Moreno, Rosina; Paci, Raffaele; Usai, Stefano

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Innovation and production clusters in Europe

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Innovation and production clusters in Europe

Rosina Moreno-Serrano
University of Barcelona

Raffaele Paci
University of Cagliari and CRENoS

Stefano Usai
University of Sassari and CRENoS

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Abstract

This paper investigates on the presence of innovation and production clusters in Europe. The analysis is based on an original statistical databank set up by CRENoS on regional patenting at the European Patent Office spanning from 1978 to 1997 and classified by ISIC sectors (3 digit) and on the Cambridge Econometrics database on production activity. We consider 138 regions of 17 countries in Europe, the 15 members of the European Union plus Switzerland and Norway.

Firstly, an analysis of the spatial distribution of innovation and production activities in Europe is performed. Some global and local indicators for spatial association are presented, summarising the presence of a general dependence process in the distribution of the phenomena under examination. The analysis is implemented for different manufacturing macro-sectors to assess for the presence of significant differences in the their spatial features. Moreover, the extent and strength of spatial externalities are evaluated for three different periods: 1981-83, 1988-90 and 1995-97.

Secondly, the spatial mapping of innovation is compared to the distribution of productive activity.

Keywords: Innovation activity, Production specialisation, Spatial analysis, European regions.

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1. Introduction

Technology activity is basically the main engine of economic dynamics in most endogenous growth models (Romer, 1986, 1990). In the spatial context this implies that local growth depends on the amount of technological activity which is carried out locally and on the ability to exploit external technological achievements through information spillovers (Martin and Ottaviano, 2001, Grossman and Helpman, 1991, Coe and Helpman, 1995). Such spillovers may follow particular patterns depending on economic, technological and geographical distances among firms and regions, that is, on agglomeration phenomena. The relationship between spatial agglomeration of economic and technological activities and economic growth is finally under scrutiny of economists who admit that industrialisation and urbanisation have been, in the past, (Kuznets, 1966) and are, nowadays, inseparable phenomena (see Baldwin and Martin, 2003).

This paper aims at studying such relationship starting from a mapping of innovative activity in European regions by means of a deep exploratory spatial analysis based on several global and local indicators of spatial dependence. The analysis is carried out for different time periods starting from the early eighties up to the middle nineties and it is implemented for different sectors in order to evaluate differences and similarities. Moreover, we attempt to analyse the geography of innovation by ascertain its correspondence to the geography of production activity and economic performance. This is done by looking, on the one hand, at measures of innovative and production activities in absolute terms and, on the other hand, at their specialisation and diversification pattern.

Here an original and updated statistical databank on regional patenting at the European Patent Office spanning from 1978 to 1997 and classified by ISIC sectors (up to 3 digit) is used for the first time allowing the analysis of the spatial distribution of innovative activity across 138 regions of 17 countries in Europe (the 15 members of the European Union plus Switzerland and Norway) to see if anything has changed through time.

The paper is organised as follows. In the following section we analyse the spatial distribution of innovative activity throughout Europe along the eighties and nineties. In the third section we analyse the spatial distribution of production activity. In the fourth section we deal with the issue of the relationship between the agglomeration of innovative activity and that of production activities. Final remarks are in the last section.

2. The spatial distribution of innovative activity

2.1 Some measurement issues

Several economists (for instance, Pavitt, 1982 and Griliches, 1990) have been debating about the problem of measuring innovative activity and technological progress, but no universal solution has been found. Starting from the concept of knowledge production function (Pakes and Griliches, 1984), two types of indicators are usually identified: technology input measures (such as R&D expenditure and employees) and technology output measures (such as patents and new product announcements).

The main drawback of the former indicators is that they include firms' effort for both innovation and imitation activities. Moreover, they do not take into account for informal technological activity, such as learning, and, as a consequence, tend to underestimate the amount of innovative activity of medium and small firms. On the contrary, patent and product announcement 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 countries and sectors (Evenson, 1993).

With respect to the object of our research, patent statistics seem particularly suitable, given that they are a more reliable indicator for innovative activity of medium and small firms which form the bulk of industrial districts. Other than this analytical justification 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 a dynamic analysis.

Our proxy for innovative activity refers to patents applications at the European Patent Office over the period 1978-97 classified by the inventor's region in Europe. Each patent has been assigned to an individual region by identifying the place of residence of the inventors[1] (Paci and Usai, 2000a; Breschi 2000).

