Technological enclaves and industrial districts.
An analysis of the regional distribution of innovative activity in Europe

Raffaele Paci

(University of Cagliari and CRENoS,
Via Sant'Ignazio 78, 09123 Cagliari, Italy
tel +39-70-6753764, fax +39-70-6753760, email: paci@unica.it)

and

Stefano Usai

(University of Sassari and CRENoS)

Abstract: This paper explores the spatial distribution of innovative and productive activity across 109 regions of the European Union, thanks to an original databank on regional patents statistics.

The main results worth highlighting are as follows. The technological activity in the EU appears to be highly concentrated, although concentration tends to decline over the eighties. As expected, there is a positive association between the regional distribution of innovative activity and labour productivity. Further, contrary to previous evidence on the United States, our data show a significant link between the specialisation in innovation and in production both at the country and at the industry level. This suggests that localised knowledge spillovers and agglomeration economies foster a local economic system towards a specialisation in both production and technology.

JEL: O31, R12, O34, O52

Keywords: Innovative activity, European regions, technological specialisation, productive specialisation.

Revised version: July 1998

1. Introduction[*]

The debate on the existence of agglomeration economies, which suggests that firms benefit from being near other firms, has been long, rich but rather erratic. The pioneering arguments of MARSHALL (1890) and WEBER (1909) have being revitalised just in the fifties by development and regional economists, such as MYRDAL (1957) and PERROUX (1950), and have only recently regained the forefront of economists' debate thanks to scholars such as ARTHUR (1988), KRUGMAN (1991) STORPER (1992) and NELSON (1993). Such contemporary authors follow quite different approaches: while the former two try to emend the orthodox framework by considering increasing returns and multiple equilibria, the latter two moves along the Shumpeterian tradition within a rather different setting, that of evolutionary economics (see NELSON and WINTER, 1982). Nonetheless, all contributions share the belief that there exist self reinforcing mechanisms which are spatially bounded. In practice, as firms gather in a locality, this is likely to gain useful infrastructures, an appropriate specialisation and diversification pattern facilitating the provision of specific goods and services, more convenient relative prices and qualities of the labour force and of primary and intermediate goods[1]. As a result, there appear social networks which are based on the exchange of information and expertise within a specific area. Information and expertise that, according to VON HIPPEL (1995), despite the great progress in information technologies (thanks to Internet, for example), is still costly and difficult to transmit across areas. Proximity, as a result, is still very important because such a sticky knowledge, which is the prime base of technological change, is locally non rival and can thus be easily appropriated by firms in a specific area. This is to say that,

[*] We would like to thank Alessandra Amitrano and Ernesto Batteta for valuable assistance in setting up the data base on regional patent statistics. Financial support from CRENoS and CNR is gratefully acknowledged.

[1] There may, obviously, be also agglomeration disecomies due most of all to congestion effects. It should be, however, remarked that such effects are likely when externalities operate through physical infrastructure rather than through knowledge channels, which are central in our research. For simplicity sake, we refer to increasing returns to indicate all those cases when net benefits between economies and diseconomies are positive.

parallel to agglomeration economies which contribute to the creation of industrial districts, there exist other increasing returns in spatial form which favour the formation of technological enclaves.

On the other hand, there is an important stream of the literature [see COE and HELPMAN (1995) and FAGERBERG (1994) amongst the latest contributions] which emphasises the nature of technological progress as a public good -- that is, indivisible and non rival. According to this perspective R&D spillovers go across borders and may contrast the appearance of spatial patterns of innovative specialisation. In conclusion, there exist countervailing forces – those ones which facilitate spatial diffusion of knowledge, experience and technologies and those ones which enhance local increasing returns – which are both in action. Which effect is prevailing in the case of the European regions is a question that we directly address in the paper.

The existence of spatially bounded economic poles is not anew in the industrial economics literature, where there has been an extensive amount of research on “local production systems” and “industrial districts” [BRUSCO (1982), PYKE *et al.* (1990), SABEL (1989)] and also on “spatial innovation networks” and “innovative milieu” [CAMAGNI (1991, PECQUEUR and ROUSIER (1992), COOK and MORGAN (1994)]. This literature usually grounds its research on case studies of specific areas which allow for very detailed analysis of the complex interacting forces that shape the development of a local system (i.e. a combination of economic, social, and cultural elements). However, as it has been recently shown by some studies on the spatial distribution of innovation and production in the United States [JAFFE *et al.* (1993) and AUDRETSCH and FELDMAN (1996), among others], there is much to be learned also from the spatial analysis of technological and productive specialisation in larger economic systems.

So far this latter line of research at the European level has been hindered by the absence of comparable disaggregated data both at the geographical and sectoral level, especially with regard to the technological indicators. Such a lack has not allowed to construct a map of the innovative activity at the regional level in Europe, despite this is now essential since national markets, also thanks to several European Union policies, are getting more and more integrated and a higher mobility of labour and physical capital is likely. In the light of this need, some studies have, actually, started appearing but none, to our knowledge, addresses explicitly the issue of both technological and productive specialisation. In particular, BRESCHI (1997) introduces patents as a regional indicator of technology, while VERSPAGEN (1997) explores the existence of clubs of European regions on the basis of both economic and technological variables, even though at the aggregate level. CANIELS (1997) examines the geographical and sectoral distribution of innovative activity across 72 European regions in just 5 countries (France, Italy, Netherlands, Spain and United Kingdom).

This paper has two principal aims. First, we intend to widen the analysis of spatial distribution of aggregate innovative activity to all the regions of the European Union.[2] More specifically, we aim at evaluating to which extent the regional distribution of innovative activity in Europe is characterised by the presence of technological enclaves and how such a presence, if any, has changed along the eighties. Secondly, we analyse the innovative activity at the sectoral level. This split allows us to investigate more deeply the complex relationship between innovative and productive specialisation at the regional level in Europe. Moreover, we present a preliminary examination of the link among heterogeneity of technological and productive levels and its implications in terms of regional integration.

To achieve our goals we have set up an original databank on regional patent statistics based on the data collected by the European Patent Office (EPO) and rearranged by assigning each patent to its region of origin through the postal code of the inventor's residence. More precisely, our series

[2] Some studies have documented the spatial distribution of innovative activity across regions within a single country. Boitani and Ciciotti (1990), among others, deal with the Italian regions; Buswell *et al.* (1985) and Guerrero and Serò (1997) examine the United Kingdom and Spanish regions, respectively.

refer to 53,270 patent applications for the years 1980, 1985 and 1990, classified by the inventor's region and covering 109 territorial units belonging to the twelve countries members of the European Union during the eighties.

The paper is organised as follows. Section 2 presents the new data-base on regional innovative activity and discusses some measurement issues. Section 3 documents the spatial distribution of aggregate innovative activity. Section 4 presents the sectoral analysis; more specifically, section 4.1 examines the innovative specialisation across the European regions at the sectoral level; section 4.2 analyses the association between innovative and productive specialisation and section 4.3 addresses the issue of technological heterogeneity. Section 5 concludes.

2. Some measurement issues

No single measure of innovative activity is perfect. As a result, there is an ongoing debate [see, for instance, PAVITT (1982) and GRILICHES (1990)] on which technological indicator provides the best representation of innovative activity within an economic unit (country, sector, firm). Starting from the concept of knowledge production function [PAKES and GRILICHES (1984)], two types of indicators have been identified: technology input measures (such as R&D expenditure and employees) and technology output measures (such as patents and new product announcements). The former indicators include, without distinction, firms' effort for invention, innovation and imitation activities. Conversely, patents and product announcements represent the outcome of the inventive process that is expected to be economically valuable, although such a "value" is highly heterogeneous and the propensity to patent or to announce can vary across space, firms and sectors [EVENSON (1993) and SASSU and USAI (1996)]. With respect to the object of our research -- that is to study local patterns of specialisation -- patent statistics have, therefore, pros and cons. On the one hand, they are considered a more reliable indicator than R&D for innovative activity of small and medium firms (which form the bulk of local systems of production) because most such firms do not formally register R&D expenditure. On the other hand, patents still underestimate the innovative activity of small firms given that direct and indirect costs of patenting at EPO may prove very high for such firms which exhibit a lower propensity toward internationalisation.

Despite these problems, patents are chosen because they are the only available indicator with some useful characteristics, such as: (a) they give information on the residence of the inventor and proponent and can thus be grouped regionally, while R&D statistics are available just for some regions or at the national level; (b) they record the technological content of the invention and can, thus, be classified according to the industrial sectors, (c) they are available for a long time span and this allow for some tentative dynamic analysis.

Our analysis of the innovative activity across the European regions is based on information provided by the European Patent Office through the European Patent Bulletin Information on CD-ROM. More precisely, our series refer to patent applications, classified by the inventor's region, for the twelve member countries of the European Community over the eighties. We have examined three years - 1980, 1985 and 1990 – and a total of 53,270 patents.

The classification by inventor's region has been preferred given that the location of the patent's proponent, which usually corresponds to the firm's headquarters, may provide an incorrect information whenever the invention has been developed in a firm's subsidiary located in another region. For instance, Enichem, the Italian petroleum and chemical multinational, is located in Milan (Lombardia) but the innovative activity (as indicated by residence of the inventors) is much more dispersed due to the presence of several plants in other regions (e.g. Veneto, Sicilia, Liguria and Sardegna). The region of residence of the inventors, on the contrary, gives a more precise measure on the exact geographic origin of the inventive and innovative activity.[3] It is worth noting, however, that the regional distributions of the two patent series (inventors and proponents) are quite similar (r=0.94).

