Pooled Generalized Least Square		Pooled ML SAR Estimation*		Pooled ML SEM Estimation**		Pooled ML Spatial Durbin Est.***	
Variables	Coefficient	Asymptotic t-ratio	Coefficient	Asymptotic t-ratio	Coefficient	Asymptotic t-ratio	Coefficient	Asymptotic t-ratio
Intermediate demand	17.622	24.88***	18.323***	12.01	18.271***	11.96	18.131***	11.70
Share of population with tertiary education	0.136	3.52***	0.186*	1.90	0.170*	1.75	0.197**	1.98
Patents in ICT over population	0.179	7.44***	0.208***	6.31	0.203***	6.13	0.208***	6.17
R&D over GDP	6.460	3.31***	7.131	1.47	7.200	1.50	7.734	1.60
Population density	0.028	13.38***	0.028***	18.54	0.029***	19.41	0.028***	18.48
Regions with capital cities	19.328	5.89***	19.140***	3.41	18.252***	3.35	19.204***	3.40
BS Specialisation in neighbours regions			0.100**	2.00			0.142*	2.45
Spatial Error Autocorrelation					0.194**	2.56		
Lagged intermediate demand							-14.867***	-2.99
Lagged Share of population with tertiary education							0.121	0.41
Lagged Patents in ICT over population							0.231**	2.25
Lagged R&D over GDP							8.633	0.39
R^2	Wald X^2=9268.66		0.77		0.77		0.77	
Log-likelihood			-4023.84		-4022.70		-4018.96	
Obs.	840		840		840		840	

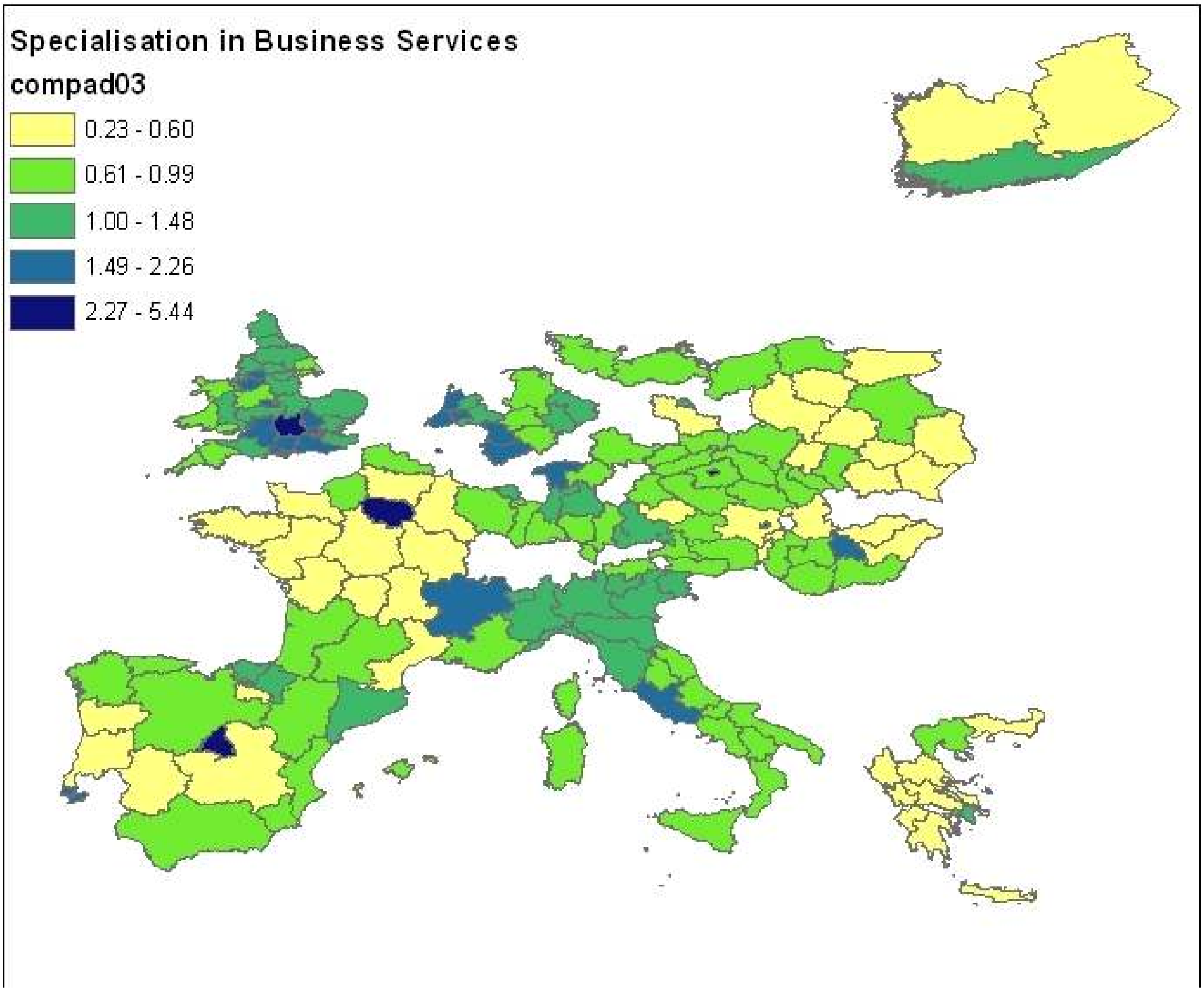
Notes: Estimates are heteroscedasticity-consistent. *, **, *** indicate significant at the 10%, 5% and 1% levels respectively. Country dummy variables are included. Coefficients cannot be interpreted as elasticities.
* Pooled Model with Spatially Lagged Dependent Variable and Time Period Fixed Effects (Elhorst, 2003)
** Pooled Model with Spatial Error Autocorrelation and Time Period Fixed Effects (Elhorst, 2003)
*** Pooled Model with Spatially Lagged Dependent and Independent Variables and Time Period Fixed Effects (Elhorst, 2003)