As for the territorial break up we have only partially followed the classification provided by EUROSTAT through NUTS (Nomenclature des Unités Territoriales

[1] For the case of patents with more than one inventors, a proportional fraction of each patent has been assigned to the different inventors' regions of residence.

Statistiques)[2]. For some countries, this classification turns out to be artificial, based mainly on statistical concerns and it fails to identify uniform regional areas in terms of economic and social elements (Paci, 1997). In fact we have tried to select, for each country, a geographical unit with a certain degree of administrative and economic control.[3] The result is a division of Europe (15 countries of the European Union plus Switzerland and Norway) in 138 sub-national units (which, from now on, we will simply call, *regions*) which are a combination of NUTS 0, 1 and 2 levels (see Appendix for details).

2.2. Descriptive statistics of the geography of innovative activity

At the beginning of the period under consideration (early eighties) a strong central-periphery distribution of innovation activity is observed in Map 1.[4] Innovation activity is concentrated in regions in Switzerland, West Germany, North and East of France, North of Italy, United Kingdom, Denmark, the Netherlands and Sweden. None or modest technological activity is documented in most regions of the South of Europe: Spain, Greece, Portugal and South of Italy.

This picture is confirmed looking at the innovative activity at the country level (Table 1) and among the twenty most innovative regions (Table 2). At the beginning of the eighties the most innovative country is Switzerland, followed by Luxembourg and Germany. A similar picture appears at the regional level, where, among the top performers, we find 6 Swiss regions, 6 German regions plus the capital regions of other countries (London, Paris, Stockholm, Brussels).

Looking at the evolution over time of the innovative activity, it is possible to remark some important elements. First, the intensity to innovate has increased considerably over the two decades in all countries.[5] More importantly, the innovations have been spreading to some more regions in the South of Europe (especially in Spain and the South of Italy) and even more in the mid-nineties (see Map 2). The spatial diffusion of technological activity is also confirmed for the case of some regions in central Europe (France and East Germany).

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[2] Eurostat classification list four categories of territorial units: 15 NUTS 0 nations; 77 NUTS 1 regions, 206 NUTS 2 regions and 1031 NUTS 3 regions.

[3] The perfect territorial unit is difficult to be found. However administrative units not necessarily reflect economic phenomena. Better territorial units used in the empirical literature are the functional urban region just for main urban centres at the European level (Cheshire, 1990 and Cheshire and Magrini 2002), the local labour system in Italy (Paci and Usai, 1999), the *basin d'emploi* in France (Combes, 2000).

[4] Throughout the paper patents per capita are used, even though main results do not change if one uses the absolute value of patents.

[5] This phenomenon is partly due to a shift of patent applications by European firms from National patenting offices to the European one.

However, the most brilliant performance is shown by Finland, which in the nineties manage to reach the second position in the ranking (Table 1).

The analysis can be also carried out by looking at the distributions of the patents per capita through the kernel density functions for the three periods under examination, as reported in Figure 1. It is clear that the distribution is skewed to the lower values of patents during all the period under consideration, whereas the outliers are in the upper band of patents (basically some regions in Switzerland and Germany). However, the kurtosis is much clearer at the beginning of the 80s, with a clear smoothing process in late 80s and mid-90s, so that the right-hand tale becomes thicker, in other words, more regions are obtaining output in the innovative activity.

The level of inequality in the spatial distribution of the innovative activity is very high: the ratio between the most innovative country (Switzerland) and the least (Portugal) is equal to 245. In general, the coefficient of variation (CV) in the patenting activity among the 138 regions considered is 1.47 in 1980. It is important to notice that the degree of disparity tends to decrease over time, as it is clearly show in Figure 3 by the evolution of the CV which equals 1.16 at the end of the period. A similar pattern is also shown at the macro-sector level.