As for the geographical split, we have considered 109 national and sub-national units selected in order to ensure a certain degree of economic homogeneity and administrative functionality. Needless to say, this choice is only partially consistent with the ideal spatial unit of observation which would be probably smaller. However, the selected units of observation correspond to Eurostat's classification of NUTS (Nomenclature des Unites Territoriales Statistiques) which is the main source for comparable spatial data in Europe. The selection is as follows (the complete list is reported in the Appendix's table): NUTS-0 (countries) for Denmark, Luxembourg, Ireland; NUTS-1 for Belgium (3 Régions), Germany BR (11 Lander), Netherlands (4 Landsdelen), United Kingdom (11 Standard regions); NUTS-2 for Greece (13 Development regions), France (22 Régions), Spain (17 Comunidades Autònomas), Italy (20 regioni), Portugal (5 Commissaoes de Coordenacao Regional).

Before discussing the main descriptive features of the data it seems important to highlight some caveats. Patent applications to a foreign institution (through either the EPO or the national patent office) represent only a fraction of the total number of patents filed domestically by residents [SASSU and PACI (1997)]. Indeed, the high costs of application and implementation of patenting abroad imply that several domestic patents with scarce economic relevance and mainly owned by individual inventors are not extended to foreign markets [SOETE and WYATT (1983)]. At the same time, the increasing commercial integration across the European countries requires firms to protect their profitable innovations not only domestically but also in the foreign markets where they are

[3] It should be considered that more than half of the patents register multiple inventors. In total, we have counted 2 inventors out of one patent. Therefore, to avoid arbitrarily duplications, we have preferred to consider only the first inventor. This procedure introduces a bias in our description of regional innovative activity only when, for a given patent, inventors reside in different regions. However, several tests on our database have indicated that such a case is

willing to trade. A patent granted by EPO may have a simultaneous validity over several European countries, therefore this organisation is gaining in importance since it was formed in 1978 and now grants almost the totality of external cross-patents among the European countries [PACI, SASSU and USAI. (1997)]. In a nutshell, patent applications to EPO represent a subset of the total domestic innovative capability of each region which can, indeed, be considered the component with the highest quality and economic potential and, as a result, a rather good proxy for the regional innovative activity.

A summary of the patents included in the database, divided by country of origin, is reported in Table 1. It is immediately evident that the number of patent applications to EPO by the twelve countries under exam has remarkably increased during the eighties: from 10 thousands in 1980 to 25 thousands in 1990. However, rather than an indication of an explosive growth of innovative activity in European regions, this should be interpreted primarily as the result of the growing propensity to patent at EPO. Such a growth, in other words, is mostly attributable to the fact that along time European innovators have become both aware of the advantages achievable by patenting at EPO and accustomed to the different procedure (at least for non-Germans inventors) for obtaining a patent by the office in Munich. The highest share (about 47% in 1990), not surprisingly, refers to the inventors located in Germany, followed by France (19%) and United Kingdom (14%).[4] At a glance,

Table 1 shows that the innovative activity in Europe is performed in almost nine thousand localities which result as places of origin of a patent in 1990. Furthermore, the ratio between the number of patents singled out by inventors' residence and those classified thanks to proponents' location is higher than unity (1.05). In other words, the European inventors registered at EPO are

very limited. Moreover, it should be considered that usually inventors are listed according to their contribution to the inventions and this makes the choice of the first inventor even more justifiable.

[4] The high share of German patents is not only due to the well known high technological capacity of German firms, but also to the fact that EPO regulations closely follow the granting procedures of the German national system. Therefore, especially in the early eighties, it was easier for German companies to apply directly to EPO.

more than the European applicants. This is mainly due to the presence of a relevant number of company headquarters outside the EU (e.g., United States, Switzerland and Sweden) that act as patents' proponents even though inventors (and the plants where they are employed) are actually located inside the European countries. This result validates our choice to use the inventor's location to analyse the geographical distribution of innovative activity within Europe. The only countries where the ratio between inventors and proponents is smaller than unity are Luxembourg (0.76) and Netherlands (0.97), most probably because these countries host a number of headquarters of multinational corporations. At the other extreme, one finds Greece where for every three inventions attributed to a Greek resident only one turns out as a Greek application to EPO.

3. The regional distribution of aggregate innovative activity

This section presents a description of the aggregate innovative activity across the regions of the European Union. Such a picture is based on the comparison of the number of patent applications normalised by the size of the geographic unit, expressed by the number of inhabitants. A complete list of patents per capita for the 109 regions is provided in the first column of Table A1 in the Appendix.

An effective overview of the spatial distribution of technological capacity among the European regions in 1990 is presented in Figure 1. The innovative activity appears mostly concentrated in the German regions, while some other relevant clusters result in the South of the United Kingdom, in central France, and in northern Italy. It is worth remarking that there is a group of 22 regions, all belonging to southern Europe (that is, Greece, Italy, Portugal and Spain), where there has been no patenting activity through EPO in 1990. Moreover, another 19 regions show a very low innovative activity - less than 6 patents per million of inhabitants – and it consists of other southern European regions, plus Corsica and Northern Ireland.[5] In conclusion, there appears to be a clear dualistic structure in the innovative activity within the European regions. It is, therefore, obvious to ask how much of such a structure is a by-product of the differences in the economic performance of the productive system or vice-versa. Unfortunately, the available information do not allow for any rigorous statistical testing of causality, nevertheless it is interesting to evaluate whether the innovative activity is associated to the level of productivity.[6] A first evaluation can be derived from Figure 2, which reports an overview of the labour productivity level across the European regions in 1990.[7] Such an overview displays a less clear-cut picture than that provided by the previous figure. The most productive regions are now more dispersed around several countries, even though there remains a clear split between North and South. The top 25 regions (with GDP per worker higher than 8% of the average EU value) consists of 10 French regions, 6 Italian ones, 6 German ones, two Belgian ones and a Spanish one.

Although the comparison of Figures 1 and 2 gives some interesting information, quantitative measures are needed to corroborate our initial evaluations. Such measures are provided in Table 2, where the dispersion of labour productivity and of innovative activity (measured by the coefficient of variation[8]) are reported for the European Union and for the largest countries. As far as the regional distribution of the innovative activity in the whole EU is concerned, this appears to be highly concentrated (CV = 1.28 in 1990) mainly because of the huge differences between southern and

[5] It should be however noted that these two territorial units belong to the backward regions' group (objective 1) defined by the European Union, so that they can be correctly joined to the southern European regions from an economic point of view.

[6] The relationship between technology and economic performance at the European regional level has been studied by Verspagen (1997) which explores the existence of regional clubs for five European countries (Germany, France, Italy, Spain and United Kingdom). Moreover, Fagerberg and Verspagen (1996) analyse the effects of R&D expenditures on the catching up process for a group of 49 European regions.

[7] The aggregate labour productivity for the European regions is calculated as GDP, expressed in purchasing power parity (PPP), divided by total employment. See Paci (1997) for details.

[8] The results do not change if we use Gini and Herfindal indices as measure of concentration. Therefore, throughout the paper, we present the results based only on the coefficient of variation.

northern Europe that we have already remarked. As a result, the innovative activity appears more equally distributed within each country. The highest dispersion (1.02 in 1990) is recorded in Italy, where the disparities between the northern regions and the Mezzogiorno do not show any clear tendency to decline over the decade. On the other hand, Germany and United Kingdom display the lowest spatial concentration of technology (around 0.5). Another interesting stylised fact to be noted is the presence of a clear declining trend of the regional dispersion of innovative activity over the decade under exam (from 1.51 in 1980 to 1.28 in 1990). It must be remembered, however, that this result is only partially attributable to a growing similarity of the regional innovative potential displayed by European regions. Actually, such a change can be due to the growing propensity to patent at EPO by the peripheral countries and regions of southern Europe[9]. It may be reasonable to argue that the "propensity to patent" effect has been predominant in the first half of the decade and that the "innovative convergence" has grown in importance in the latest years with the decline of transaction costs associated to patenting at EPO.

As for the labour productivity, it is remarkable that its level of dispersion is much lower with respect to the innovative activity, both at the European and at the country level[10]. This seems to imply that spatial increasing returns and localised spillovers are more important for the innovative rather than for the productive activity. Furthermore, there appears just a weak sign of convergence in productivity levels across European regions (the dispersion goes from 0.25 in 1980 to 0.24 in 1990). At the country level, it is worth noting that Italy has, again, the highest degree of regional inequality (0.14), while United Kingdom shows the most homogenous structure (0.05). Finally it is interesting to stress that among the German Lander the dispersion in labour productivity is higher, relatively to

[9] It should be also considered that Greece was admitted to the European Community in 1981 and Spain and Portugal only five years later in 1986.

[10] This confirms the evidence shown by Caniels (1997) for just five countries (France, Italy, Netherlands, Spain and United Kingdom) out of our sample of twelve countries.

the other countries, than the dispersion in the innovative activity; we will return on this point later. These findings confirm the patterns of the convergence process across the European countries shown by Paci (1997).