Figure 1 – Specialisation in BS in EU regions - 1999



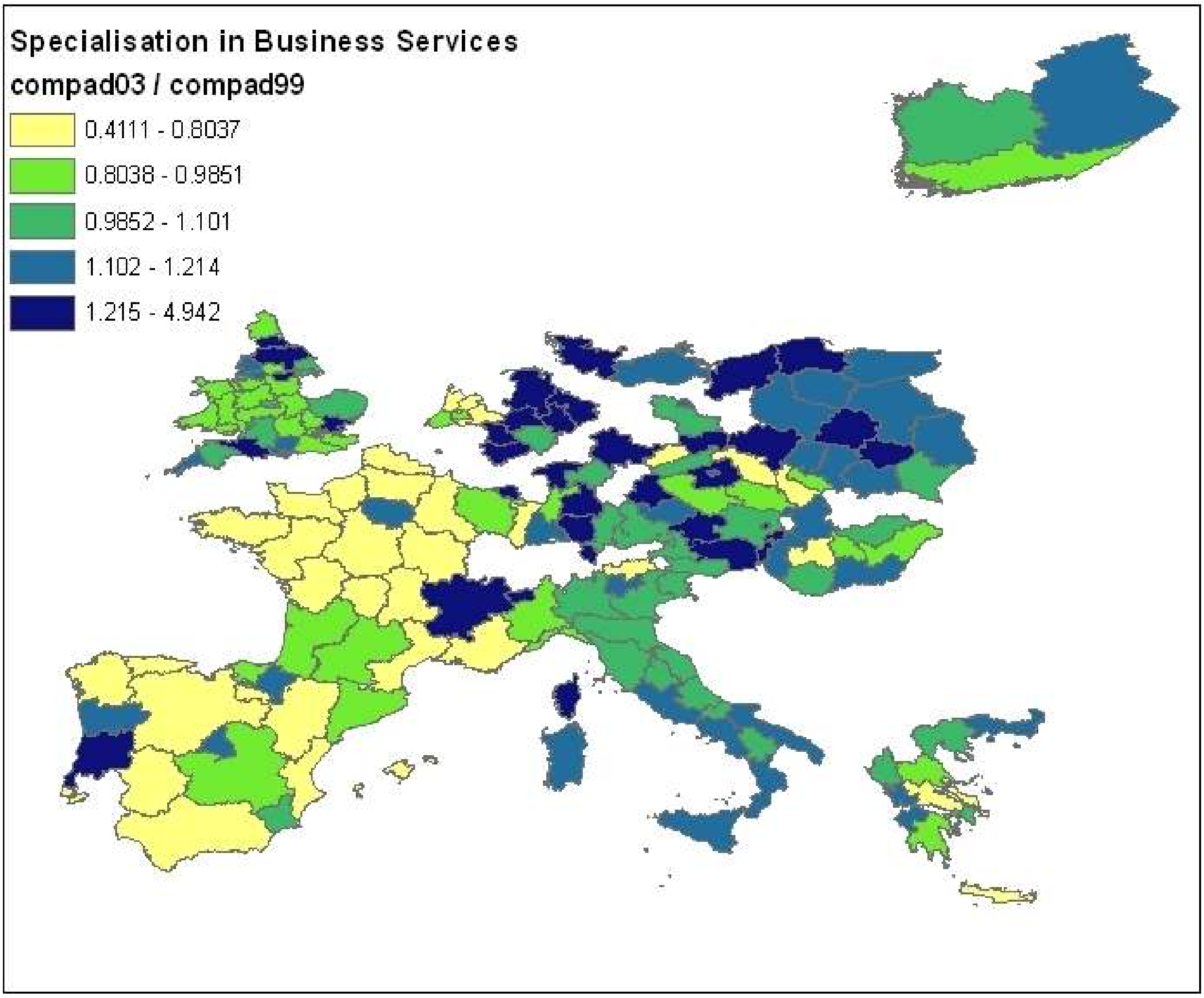
Source: Eurostat REGIO database

Figure 2 – Specialisation in BS in EU regions - 2003



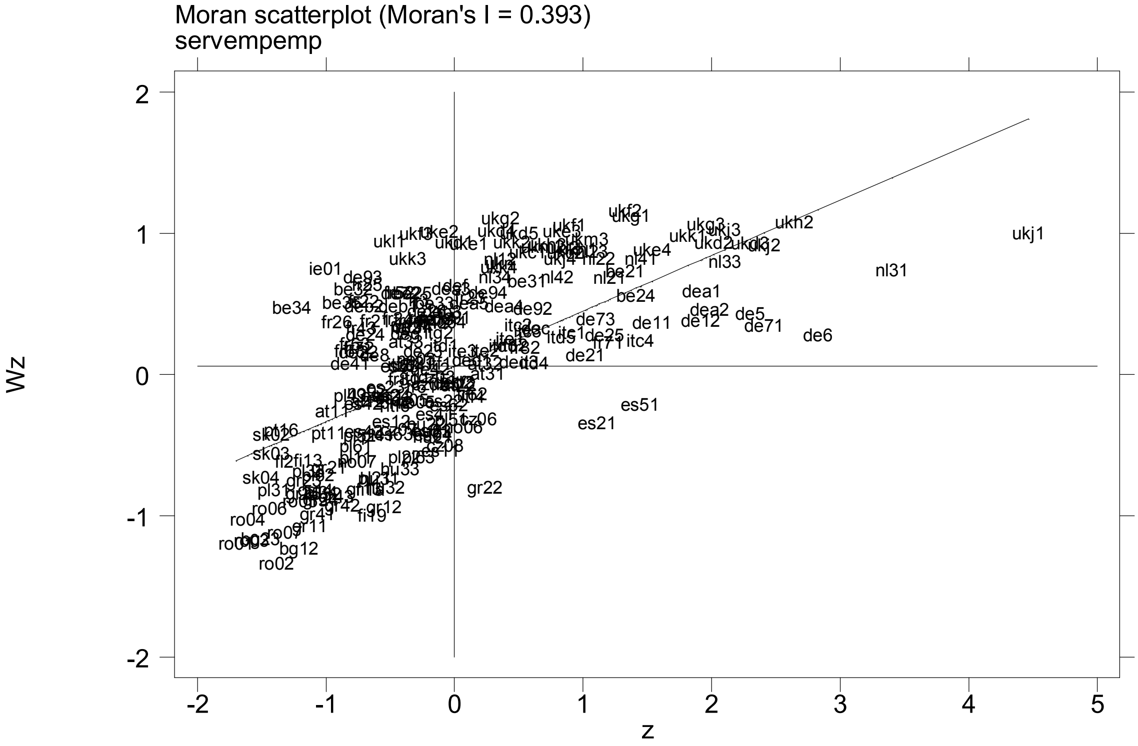
Source: Eurostat REGIO database

Figure 3 – Change in specialisation in BS in EU regions – 1999-2003



Source: Eurostat REGIO database

Figure 4: Specialisation in BS across European regions: Local Spatial Autocorrelation (Moran Scatterplot - Moran's I = 0.393)



Source: EUROSTAT Regio database

Notes: Distance band between 0.0 and 7.0; Regions with capital cities have been excluded.

z = vector of BS specialisation (deviation from the regional mean)

Wz = Spatial lag of BS specialisation