2.3 Spatial dependence of innovative activity

As for the analysis of spatial dependence, the use of the Moran index for the entire economy (see first rows in Table 3) shows a clear rejection of the null hypothesis with a positive value of the statistic: strong positive spatial autocorrelation, confirming the visual impression of spatial clustering given by the maps. If one also considers the spatial correlogram, this rejection is observed till the third order of contiguity, reported in Table 3. Nonetheless, there appears a pattern of decreasing autocorrelation with increasing orders of contiguity typical of many spatial autoregressive processes.[6]

We have also constructed the Moran's I for different distance matrices and for different bandwidth. With respect to the latter case, results show that the Moran's I is significant till a band of 725 km, which is a quite a wide length. This outcome suggests that regions are not always the proper unit of analysis. An interesting and promising result is that the distance rises with time, which implies that diffusion effects of innovative activity are

[6] The correlogram also shows a strong spatial autocorrelation for the fourth order at the end of the period, which would tend to indicate that spatial dependence across regions has widened with time. This result needs to be taken with caution since, in fact, the territorial unit chosen may prove too wide to reflect the real technological process causing the diffusion of technology.

spatially enlarging with time. Among the probable causes of this outcome we can perceive the development and diffusion of the ICT and, in general, of the New Economy which are producing the phenomenon known as "death of distance". Of course, more research is required on this respect.

We have also constructed the scatter maps in order to assess the sign of the spatial association in the different areas. The scatter maps show that there is a clear association of high-high values in the centre, and low-low values in the south (see Map 3 for the period 1995-97). This positive association remains true in all the period, with some specific changes: some regions in the North of Italy presented high value of patents and were surrounded by low values and in the end of the eighties changed to be surrounded by high values. Additionally, Finland has performed remarkably well along this period, presenting low values at the beginning surrounded by low values, but changing to high values. Finally, we have computed the LISA statistics and the corresponding maps for the three periods (see Map 4 for the period 1995-97). Such maps show clusters around a region of similar values significantly higher than expected if the variable would be homogeneously distributed. In this sense, there is only one significant cluster, which is not disseminated in the space but in the centre of Europe, basically consisting of some regions in West Germany. In other words, this only cluster presents similar values of patents (high magnitudes), without observing any region with a dissimilar behaviour with respect to their neighbours. These are also the regions that contribute the most to the value of the global test of Moran's I. This pattern shows almost no difference along time.[7]

In Table 3 we have also reported the Moran tests for spatial autocorrelation in the innovative activity for seven macro-sectors. The sectoral results confirms the presence of spatial association up to the third contiguity order for all sectors considered. This means that patenting activity in a certain sector tends to be correlated to innovation performed in the same sector in contiguous areas, determining the formation of specialised clustering of innovative regions in different sectors.

3. The spatial distribution of production activity.

3.1. Descriptive statistics of the geography of production activity

[7] Scatter and LISA maps for the other periods are not reported in the paper, but they are available on request.

Our analysis of the spatial distribution of production activity, or better labour productivity, proceeds on two stages as it as been done for innovative activity, we look first at the international distribution and then we focus on the interregional level[8]. In Table 4 we report an index of productivity (total value added per worker) for the 17 countries under comparison. It is clear that there is some variability among countries going from the lowest values for Portugal (from 2.03 to 2.95) to the highest ones for Switzerland (from 10.06 to 11.86). So that productivity in the most productive country has been around five times bigger than that of the least productive. It is, therefore, readily understood that the degree of diversity in productivity is significantly smaller than that in innovative activity where the same ratio was around 245. The level of inequality at the country level has however clearly decreased during the years going from a coefficient of variation of 0.33 in the early eighties to 0.31 in the middle nineties.

In such a less diversified pattern, however, we can spot more than just simple convergence in productivity going on. It is, in fact, interesting to see how countries perform with respect to other by comparing the relative rankings of countries across the years. This is to see whether there have been some miracles or debacles across EU.

As for the good performers it is worth mentioning the cases of Austria, going from 4th to 2^{nd,},.Denmark from 10th to 7th, France (from 7th to 4th), Italy (from 9th to 5th) and Ireland[9] (from 15th to 13th).

As for the bad performances, the case of Germany is noteworthy and can mainly attributed to the merging process with East Germany. Germany goes from the third ranking to ninth. Other bad performers are Switzerland, going from 1st to 3rd, and Netherlands which goes from 6th to 10th.