Finally, the last two columns of Table 2 attempt to offer an answer to the question put forward above about the degree of association between the regional distribution of innovative activity and labour productivity. The two series turn out to be positively and significantly associated for the whole European Union; most importantly the correlation is increasing (from 0.45 in 1980 to 0.52 in 1990). Considering the correlation within the boundaries of each country, there appears to be a positive and strong association for France, Italy and the United Kingdom. Conversely, there is no association between the distribution of innovative activity and labour productivity for the case of the German regions. To address this puzzle we have calculated the correlation excluding from the aggregate productivity level the agriculture sector and also using only the industrial productivity. In both cases we have found the same result: a lack of association among the German regions between the distribution of innovative activity and the measure of labour productivity. This surprising result may be attributed to the fact that the beneficial effects of technological change (as detected by our indicator) spill over several regions, for example thanks to both a more diffused network of plants around the country and a social network which carries information and expertise over regional borders.[11] Such a result is investigated in greater detail in the next section in order to understand to which extent this feature represents a point of strength of the German economic and industrial structure which distinguished it from the other European ones.

It may be interesting, at this point, to get a closer look at the top twenty innovative regions identified in Figure 1. Table 3 shows that half of them belongs to Germany, while four pertain to

[11] A similar result, that is the existence of a national cluster of regions in Germany, is found by Verspagen (1997) and is interpreted as a signal of the impact of a national system of innovations.

France, three to Italy, two to United Kingdom and one to Netherlands. The European region with the highest technological activity is Baden Wurttemberg, with 278 patents per million inhabitants. The success of this Land is based on an oft-studied “innovation network” where many different institutions support the activity of several large and small enterprises in the automotive and electronic industries (COOK and MORGAN, 1994). The second position is obtained by a Dutch region, Zuid Nederland with 242 patents per million inhabitants. Both regions were preceded in the 1980 ranking by another German region, Hessen, which has declined to the third position in 1990. In general the rank correlation between the initial and the final year is quite high (r=0.92). However, it is possible to highlight several up and down movements in the top positions. For instance, Luxembourg has descended from the 8th to the 25th position, Bruxelles from 11th to 22nd. At the same time some regions, especially Italian ones, have greatly improved their ranking, for instance Lombardia (from 36th to 12th), Friuli Venezia-Giulia (from 49th to 17th) and Piemonte (from 48th to 19th). Again such oscillations may be interpreted either as a result of a real reshuffle in innovative capacity across European regions or, most likely, as a consequence of a mutated propensity to patent. On this point, let recall that some European regions (especially in Italy) were in great trouble during the early eighties in the aftermath of the two oil shocks. At that time, such industrial regions could not afford risky and costly investments as the expenditure in R&D. In other words, technological progress in those years was achieved mainly through industrial reorganisation, learning and imitation instead of innovation.

4. The regional specialisation in innovation and production

An interesting feature of the database under exam is that it allows to illustrate the sectoral technological specialisation of each region. The EPO arranges patent series according to the sections and categories of the International Patent Classification (IPC), which reflects the invention’s function rather than its industrial contents. Therefore, it happens that any IPC section contains unrelated innovations concerning the most diverse sectors of production. Such a shortcoming makes IPC series inadequate for any comparative analysis with other economic variables (e.g., value added, employment). For this reason we have converted the original IPC data (over 600 sub-categories) to the NACE classification at the three digit level on the basis of the productive sector where the innovation has been originated.[12]

As a measure of sectoral specialisation we use the index of Revealed Technological Advantage (RTA) which gives information on the specialisation of a region compared to other areas.[13] This index has the advantage to be double weighted so that the resulting description of technological specialisation is not influenced by sectoral or national differences in the "propensity to patent". We start examining in section 4.1 the regional distribution of the innovative activity at the industry level, then the relationship between productive and technological specialisation is considered in section 4.2, finally in section 4.3 we address the issue of technological heterogeneity.

4.1 The sectoral innovative specialisation of the European regions

A first picture of the sectoral distribution of the technological activity is presented in Table 4 where the six most innovative sectors at the two digit level for 1990 are reported. It is quite clear that innovative activity is not only clustered in some advanced regions but that it is also spatially grouped within specific industries. For example, almost 20% of innovations in drugs is attributable to Nordhrein-Westfalen, where Bayer operates among others; while Bayern, Ile de France and Zuid

[12] See Sassu and Paci (1989) for a complete description of the conversion process. It may happen that the patent's document reports more than one IPC categories. In such a case we have considered only the primary IPC category to avoid arbitrary duplications. The concordance table is available under request from the author.

[13] The index of comparative technological specialisation is calculated as $RTA = P_{ij}\ SSP_{ij} / (S_iP_{ij}S_jP_{ij})$ where P_{ij} are the patents demanded by inventors resident of region j in sector i. The index is greater than one when the country has a comparative advantage in that sector and is less than one when it has a disadvantage. In section 4.2 we use a similar

Nederland account for almost 40% of European innovations in electric and electronics thanks to the innovations of Siemens, Thomson and Philips, respectively.

Table 4 provides just a sketchy but significant picture which is confirmed in Figure 3 with an overview of the sectoral technological specialisation of the European regions in 1990, obtained by disaggregating the industrial activities in four sectors as suggested by PAVITT (1984)[14]. The first sector, which holds only a small fraction of total patenting activity in Europe (5%), includes the traditional activities such as textiles and apparel, wood and constructions. The chart reveals that there are just six regions (four in Italy and two in Spain) which are highly specialised in traditional activities. Among them, it is important to highlight the presence of Veneto which, thanks to a diffused network of small and medium firms, has gained a significant comparative advantage in Textiles. The cluster of regions specialised in traditional activities is the most numerous (there are more than thirty regions which display a RTA in this sector higher than unity) and dispersed (the coefficient of variation is 1.2). The largest group (57% of total patents) is the scale intensive one, which consists of energy and chemical products, metal industries, food, transport equipment and consumer machinery. Needless to say, this is a very heterogenous sector where one finds both southern regions (such as Sardinia and Sicily) and northern regions (such as, among many others, Zuid Nederland, Nordrhein-Westfalen and Hessen). In the former case, scale intensive specialisation is mainly due to the past massive public investments in chemical industries; while in the latter case, this result is attributable to a more robust and diffused industrial structure which has, nevertheless, some “local” champions such as Philips, Bayer and Hoechst respectively. As for the specialised supplier sector, which includes industrial machinery, printing and railroad, this amounts to 22% of

index which is based on sectoral employment – the Revealed Productive Advantage (RPA) - to analyse the comparative industrial specialisation.

[14] In Figure 3, regional technological specialisation is calculated by the RTA index divided by the coefficient of variation in order to take into account for the different dispersion in each sector.

total patents. Again, this is a very heterogenous cluster. It is, however, interesting to notice that many Italian regions belonging to the so called "Third Italy" (that is Emilia, Tuscany, Marche and Umbria) display a high specialisation in this sector, mainly due to their successful machinery industries. Finally, the science based sector, which includes pharmaceuticals, office and precision instruments and aerospace, represents 16% of total patenting. This cluster, not surprisingly, includes most of the capital town regions (Ile de France, South East, Lazio) where one finds the main government research centres and the most important universities, which are crucial in this sector. It is also worth highlighting the presence of some regions which host either important computer companies (Siemens in Bayern, Thomson in Ile de France, and several subsidiaries of important multinationals in Ireland) or pharmaceutical ones (for example, ICI and Glaxo in South East).

A more detailed analysis of the sectoral specialisation, based on 11 industrial sectors, is reported in Table 5 for the 20 most innovative regions, while the index for all the 109 regions is reported in Table A1 in the Appendix. It is interesting to remark that the specialisation pattern for the technologically most advanced regions appears to be quite heterogeneous given that nine out of eleven sectors appear as the main sector in different regions (just are Building and construction and Non-electrical machinery missing). Moreover such a structure appears rather stable along time given that the correlation of RTA distribution in 1980 and 1990, reported in the last column, is usually positive (with the only exception of Schleswig-Holsten (-0.09) and Niedersachsen (-0.5)).

4.2 Technological and productive specialisation

To which extent is the technological specialisation of European regions associated to their productive specialisation? To answer this relevant question, in this section we firstly estimate the sectoral specialisation of the industrial system by computing for each region the index of Revealed Productive Advantage (RPA) -- previously defined in note 13 -- based on data on sectoral employment in 1990.[15] Secondly, we compare the sectoral patterns of technological specialisation of each region (as it emerges from the RTA index described in section 4.1) with the productive one. Table 6 reports the correlation coefficients (Pearson and Spearman's rank correlation) for the whole Europe and across countries and sectors.

The first result to be remarked is that there is a positive and significant association between the spatial and sectoral specialisation of the innovative and productive activities. Such a result may be interpreted as a signal of the presence of both technological and productive increasing returns (i.e. localised knowledge spillovers, agglomeration economies) which positively influence each other and, in so doing, propitiate the establishment of regional specialisation patterns. STORPER (1992) discusses some examples from France, Italy and the U.S. of such processes. Again, to confirm such a suggestive interpretation more detailed analysis on the complex and differentiated nature of spatial spillovers is required. In the next section, some progress is made in this direction.