This important changes in the ranking of nations have usually an important counterpart at the regional level. This is why in Table 5 we report the top most productive regions for the three periods in order to see how much of these changes are due to national phenomena or are specific to some regions within the country. (See also Map 5 for the eighties and Map 6 for the nineties)

Parallel to the national ranking, we find 6 Swiss and 4 German regions among the best performers in the eighties. This feature changes slightly through time given that in the nineties

[8] Previous empirical contributions in this area have been recently surveyed in Combes and Overman (2003).
[9] Ireland performance is much more evident if one focuses on just the manufacturing sector. The same applies to Finland, which, likely thanks to its brilliant innovative performance (see Table 1), improves significantly its productivity along the years.

we find just 4 Swiss and 2 German regions in top twenty ranking. This is due to the fact the some newcomers have entered the best positions. In particular we find more Italian, Swedish and Austrian regions in the nineties with respect to the eighties. It is interesting to note that Italy as a whole has had a bad performance, so we can infer that at the same time other backward regions were performing very badly, especially in the South. As for Sweden and Austria they are among the best performers and therefore the success of some regions has been influential on the country as a whole.

Other interesting features of our table are as follows:

1) The main urban centres are performing very well, the first six regions in the nineties are main urban areas, Hamburg, Ile de France, Stockolm, Hessen, Wien and Zurich. This seems to imply that urbanisation economies are playing an important role in boosting economic activity. However, one should remember that with falling transport costs the commuting areas have been increasing along time making the regional division in administrative units less and less reliable.[10]
2) There are 5 regions which host the capital: Ile de France, Stockholm, Wien, Lazio, Noord-Nederland.
3) There are no regions from the Cohesion countries (Spain, Greece, Ireland, Portugal).

Looking at the map we can start visually comparing the distribution of innovative and productive activity. Let us focus on just the final period from 1995 to 1997 reported in Map 6. The two distributions (see also Map 2) appear to be similar due to the clear dualism between the north-centre and south. Nonetheless, some specific differences in production distribution compared to patents are worth highlighting.

Most rich regions are in the very core of Europe, we can trace an international cluster which goes from North Italy up to the Netherland passing by Switzerland, Austria, Germany and the South East and the North-East of France. The Scandinavian regions present another interesting cluster which have been enlarging during the nineties thanks to a good innovative performance.

In Figure 4 we plot the CV for value added per capita for the whole European regions and for the macro-sectors. There has been some slight convergence in the whole of Europe

[10] In the case of Hamburg, for example, it is important to note that this Lander is rather small with respect to the others and its size does not correspond at all to the so called functional urban area (see Cheshire, 1990), so its productivity may be biased upwards.

(where the CV has decreased from 0.47 to 0.44)[11]. As for sectors the picture is more varied as some sectors became more similar (see for example the energy and mining sector) and some others became more diversified (see for example textiles and clothing).

As we have said the degree of dispersion of labour productivity is remarkably lower than that of innovative activity (see figure 3), both at the country and at the European level. This difference is only partially a reflection of the particular features of our technological indicator, which may be biased with respect to the size composition of firms and with respect to the regional production structure. It can be argued that this difference is mainly the result of higher agglomeration forces working in the knowledge intensive activity of innovation rather than in the production activity. In the former, in fact, face to face interactions and day by day formal and informal exchanges of tacit knowledge is a crucial component of the local knowledge production function.

3.2 Spatial dependence of production activity

As for the analysis of spatial dependence the use of the Moran index (see first rows in Table 6) shows a clear rejection of the null hypothesis with a positive value of the statistic. Production activity appears to be strongly and positively correlated in space, confirming the picture of spatial clustering given by the map. The spatial correlogram indicates that this rejection is observed till the third order of contiguity. Moreover we see that the value of the Moran index is increasing through time signalling possibly an increasing level of spatial dependence.

As for the sectoral distinction we find spatial autocorrelation in all sectors but in mining and energy. Again, in almost all cases spatial autocorrelation does not disappear until the third level of contiguity. As for the dynamics aspect we see that the strength of spatial dependence is increasing in four sectors (Textile and clothing, Chemical and Plastics, Transport equipment and Other manufacturing) whilst it is decreasing in other two, Food and Electronics. The latter sector had the highest level of spatial dependence in the eighties (Moran I= 10.4) whilst now the sector with more spatial dependence is Other manufacturing (Moran I=10.1).

We have also constructed the scatter maps in order to assess the sign of the spatial association in the different areas. The scatter maps show that there is a clear association of

[11] Remember that the Gini coefficients provide similar result to the CV: it goes from 0.25 in 1981-83 to 0.24 in

high-high values in the centre, and low-low values in the south (see Map 7 for the period 1995-97).

Finally, we have computed the LISA statistics (see Map 8 for the period 1995-97).

4. Agglomeration economies in innovation and production activities

In this section we investigate on the relationship between innovation and production activities. More specifically we try to assess whether there are agglomeration economies that support the development of specialised regional clusters.

The main goal is to provide new empirical evidence to answer the question posed clearly in some recent theoretical (Baldwin and Martin, 2003) and empirical (Glaeser *et al*, 1992; Ciccone, 2002; Rodriguez-Pose, 2001; Usai and Paci, 2003) contributions about the presumed positive relation between growth and agglomeration through technological localised spillovers. Such question, in fact, has not been so far directly confronted due to the lack of information on technological activity disaggregated simultaneously in two dimensions: geographical and industrial. The only exception, to the best of our knowledge, is Paci and Usai (2000a) who analyse it for nine countries based on data on employment and just for one year.

Unfortunately, the sectoral breakdown of the patent data is not matched by data on productivity[12]. This is why our comparative analysis on the geographical specialisation patterns in regions in Europe is referred to just seven macro sectors. As a measure of sectoral specialisation we use the usual Balassa index, or location quotient, or revealed advantage which is the result of a double weighting of the regional sectoral production, with respect to the total production in the region and with respect to the national quota of that sector.

In Table 7 we report the correlation, measured by Pearson index, between innovation and production specialisation, measured by Balassa indexes, for the three periods under examination. Such analysis is performed for the whole of Europe, for some individual countries and for each of the seven sector for which data is available both for production and innovation.

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the second period and it reaches 0.22 in the middle nineties.

[12] We use the Cambridge Econometrics database. The availability and reliability of data at the regional level in Europe is rather problematic (see Combes and Overman, 2003).

Results are very interesting and mostly confirm the previous work on this issue at the European level (see Paci and Usai, 2000a): there is association in the spatial and sectoral specialisation of innovative and productive activities in Europe.

Nonetheless, there are some significant peculiarities and novelties when one differentiates among countries and among sectors. Other interesting insights emerge also from the analysis of the dynamics.

First of all, correlation is positive and significant in four out of six countries (Germany, France, Italy and United Kingdom). Moreover it is positive in the other group, Other countries which includes all small and one-region countries (Netherlands, Ireland, Denmark, Norway, Sweden, Portugal, Finland, Switzerland and Luxembourg). On the contrary correlation is positive but not significant in Spain and Greece, two cohesion countries. In fact in the second period in Greece the correlation is even negative and significant.

As for the dynamics, the similarity of the two specialisation patterns is getting higher in the whole of Europe (from 0.08 to 0.18) whilst the picture is more complex at the country level. We find that it is steady in Germany where, however, it was decreasing in the first period. It is increasing in Italy and in the other countries, whilst it is decreasing in France in a very significant way, and in the United Kingdom, where, however, it has reached its minimum in the second period.

As for sectors, results are more puzzling and multifaceted. We find that correlation is mostly positive. It is less present in traditional sectors, such as Mining and energy and Food where it is almost always not significant. The highest index is found in the Transport equipment sector (0.465) where surprisingly there was no correlation at the beginning of the period. Correlation was very high in the Electronics sector at the beginning of the period (0.44) but it has now decreased to 0.26. Other positive, significant and increasing indexes are found for Chemicals (but just in the two latest periods) and in Other manufacturing.

5. Conclusions

In the paper we attempt to provide new empirical evidence on the relationship between spatial agglomeration of economic and technological activities in Europe.

We have started from a mapping of innovation activity in European regions by means of a deep exploratory spatial analysis based on several global and local indicators of spatial

dependence. The analysis has been carried out for different time periods and sectors in order to evaluate differences and similarities. Two main outcomes are worth remarking. First, the presence of a strong central-periphery distribution of innovation activity at the beginning of the period. Innovation activity is concentrated in regions in North and centre Europe, while none or modest technological activity is performed in most Southern European regions. Second, this concentration tends to decrease over time and the innovations have been spreading to some more regions in Scandinavia and in the South of Europe.

The analysis of global indicator of spatial association confirms the presence of a strong and positive spatial autocorrelation process in the innovative activity. This means that patenting activity in a certain region tends to be correlated to innovation performed in contiguous areas. Moreover the local indicators show the existence of a significant local cluster of highly innovative regions in West Germany. Spatial association is also found at the sectoral level determining the formation of specialised clustering of innovative regions in different sectors.

The descriptive analysis of the spatial distribution of the production activities confirms that economic performance is much less concentrated than innovation activity and that there is a slow process of convergence among European regions. However such a process proves rather heterogenous with some regions managing to move forwards in their rankings and some others still lagging behind.