The result for the entire Europe is confirmed, but for few exceptions, by the correlations computed at the national and sectoral level. All countries present a positive and significant association between technology and productive specialisation, displaying very high levels of significance.[16] Only for the small countries - like Belgium and Netherlands - the significance is less than 10% for the Pearson correlation. In this case the territorial split is too limited and it prevents a precise evaluation of the spatial specialisation. As regards to the correlation for each industrial sector over the 69 regions, it appears that 7 out of 9 sectors show a positive and significant association

[15] We have excluded from our analysis Spain, Greece and Portugal because their technological activity is too low to allow for sectoral comparison. For the same reasons we have excluded 5 other regions which hold less than 5 patents in 1990. Therefore we are considering here a total of 69 European regions. Sectoral employment comes from Eurostat's *Regio*. For Germany and United Kingdom data have been kindly provided by De Nardis *et al.* (1996) who have studied the manufacturing specialisation of 56 territorial units in Europe in the context of the optimal currency area's debate. To make technology and employment sectoral data comparable, in sections 4.2 and 4.3 we limit our analysis to 9 industrial sectors.

[16] Due to the limited number of observations, we have considered together the mono-region countries – Ireland, Denmark, Luxembourg.

between innovative and productive specialisation. This association results particularly strong in the highly integrated and scale intensive sectors like Energy, Chemicals and Transport equipment, and also in more traditional industries such as Textiles and apparel.[17] The results are more controversial in sector 8, probably due to the high heterogeneity of the productions here included: wood, paper and other manufacturing industries. Moreover, the spatial correlation between technology and production is non existent in the case of Building and construction, since this particular activity is obviously rather evenly spread throughout all areas.

4.3 Spatial dispersion of technology and production

In the previous sections we have found that technological enclaves exist together with industrial districts at the regional level in Europe. Furthermore, we have found that high levels of technological activity are associated to high levels of productivity (but for Germany) and that productive and innovative specialisation patterns are often specular phenomena. All such evidence seem to invite to conclude that increasing returns are at work both for technological and productive activity and that they reinforce each other. However, the German "puzzle" highlighted above discourages too a rigid conclusion and asks for some more analysis on the complex relationship between production and technological activity at the regional level.

More specifically, in this section we analyse the degree of spatial dispersion of the innovative and productive activity for nine industrial sectors. Table 7 displays the coefficients of variation for the whole European Union and within the four largest countries. Considering the European Union, one notes that in 1990 the industries with the strongest spatial heterogeneity of the innovative activity are Transport equipment (CV=2.82) and Energy (2.69). At the other extreme, the

[17] For the Textiles and Apparel sector the correlation between technological and productive specialisation appears particularly high in the Italian regions, where this industry is organised, as it is well known, by locally integrated "industrial districts".

technological capability of Food (2.05) and Wood (2.10) appears to be more evenly distributed across regions.[18] As regards the productive activity, the most concentrated sectors are Metal and non-metal industries (1.97) and Energy (1.65), while the most dispersed ones are Food (0.88) and Building and construction (1.06). It has to be remark that the spatial concentration is higher in innovation rather than in production for all the sectors considered.

Considering the spatial dispersion within the largest European countries, it is worth noting that, as expected, the within-country concentration is usually lower for all sectors with respect to the European one. The profile of technological concentration at the national level appears quite homogeneous, few sectors show a spatial high concentration in all countries: Transport equipment, Energy, Machinery and Chemicals. Moreover, interesting local peculiarities are the high spatial concentration of innovative activity in the Food sector in United Kingdom and in the Textile industries in Italy. It is also interesting to note that the average levels of technological dispersion within the regions of each country are rather different. At one extreme one finds France (2.08) characterised by very specialised regions, probably as a result of public policies that have fostered the development of very specialised "technopole" around country (LONGHI and QUERE, 1991); at the other extreme, one finds Germany with a coefficient of variation of 1.2, which implies, again, a rather homogenous pattern of regional technological activity.

As regards the spatial distribution of sectoral productive activity, this appears more irregular, since each country tends to follow its own pattern of regional concentration of the sectoral activities. For instance, the most spatially concentrated sectors are: Energy in Germany, Chemicals in France, Machinery and office in Italy, surprisingly the Wood, paper and other manufacturing in the United Kingdom, and finally the Metal and non metal industries at the European level. In a nutshell, the

[18] If the same indicators are computed for 1980 one finds that the degree of concentration over the eighties shows a tendency to decline in all sectors – with the exception of Metal industries - and this trend is particularly evident in Chemicals and Electrical machinery.

spatial concentration of innovative activities at the sectoral level seems to follow only partially a pattern similar to the one of industrial concentration of the production. In general, we have on the one hand a high concentration in the scale intensive sectors usually dominated by few "national champion" firms located in different regions. On the other hand the traditional industries, characterised by a more relevant presence of small and medium firms, show a more dispersed spatial distribution of the innovative and productive activities. At the same time, countries display several interesting sectoral peculiarities in their spatial profile which can be interpreted in terms of different levels of integration among regions for innovation and production.

In particular, it should be noted that Germany shows the lowest spatial concentration both for the aggregate and average sectoral innovative activity, respectively CV=0.51 in Table 2 and CV=1.20 in Table 7. This evidence can be read as a further indication of a network of innovative activity which is not strongly segmented at the regional level. Recently, TAMURA (1996) has suggested that the more homogeneous is the distribution of knowledge and innovative activity among regions, the easier is the process of regional integration in production in order to exploit different paths of specialisation *a' la* Smith. Interestingly, Germany displays a high level of spatial concentration of production (average CV = 1.11 in Table 7).[19] One may argue that this reflects a high level of regional integration, with each region following a different comparative advantage and exploiting more deeply available economies of scale and scope. In other words, Germany seems to have its main point of strength in an innovative system which is able to share technological knowledge and expertise more than other national systems, and which favours an integrated and therefore more efficient interregional productive system This evidence may help in explaining the

[19] The only country which has a higher level of productive concentration is Italy due to the presence of a still strong division between North and South both in terms of per capita income and of structure of production (see Paci and Pigliaru, 1998).

lack of association between aggregate innovative capacity and productivity levels among the German Lander we have previously detected.

Another interesting way to analyse the dispersion of the technological activity is to look at how innovations within each region are spread across sectors. Using this dispersion measure, if we calculate across all regions the association between the degree of sectoral dispersion of technology and the aggregate productivity levels, there appears a negative and significant correlation (r=-0.45). In other words, the European regions which enjoy a more homogeneous distribution of their technological capability across different industrial sectors appear to be also characterised by a higher productivity level. This outcome suggests the presence of positive inter-industries externalities which favour those regions that succeed in covering a broader range of technological activities. However, there may be alternative explanations due to the fact that this relationship is very much endogenous in nature. In other words, it may be that those regions which becomes richer, are, for this very reason, able to attract entrepreneurs and firms in different sectors. Cross section analysis do not allow for an assessment of the relative strength of such alternative explanations. Assessment which should be addressed by future research if more data on the temporal dimension become available.

5. Conclusion

Europe is becoming more and more integrated thanks to several policies aimed at decreasing the core of the transaction costs which affects factors' mobility. How is the current pattern of regional industrial specialisation going to change due to such a process of integration? To propitiate a correct answer to this question, this paper starts constructing the map of the spatial distribution of innovative and productive activity in Europe and assessing the level of integration between them. Such an analysis is made possible thanks to an original databank on regional technological statistics based on patent data from the European Patent Office (EPO) and rearranged by assigning each patent to its region of origin through the postal code of the inventor's residence.

The main results of the aggregate analysis worth highlighting are as follows. First, the technological activity in the EU appears to be highly concentrated, although concentration tends to decline over the period. This results from the huge differences between southern and northern Europe. Secondly, as expected, the degree of disparities in the productivity distribution appears much lower with respect to innovative activity both at the European and at the country level. Nonetheless, the correlation coefficients between the regional distribution of aggregate innovative activity and labour productivity turns out to be positive and significant at the European level and for all countries but for Germany. This last puzzling result advocates for some interpretative caution and confirms that the relationship in exam is a complex one.

The disaggregated analysis at the sectoral level aims at unravelling some of such complexity. First of all, innovative activity is observed to be spatially clustered within specific industries. In other words there is a tendency towards the formation in Europe of highly specialised technological enclaves, especially in some sectors - Machinery, Transport equipment, Energy. Moreover, we have documented how the spatial and sectoral specialisation of innovative and productive activities is positively and significantly correlated. This seem to suggest that localised knowledge spillovers and agglomeration economies foster a local economic system towards a specialisation in both production and technology. Finally, we have looked at the regional technological and productive heterogeneity and two main results have arisen. Firstly, Germany proves to be a special case due to the coexistence of a low level of technological dispersion and a relatively high level of productive dispersion. This has been interpreted as evidence of the presence of a network which carries technological spillovers across regions and which favours an integrated interregional market for production. Secondly, we observe a negative correlation between sectoral technological concentration and aggregate productivity across the regions. This suggests that the European regions which enjoy a more homogeneous distribution of their technological capability across different industrial sectors appear to be also characterised by higher productivity levels.