The second step concerns the analysis of the correspondence of the geography of innovation to the geography of production activity and economic performance. This is done by looking at their specialisation and diversification pattern. The analysis of the correlation of the specialisation indexes of innovation and production shows that the two phenomena are well linked even though this link appears very mutable across nations, time and sectors.

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Appendix *Table A.1 European Regions in CRENoS database*

(ID-CRENoS; ID-NUTS; Region; Nuts level)

1	AT11	BURGENLAND	2
2	AT12	NIEDEROSTERREICH	2
3	AT13	WIEN	2
4	AT21	KARNTEN	2
5	AT22	STEIERMARK	2
6	AT31	OBEROSTERREICH	2
7	AT32	SALZBURG	2
8	AT33	TIROL	2
9	AT34	VORARLBERG	2
10	BE1	BRUXELLES_BRUSSEL	1
11	BE2	VLAAMS GEWEST	1
12	BE3	REGION WALLONNE	1
13	CH01	REGION IEMANIQUE	2
14	CH02	ESPACE MITTELLAND	2
15	CH03	NORDWESTSCHWEIZ	2
16	CH04	ZÜRICH	2
17	CH05	OSTSSCHWEIZ	2
18	CH06	ZENTRALSCHWEIZ	2
19	CH07	TICINO	2
20	DE1	BADEN_WURTTEMBERG	1
21	DE2	BAYERN	1
22	DE3	BERLIN (WEST)	1
23	DE4	BRANDENBURG	1
24	DE5	BREMEN	1
25	DE6	HAMBURG	1
26	DE7	HESSEN	1
27	DE8	MECKLENBURG VORPOMMERN	1
28	DE9	NIEDERSACHSEN	1
29	DEA	NORDRHEIN_WESTFALEN	1
30	DEB	RHEINLAND_PFALZ	1
31	DEC	SAARLAND	1
32	DED	SACHSEN	1
33	DEE	SACHSEN ANHALT	1
34	DEF	SCHLESWIG_HOLSTEIN	1
35	DEG	THUERINGEN	1
36	DK	DENMARK	0
37	ES11	GALICIA	2
38	ES12	PRINCIPADO ASTURIAS	2
39	ES13	CANTABRIA	2
40	ES21	PAIS VASCO	2
41	ES22	NAVARRA	2
42	ES23	RIOJA	2
43	ES24	ARAGON	2
44	ES3	COMUNIDAD DE MADRID	2
45	ES41	CASTILLA _ LEON	2
46	ES42	CASTILLA _ LA MANCHA	2
47	ES43	EXTREMADURA	2
48	ES51	CATALUNA	2
49	ES52	COMUNIDAD VALENCIANA	2
50	ES61	ANDALUCIA	2
51	ES62	REGION DE MURCIA	2
52	FI	FINLAND	0
53	FR1	ILE DE FRANCE	2
54	FR21	CHAMPAGNE_ARDENNE	2
55	FR22	PICARDIE	2
56	FR23	HAUTE_NORMANDIE	2
57	FR24	CENTRE	2
58	FR25	BASSE_NORMANDIE	2
59	FR26	BOURGOGNE	2
60	FR3	NORD _ PAS_DE_CALAIS	2
61	FR41	LORRAINE	2
62	FR42	ALSACE	2
63	FR43	FRANCHE_COMTE	2
64	FR51	PAYS DE LA LOIRE	2
65	FR52	BRETAGNE	2
66	FR53	POITOU_CHARENTES	2
67	FR61	AQUITAINE	2
68	FR62	MIDI_PYRENEES	2
69	FR63	LIMOUSIN	2