This paper has provided a first recognition of the spatial dimension of innovative and productive activity at the regional level in Europe. Such a study has been mostly descriptive in nature and considerable progress is still to be made in order to identify, and test appropriately, the main determinants of the self reinforcing mechanisms which lead to innovative and productive clusters. However, we may prudently discuss some preliminary policy implications of our results. The existence of self-reinforcing mechanisms at the regional level which may lock regions in either losing or winning paths of specialisation in production and technological activity seems to encourage policies which should lead regions towards the right direction. This is not an easy task, for, in these circumstances, governments, as asserted by DAVID (1987), resemble "blind giants" with "narrow windows of opportunities". Unfortunately, our results do not manage to cancel this blindness or to enlarge such windows, nevertheless they suggest that region-specific policies to strengthen their technological “infrastructure” and help reversing potentially vicious circles are still up in the agenda. The German case, moreover, seems to indicate that the presence of more similar regions in terms of technological capacity favours interregional spillovers and in so doing the formation of a more integrated and hopefully more efficient national market.

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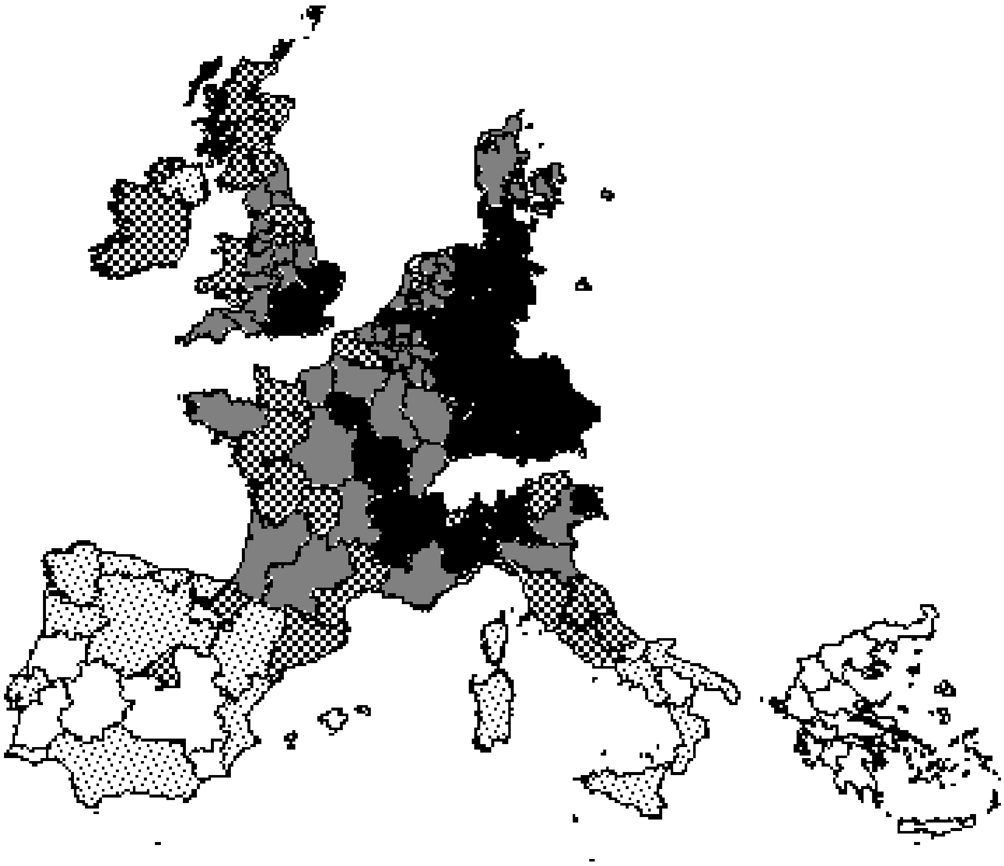
Figure 1. Innovative activity in the European regions. 1990

p: number of patents per million of inhabitants



Range:

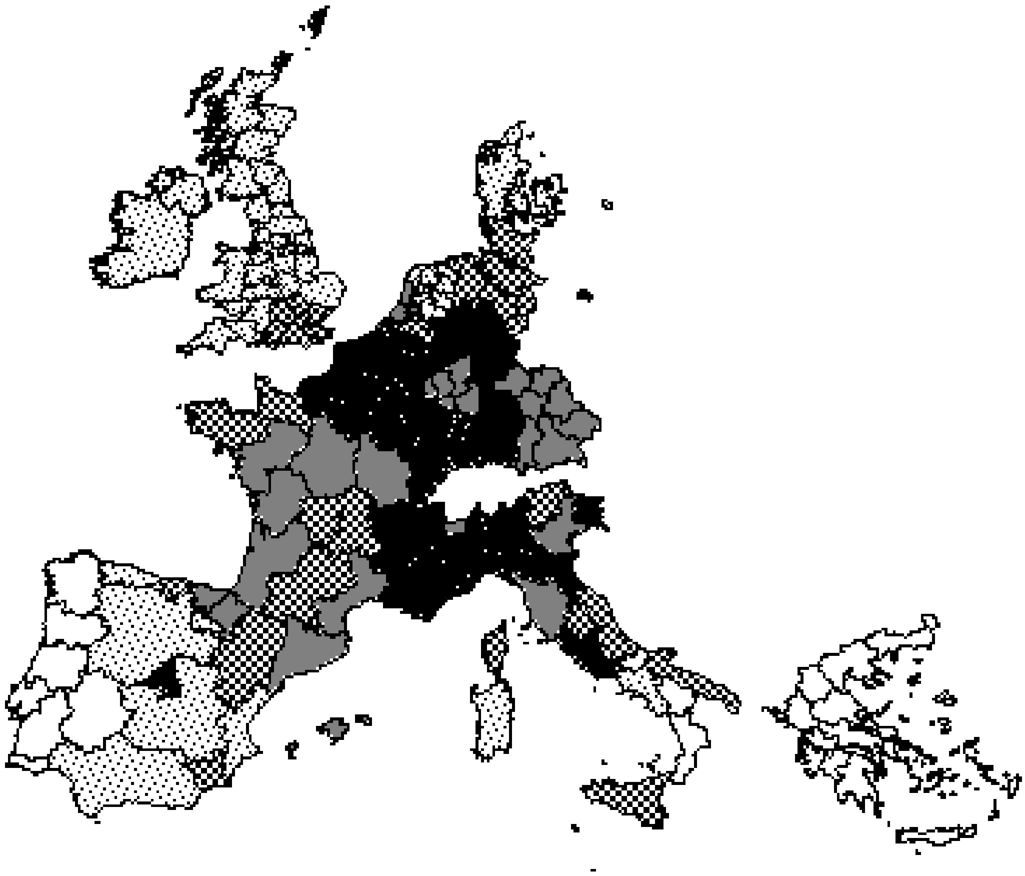
p = 0	0 < p < 6	6 < p < 40	40 ≤ p < 80	p ≥ 80

Frequency:

f = 22	f = 19	f = 21	f = 27	f = 20

Figure 2. Labour productivity in the European regions. 1990

Y: index of Gross Domestic product per worker, European Union = 100



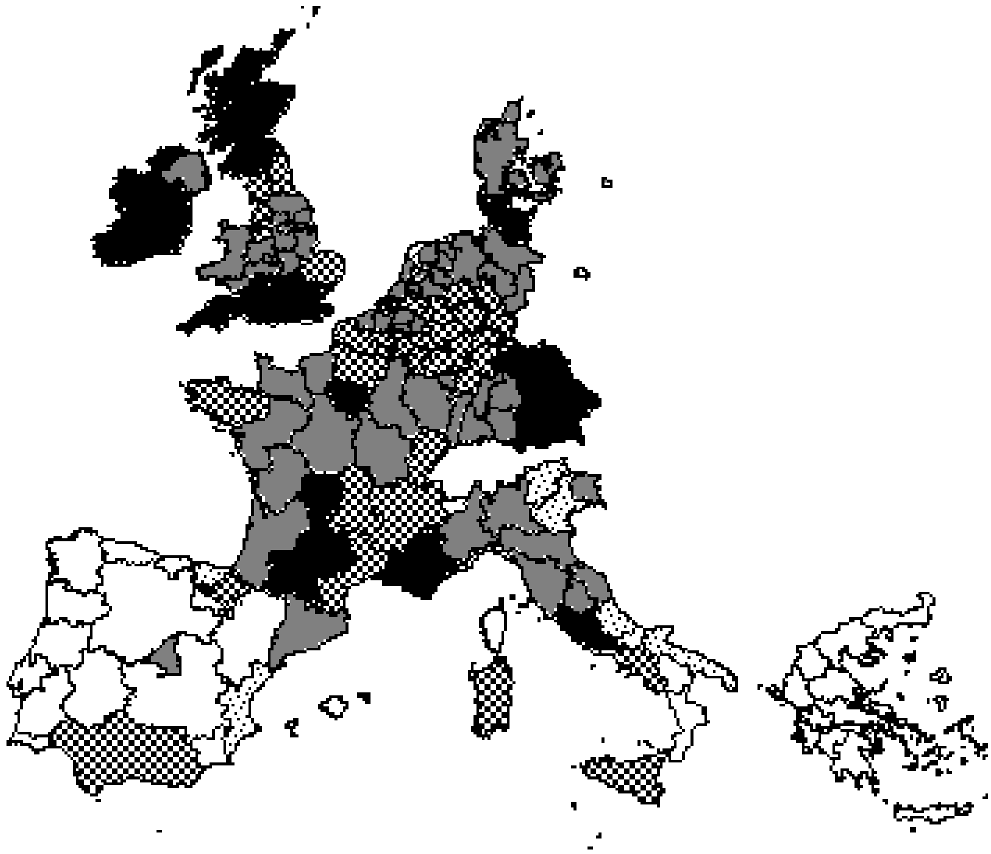
Range:

$0 \le Y < 88$	$88 \le Y < 99$	$99 \le Y < 109$	$109 \le Y < 117$	$Y \ge 117$

Frequency of different groups:

f = 23	f = 22	f = 20	f = 19	f = 25

Figure 3. Technological specialization in Pavitt sectors (1990)



not included	traditional	scale intensive	specialised suppliers	science based

Frequency of different groups:

f = 33	f = 6	f = 25	f = 32	f = 13

Table 1. Patent applications at the European Patent Office by European countries

Country	Distribution of patents by inventor (percentage values)			Number of locations	Ratio inventor/proponent	Patents per location
	1980	1985	1990	1990	1990	1990
Belgium	2.5	2.4	2.2	280	1.35	2.0
Germany	50.0	47.2	47.0	2492	1.03	4.8
Denmark	1.0	1.2	0.9	114	1.04	1.9
Spain	0.3	0.5	1.0	89	1.09	2.7
France	20.9	18.5	19.4	1679	1.04	2.9
Greece	0.0	0.1	0.0	2	3.00	1.5
Ireland	0.1	0.2	0.3	41	1.14	1.6
Italy	3.7	6.9	9.1	789	1.07	2.9
Luxembourg	0.2	0.1	0.1	18	0.76	1.4
Netherlands	5.0	6.2	6.3	434	0.97	3.7
Portugal	0.0	0.0	0.0	4	1.25	1.3
United Kingdom	16.4	16.7	13.8	2874	1.12	1.2
European Union	100.0	100.0	100.0	8816	1.05	2.9
(absolute value)	(10,426)	(17,511)	(25,333)			

Table 2. Regional dispersion of innovative activity and labour productivity

Country	Num. of obs.	Innovative activity (a)		Labour productivity (b)		Correlation (c)	
		1980	1990	1980	1990	1980	1990
Germany	11	0.61	0.51	0.12	0.12	-0.19	-0.04
France	22	1.04	0.77	0.11	0.11	0.60	0.76
Italy	20	1.08	1.02	0.13	0.14	0.73	0.79
United Kingdom	11	0.53	0.55	0.05	0.05	0.72	0.60
European Union	109	1.51	1.28	0.25	0.24	0.45	0.52

Notes:
(a) coefficient of variation of patents per capita
(b) coefficient of variation of GDP per worker
(c) correlation coefficient between the spatial distribution of innovative activity and labour productivity

Table 3. Innovative activity and labour productivity of the top twenty innovative regions. 1990

Code	Region	Innovative activity			Labour productivity		
		Value *	Rank	Rank var. 1980-90	Value **	Rank	Rank var. 1980-90
D1	Baden-Wurttemberg	279	1	4	31326	24	3
N4	Zuid-Nederland	242	2	5	26235	61	-50
D6	Hessen	239	3	-2	35046	3	10
D2	Bayern	224	4	-1	29164	42	3
D9	Rheinland-Pfalz	204	5	-1	29730	36	-1
F1	Ile de France	203	6	-4	42280	1	1
D8	Nordhrein-Westfalen	176	7	-1	30788	25	-3
F18	Rhone-Alpes	155	8	1	32107	14	9
D3	Berlin	116	9	1	33894	7	2
U4	East Anglia	107	10	3	25303	71	2
F10	Alsace	104	11	16	33426	9	-2
I4	Lombardia	96	12	24	34488	6	0
D11	Schleswig-Holstein	93	13	7	28426	47	-7
D5	Hamburg	91	14	11	40889	2	-1
D7	Niedersachsen	86	15	4	27704	54	-7
U5	South East	85	16	-4	28107	49	8
I7	Friuli Venezia Giulia	85	17	32	31534	21	7
F7	Bourgogne	81	18	-3	30330	29	9
I1	Piemonte	81	19	29	31791	16	9
D10	Saarland	81	20	4	28759	44	7

* patents per million inhabitants
** GDP per worker, millions of PPP

Table 4. Regional distribution of innovative activity for the most innovative industries. 1990

Industry (no. of patents)	Region	Number of patents	Share on industry patents
Non electrical machinery (n=5288)	Nordrhein-Westfalen	710	13.4%
	Baden-Wurttemberg	693	13.1%
	Bayern	511	9.7%
	Ile de France	344	6.5%
	Hessen	271	5.1%
	Lombardy	174	3.3%
Drugs (n=4905)	Nordrhein-Westfalen	949	19.3%
	Hessen	429	8.7%
	South-East	383	7.8%
	Rheinland	378	7.7%
	Ile de France	304	6.2%
Electrics and electronics (n=4371)	Bayern	791	18.1%
	Ile de France	530	12.1%
	Zuid Nederland	423	9.7%
	Baden-Wurttemberg	419	9.6%
	South-East	288	6.6%
Precision instruments (n=2940)	Baden-Wurttemberg	394	13.4%
	Bayern	353	12.0%
	Ile de France	289	9.8%
	South-East	244	8.3%
	Hessen	169	5.7%
Metal products (n=2211)	Nordrhein-Westfalen	375	17.0%
	Baden-Wurttemberg	258	11.7%
	Bayern	178	8.1%
	Ile de France	156	7.1%
	Hessen	132	6.0%
Motor vehicles (n=1337)	Baden-Wurttemberg	310	12.7%
	Bayern	170	12.3%
	Ile de France	164	6.4%
	Nordrhein-Westfalen	85	5.2%
	Piemonte	69	4.6%

Table 5. Specialisation of the top twenty innovative regions. 1990

Code	Region	Highest specialisation sectors				Correlation between RTA in 1980 and 1990
		First sector	RTA	Second sector	RTA	
D1	Baden-Wurttemberg	Transport equipment	1.82	Non-elect. Machinery	1.24	0.72
N4	Zuid-Nederland	Electrical machinery	3.06	-		0.61
D6	Hessen	Chemicals	1.59	Metal, non-metal ind.	1.09	0.42
D2	Bayern	Electrical machinery	1.81	Office, precision inst.	1.22	0.74
D9	Rheinland-Pfalz	Chemicals	2.47	Textiles, apparel	1.22	0.35
F1	Ile de France	Energy	1.84	Electrical machinery	1.41	0.36
D8	Nordhrein-Westfalen	Chemicals	1.59	Metal, non-metal ind.	1.52	0.81
F18	Rhone-Alpes	Textiles, apparel	2.72	Wood, paper	1.61	0.53
D3	Berlin	Electrical machinery	1.81	Office, precision inst.	1.37	0.53
U4	East Anglia	Food	3.01	Energy	2.66	0.19
F10	Alsace	Wood, paper	2.39	Chemicals	1.34	0.59
I4	Lombardia	Wood, paper	1.34	Chemicals	1.27	0.35
D11	Schleswig-Holstein	Food	1.82	Office, precision inst.	1.58	-0.09
D5	Hamburg	Food	2.23	Wood, paper	1.68	0.47
D7	Niedersachsen	Energy	2.05	Food	1.75	-0.50
U5	South East	Office, precision inst.	1.53	Food	1.45	0.60
I7	Friuli Venezia Giulia	Metal, non-metal ind.	2.99	Energy	2.29	0.04
F7	Bourgogne	Transport equipment	2.76	Building, construction	2.40	0.08
I1	Piemonte	Transport equipment	3.03	Textiles, apparel	1.46	0.43
D10	Saarland	Energy	5.42	Transport equipment	1.92	0.69

Table 7. Dispersion of innovative and productive activity across European regions for industrial sectors. 1990

		European Union		Germany		France		Italy		United Kingdom	
		innovation*	production**	innovation*	production**	innovation*	production**	innovation*	production**	innovation*	production**
1	Energy	2,69	1,65	1,33	1,56	3,05	1,13	2,94	0,81	1,32	0,58
2	Metal and non-metal industries	2,54	1,97	1,28	1,34	1,75	0,77	1,50	0,91	1,07	0,74
3	Chemicals	2,59	1,55	1,27	1,14	2,02	1,33	2,25	1,45	1,48	0,87
4	Machinery and office, precision instr.	2,41	1,48	1,15	1,08	2,24	1,07	1,78	1,50	1,30	0,90
5	Transport equipment	2,82	1,49	1,40	0,93	2,45	1,08	1,93	1,44	1,22	0,87
6	Food	2,05	0,88	0,86	0,83	2,01	0,61	1,74	1,05	1,56	0,57
7	Textiles, apparel	2,21	1,45	1,15	1,19	1,90	0,93	2,55	1,34	0,97	0,73
8	Wood, paper, other manuf. ind.	2,10	1,25	1,19	1,00	1,47	0,92	1,59	1,31	1,37	1,04
9	Building and construction	2,21	1,06	1,20	0,88	1,83	0,89	1,40	0,83	0,88	0,87
	Average	2,40	1,42	1,20	1,11	2,08	0,97	1,96	1,18	1,24	0,80

* coefficient of variation of the distribution of patents per sector across regions

** coefficient of variation of employees per sector

Table 6. Correlation coefficients between innovative and productive specialisation. 1990
(2-tailed significance)

Within countries

Country	Pearson	Spearman
Europe	0.31	0.30
(621 obs)	(0.00)	(0.00)
Germany	0.44	0.39
(99 obs)	(0.00)	(0.00)
France	0.30	0.27
(189 obs)	(0.00)	(0.00)
Italy	0.31	0.22
(144 obs)	(0.00)	(0.01)
United Kingdom	0.35	0.22
(99 obs)	(0.00)	(0.03)
Netherland	0.26	0.41
(36 obs)	(0.13)	(0.01)
Belgium	0.30	0.35
(27 obs)	(0.13)	(0.07)
Other (IR, DK, LU)	0.52	0.42
(27 obs)	(0.01)	(0.03)

Within sectors (69 obs)

Sector	Pearson	Spearman
1 Energy	0.38	0.42
	(0.00)	(0.00)
2 Metal and non-metal ind.	0.26	0.25
	(0.03)	(0.04)
3 Chemicals	0.52	0.53
	(0.00)	(0.00)
4 Machinery	0.25	0.31
	(0.04)	(0.01)
5 Transport equipment	0.31	0.33
	(0.01)	(0.01)
6 Food	0.23	0.22
	(0.06)	(0.07)
7 Textiles, apparel	0.44	0.36
	(0.00)	(0.00)
8 Wood, paper, other manuf	0.24	0.17
	(0.05)	(0.17)
9 Building and construction	0.00	-0.08
	(1.00)	(0.54)

APPENDIX

Table 1A. Innovative activity in the European regions. Average 1980-90

CODE	REGIONS	Summary statistics		Standardised Revealed Technological Advantage*										
		Average number of patents per capita	Share of total patents (%)	Energy	Metal and non-metal industries and products	Chemicals	Non-electrical machinery	Electrical machinery and electronics	Transport	Office, precision instr.	Food drink and tobacco	Textiles, apparel	Wood, paper, and other manuf. industries	Building and constr.
BE1	VLAAMS GEWEST	41	1.2	-0.06	0.11	-0.06	0.05	-0.36	0.00	-0.35	0.36	0.41	0.18	0.19
BE2	REGION WALLONNE	36	1.0	-1.00	0.14	0.22	0.00	-0.37	-0.11	-0.38	-0.04	-0.25	0.41	-0.18
BE3	REG.BRUXELLES-	64	1.9	-1.00	0.21	0.04	0.04	-0.37	-0.29	-0.38	-1.00	-0.11	0.27	0.11
DK0	DANMARK	35	1.0	0.01	0.04	0.02	0.22	-0.41	-0.02	-0.32	0.05	0.38	0.14	0.06
DE1	BADEN-WUERTTEMBERG	189	5.5	-0.50	-0.07	-0.01	0.10	0.00	0.07	0.00	-0.19	0.05	0.01	0.02
DE2	BAYERN	165	4.8	-0.11	-0.24	-0.11	-0.09	0.25	0.06	0.25	-0.10	-0.08	-0.28	-0.30
DE3	BERLIN	90	2.6	-1.00	-0.19	-0.33	-0.38	0.31	0.04	0.31	0.04	-0.61	-0.13	0.05
DE4	BREMEN	42	1.2	-1.00	-0.38	0.47	-0.17	-0.16	0.44	-0.17	-0.16	-1.00	0.52	0.46
DE5	HAMBURG	60	1.8	-1.00	-0.14	-0.03	-0.07	0.03	0.31	0.03	0.18	0.14	-0.30	-0.44
DE6	HESSEN	185	5.4	-0.66	0.14	0.00	-0.01	-0.24	0.04	-0.25	-0.02	-0.38	-0.09	-0.14
DE7	NIEDERSACHSEN	57	1.7	0.32	0.00	-0.02	0.14	-0.14	0.01	-0.13	0.20	0.13	0.06	-0.10
DE8	NORDRHEIN-WESTFALEN	130	3.8	0.23	0.19	0.13	0.05	-0.37	-0.37	-0.38	0.00	-0.03	-0.02	-0.02
DE9	RHEINLAND-PFALZ	150	4.4	-1.00	0.28	-0.18	-0.16	-0.39	-0.28	-0.39	0.04	0.04	-0.26	-0.54
DE10	SAARLAND	50	1.5	0.84	0.05	0.08	0.23	-0.49	-0.01	-0.50	-0.13	-0.04	0.40	0.18
DE11	SCHLESWIG-HOLSTEIN	64	1.9	0.07	-0.15	0.06	0.06	-0.04	0.29	-0.01	0.12	-0.37	-0.18	-0.22
GR1	ANATOLIKI MAKEDONIA,	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
GR2	KENTRIKI MAKEDONIA	0	0.0	-1.00	-1.00	0.86	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
GR3	DYTIKI MAKEDONIA	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
GR4	THESSALIA	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
GR5	IPEIROS	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
GR6	IONIA NISIA	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
GR7	DYTIKI ELLADA	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
GR8	STEREA ELLADA	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
GR9	PELOPONNISOS	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
GR10	ATTIKI	1	0.0	-1.00	-0.11	-1.00	-1.00	0.16	-0.06	0.15	0.86	-1.00	0.71	-1.00

GR11	VOREIO AIGAIO	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
GR12	NOTIO AIGAIO	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
GR13	KRITI	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
ES1	GALICIA	0	0.0	-1.00	0.19	-1.00	0.51	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
ES2	ASTURIAS	1	0.0	-1.00	-0.16	-1.00	0.22	-1.00	0.66	-1.00	-1.00	-1.00	-1.00	-1.00
ES3	CANTABRIA	2	0.1	-1.00	-1.00	0.80	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	0.91	-1.00
ES4	PAIS VASCO	2	0.1	-1.00	-0.20	0.63	0.06	-0.19	-1.00	-0.19	-1.00	-1.00	0.50	0.73
ES5	NAVARRA	7	0.2	-1.00	-0.01	0.64	0.02	-1.00	-0.11	-1.00	-1.00	-1.00	0.69	-1.00
ES6	RIOJA	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
ES7	ARAGON	2	0.1	-1.00	-0.47	-1.00	-0.12	-0.03	0.41	0.30	0.81	-1.00	-1.00	-1.00
ES8	MADRID	6	0.2	-1.00	0.05	-0.04	0.07	-0.14	0.06	-0.14	0.12	0.35	-1.00	-1.00
ES9	CASTILLA-LEON	1	0.0	-1.00	-0.01	0.64	-1.00	-1.00	0.53	-1.00	-1.00	-1.00	-1.00	-1.00
ES10	CASTILLA-LA MANCHA	0	0.0	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	0.97	-1.00	-1.00	-1.00
ES11	EXTREMADURA	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
ES12	CATALUNA	9	0.3	0.58	0.08	0.35	0.14	-0.49	-0.35	-0.50	0.06	0.36	0.14	0.48
ES13	COMUNIDAD VALENCIANA	1	0.0	-1.00	-0.29	0.53	-0.06	-0.16	-0.04	-0.17	-1.00	0.49	0.52	0.74
ES14	BALEARES	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
ES15	ANDALUCIA	1	0.0	-1.00	0.10	0.64	0.02	-1.00	-0.11	-1.00	-1.00	-1.00	-1.00	-1.00
ES16	MURCIA	1	0.0	-1.00	-0.01	0.64	0.35	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
ES17	CANARIAS	2	0.1	-1.00	0.08	0.61	0.30	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
FR1	ILE DE FRANCE	156	4.6	0.09	-0.17	-0.12	-0.12	0.20	0.12	0.19	-0.26	-0.24	0.03	0.08
FR2	CHAMPAGNE-ARDENNE	30	0.9	-1.00	-0.02	0.44	0.22	-0.39	-0.49	-0.39	0.51	0.04	-0.13	-0.09
FR3	PICARDIE	40	1.2	-1.00	0.07	0.21	0.15	-0.32	-0.35	-0.31	0.42	0.21	0.08	0.34
FR4	HAUTE-NORMANDIE	36	1.1	-1.00	0.09	0.07	0.12	-0.40	-0.01	-0.40	0.00	0.31	0.27	0.30
FR5	CENTRE	34	1.0	-1.00	-0.07	0.29	0.16	-0.29	0.09	-0.28	0.10	-0.12	0.19	0.46
FR6	BASSE-NORMANDIE	19	0.6	-1.00	0.01	0.38	0.15	-0.51	-0.03	-0.51	0.24	-0.20	0.36	0.51
FR7	BOURGOGNE	53	1.6	0.39	-0.15	0.31	-0.01	-0.01	0.13	-0.02	-0.37	-0.04	0.09	0.44
FR8	NORD-PAS-DE-CALAIS	19	0.6	-1.00	0.08	0.04	0.07	-0.32	-0.26	-0.25	0.44	0.19	0.56	0.32
FR9	LORRAINE	34	1.0	0.44	-0.05	0.55	0.09	-0.60	-0.13	-0.60	-1.00	-0.24	0.51	0.72
FR10	ALSACE	65	1.9	-1.00	0.10	0.04	0.12	-0.24	-0.20	-0.25	-0.46	0.46	-0.35	0.02
FR11	FRANCHE-COMTE	40	1.2	-1.00	-0.27	0.37	-0.01	0.07	0.01	0.10	-1.00	0.48	-0.39	-0.03
FR12	PAYS DE LA LOIRE	21	0.6	-1.00	0.00	0.10	0.29	-0.41	-0.04	-0.39	0.05	0.34	0.09	0.02
FR13	BRETAGNE	28	0.8	-1.00	-0.34	-0.40	-0.16	0.36	-0.28	0.36	0.31	-0.32	0.12	-0.12
FR14	POITOU-CHARENTES	19	0.6	-1.00	-0.11	-0.06	0.13	0.04	0.00	0.03	-1.00	0.32	0.22	0.06
FR15	AQUITAINE	28	0.8	-1.00	0.06	-0.07	0.08	-0.17	0.11	-0.16	-0.11	0.13	-0.37	-1.00
FR16	MIDI-PYRENEES	37	1.1	0.36	-0.06	-0.26	-0.07	0.04	0.18	0.03	0.03	0.16	0.25	0.23

FR17	LIMOUSIN	17	0.5	-1.00	-0.38	0.36	-0.02	0.07	0.30	0.07	-1.00	0.40	-1.00	-1.00
FR18	RHONE-ALPES	104	3.0	0.18	0.01	0.09	-0.03	0.01	-0.12	0.01	0.05	0.11	-0.17	-0.20
FR19	AUVERGNE	29	0.9	-1.00	-0.13	0.17	-0.19	0.06	-0.19	0.05	0.41	0.65	0.34	0.38
FR20	LANGUEDOC-ROUSSILLON	25	0.7	-1.00	0.15	-0.15	-0.15	-0.31	0.02	-0.25	0.34	-0.01	0.48	0.39
FR21	PROVENCE-ALPES-C. D'AZ.	41	1.2	0.08	-0.12	-0.09	-0.10	0.01	0.27	0.01	-0.26	0.07	0.40	0.53
FR22	CORSE	4	0.1	-1.00	0.19	-1.00	0.22	-1.00	0.41	-1.00	-1.00	-1.00	-1.00	-1.00
IR0	IRELAND	12	0.4	-1.00	-0.02	0.22	-0.03	-0.10	0.10	-0.11	0.31	0.40	-1.00	-1.00
IT1	PIEMONTE	47	1.4	0.05	-0.09	0.04	0.09	0.03	0.06	0.03	0.05	-0.11	-0.27	-0.24
IT2	VALLE D'AOSTA	6	0.2	-1.00	-1.00	-1.00	-1.00	0.43	-1.00	0.42	-1.00	0.91	-1.00	-1.00
IT3	LIGURIA	17	0.5	-1.00	0.06	0.10	-0.16	-0.07	0.06	-0.08	-0.19	-0.29	0.28	0.43
IT4	LOMBARDIA	55	1.6	-0.11	0.06	-0.07	0.03	-0.03	-0.17	-0.03	0.09	0.18	-0.26	-0.09
IT5	TRENTINO-ALTO ADIGE	14	0.4	-1.00	-0.27	0.20	0.04	-1.00	0.36	-1.00	-1.00	0.78	0.70	0.85
IT6	VENETO	29	0.8	-1.00	0.01	0.18	0.15	-0.43	-0.14	-0.42	0.22	0.73	-0.11	-0.07
IT7	FRIULI-VENEZIA GIULIA	44	1.3	0.86	-0.02	0.14	0.16	-0.11	-0.11	-0.12	-1.00	0.24	-0.27	-0.23
IT8	EMILIA-ROMAGNA	38	1.1	0.43	0.06	0.02	0.22	-0.40	-0.15	-0.39	0.16	0.27	0.30	0.36
IT9	TOSCANA	21	0.6	-1.00	0.06	-0.02	0.24	-0.29	-0.17	-0.28	-0.02	0.15	0.02	0.15
IT10	UMBRIA	13	0.4	-1.00	-0.16	-0.03	0.12	-0.19	0.14	-0.19	0.27	0.47	0.50	0.73
IT11	MARCHE	13	0.4	-1.00	-0.26	0.19	0.05	0.20	-0.37	0.19	-1.00	0.57	-0.13	-1.00
IT12	LAZIO	16	0.5	0.43	-0.06	0.07	-0.20	0.00	0.16	0.02	-0.14	0.18	0.33	0.48
IT13	CAMPANIA	2	0.0	-1.00	-0.05	0.48	-1.00	0.22	-0.20	0.21	-1.00	-1.00	-1.00	-1.00
IT14	ABRUZZO	6	0.2	-1.00	-0.07	-0.04	0.25	-0.33	0.23	-0.34	-1.00	0.61	-1.00	-1.00
IT15	MOLISE	1	0.0	-1.00	0.49	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
IT16	PUGLIA	1	0.0	-1.00	-0.21	0.21	-1.00	-0.09	0.04	-0.10	-1.00	0.86	0.57	0.77
IT17	BASILICATA	1	0.0	-1.00	-1.00	-1.00	-1.00	-1.00	0.81	-1.00	-1.00	-1.00	-1.00	-1.00
IT18	CALABRIA	1	0.0	-1.00	-0.35	-1.00	0.02	-1.00	0.23	-1.00	0.85	0.91	-1.00	-1.00
IT19	SICILIA	2	0.1	-1.00	-0.45	-0.59	-0.49	0.45	-0.30	0.45	0.47	-1.00	-1.00	-1.00
IT20	SARDEGNA	3	0.1	0.97	-0.05	0.52	-1.00	-1.00	0.50	-1.00	-1.00	-1.00	0.67	-1.00
LU0	LUXEMBOURG	62	1.8	0.84	0.19	-0.10	0.22	-0.80	-0.08	-0.80	0.05	-1.00	0.49	-1.00
NL1B	NOORD-NEDERLAND -	37	1.1	-1.00	0.05	-0.06	0.27	-0.68	0.27	-0.62	0.18	-0.44	-0.09	-0.05
NL2	OOST-NEDERLAND	52	1.5	-1.00	0.02	0.14	0.22	-0.31	-0.01	-0.28	-0.78	-0.25	0.26	0.23
NL3	WEST-NEDERLAND	50	1.5	0.09	0.13	-0.11	0.05	-0.42	-0.03	-0.27	0.33	0.01	0.41	0.29
NL4	ZUID-NEDERLAND	163	4.8	-0.53	-0.34	-0.32	-0.27	0.40	-0.27	0.39	-0.37	-0.49	-0.41	-0.28
PO1	NORTE	0	0.0	-1.00	-1.00	-1.00	-1.00	-1.00	0.76	-1.00	0.90	-1.00	-1.00	-1.00
PO2	CENTRO (P)	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
PO3	LISBOA E VALE DO TEJO	1	0.0	-1.00	-0.01	0.21	-1.00	-1.00	0.37	-1.00	-1.00	0.74	0.76	0.88
PO4	ALENTEJO	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

PO5	ALGARVE	0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
UK1	NORTH	32	0.9	-1.00	0.16	-0.25	0.07	-0.21	-0.25	-0.17	-0.24	0.00	0.11	0.07
UK2	YORKSHIRE, HUMBERSIDE	30	0.9	0.49	0.15	0.15	0.10	-0.61	0.02	-0.59	0.13	0.08	0.11	0.24
UK3	EAST MIDLANDS	37	1.1	0.45	0.00	-0.04	0.17	-0.22	0.06	-0.22	0.43	0.04	0.12	0.20
UK4	EAST ANGLIA	81	2.4	-1.00	-0.10	-0.39	-0.10	0.21	0.04	0.20	0.30	-0.83	-0.33	-0.64
UK5	SOUTH EAST (UK)	69	2.0	-0.07	-0.02	-0.08	-0.19	0.07	0.19	0.07	0.08	-0.20	-0.14	-0.32
UK6	SOUTH WEST (UK)	49	1.4	-0.04	-0.12	0.03	0.01	0.03	0.21	0.03	-0.16	-0.02	0.15	-0.32
UK7	WEST MIDLANDS	46	1.3	0.45	-0.05	0.21	0.16	-0.12	-0.11	-0.12	0.06	-0.13	0.09	0.19
UK8	NORTH WEST (UK)	46	1.3	0.19	0.17	-0.06	-0.11	-0.21	-0.04	-0.22	0.23	-0.26	-0.06	0.04
UK9	WALES	22	0.6	0.53	-0.02	0.08	0.03	-0.15	0.14	-0.16	0.13	0.02	0.32	0.29
UK10	SCOTLAND	21	0.6	-1.00	0.02	-0.09	0.11	-0.14	0.15	-0.15	-0.14	-0.37	0.07	-0.17
UK11	NORTHERN IRELAND	8	0.2	-1.00	-0.04	-0.06	0.19	-0.22	0.11	-0.23	0.66	0.13	-1.00	-1.00

* Standardised RTA indeces are computed according to the formula: (RTA-1)/(RTA+1) and are, therefore, constrained within the interval (-1,1).