70	FR71	RHONE_ALPES	2
71	FR72	AUVERGNE	2
72	FR81	LANGUEDOC_ROUSSILLON	2
73	FR82	PROVENCE_ALPES_COTE_D'AZUR	2
74	FR83	CORSE	2
75	GR11	ANATOLIKI MAKEDONIA, THRAKI	2
76	GR12	KENTRIKI MAKEDONIA	2
77	GR13	DYTIKI MAKEDONIA	2
78	GR14	THESSALIA	2
79	GR21	IPEIROS	2
80	GR22	IONIA NISIA	2
81	GR23	DYTIKI ELLADA	2
82	GR24	STEREA ELLADA	2
83	GR25	PELOPONNISOS	2
84	GR3	ATTIKI	2
85	GR41	VOREIO AIGAIO	2
86	GR42	NOTIO AIGAIO	2
87	GR43	KRITI	2
88	IE	IRELAND	0
89	IT11	PIEMONTE	2
90	IT12	VALLE D'AOSTA	2
91	IT13	LIGURIA	2
92	IT2	LOMBARDIA	2
93	IT31	TRENTINO_ALTO ADIGE	2
94	IT32	VENETO	2
95	IT33	FRIULI_VENEZIA GIULIA	2
96	IT4	EMILIA_ROMAGNA	2
97	IT51	TOSCANA	2
98	IT52	UMBRIA	2
99	IT53	MARCHE	2
100	IT6	LAZIO	2
101	IT71	ABRUZZI	2
102	IT72	MOLISE	2
103	IT8	CAMPANIA	2
104	IT91	PUGLIA	2
105	IT92	BASILICATA	2
106	IT93	CALABRIA	2
107	ITA	SICILIA	2
108	ITB	SARDEGNA	2
109	LU	LUXEMBOURG	0
110	NL1	NOORD_NEDERLAND	1
111	NL2	OOST_NEDERLAND	1
112	NL3	WEST_NEDERLAND	1
113	NL4	ZUID_NEDERLAND	1
114	NO	NORWAY	0
115	PT11	NORTE	2
116	PT12	CENTRO	2
117	PT13	LISBOA E VALE DO TEJO	2
118	PT14	ALENTEJO	2
119	PT15	ALGARVE	2
120	SE01	STOCKHOLM	2
121	SE02	OSTRA MELLANSVERIGE	2
122	SE04	SYDSVERIGE	2
123	SE06	NORRA MELLANSVERIGE	2
124	SE07	MELLERSTA NORRLAND	2
125	SE08	OVRE NORRLAND	2
126	SE09	SMALAND MED OARNA	2
127	SE0A	VASTSVERIGE	2
128	UKC	NORTH EAST	1
129	UKD	NORTH WEST	1
130	UKE	YORKSHIRE, THE HUMBER	1
131	UKF	EAST MIDLANDS	1
132	UKG	WEST MIDLANDS	1
133	UKH	EASTERN	1
134	UKJ+ UKI	SOUTH EAST+LONDON	1
135	UKK	SOUTH WEST	1
136	UKL	WALES	1
137	UKM	SCOTLAND	1
138	UKN	NORTHERN IRELAND	1

Tab 1. Innovative activity in European countries

(patents per 100.000 inhabitants, annual average)

		Period					
Nation	**Num. of**	**1981-83**		**1988-90**		**1995-97**	
	regions	**Pat pc**	***ranking***	**Pat pc**	***ranking***	**Pat pc**	***ranking***
1 - Austria	9	3.7	*8*	8.0	*6*	8.1	*8*
2 - Belgium	3	4.4	*6*	8.7	*5*	9.2	*5*
3 - Switzerland	7	17.1	*1*	26.4	*1*	23.8	*1*
4 - Germany	17	7.9	*3*	14.2	*2*	10.4	*4*
5 - Denmark	1	3.0	*10*	5.7	*11*	7.9	*9*
6 - Spain	15	0.1	*16*	0.4	*15*	0.8	*15*
7 - Finland	1	1.9	*11*	6.7	*8*	11.5	*2*
8 - France	22	3.2	*9*	6.0	*10*	6.1	*10*
9 - Greece	13	0.0	*16*	0.1	*17*	0.1	*17*
10 - Ireland	1	0.6	*14*	1.7	*14*	2.4	*14*
11 - Italy	20	1.1	*13*	2.9	*13*	3.4	*13*
12 - Luxembourg	1	9.4	*2*	7.0	*7*	8.4	*7*
13 - Netherlands	5	4.7	*5*	9.2	*4*	9.2	*6*
14 - Portugal	5	0.0	*17*	0.1	*16*	0.1	*16*
15 - Norway	1	1.6	*12*	3.5	*12*	3.9	*12*
16 - Sweden	8	7.2	*4*	9.4	*3*	11.0	*3*
17 - United Kingdom	11	3.9	*7*	6.2	*9*	5.4	*11*
EU	**138**	**3.7**		**6.4**		**6.3**	
CV across nations		*1.06*		*0.93*		*0.80*	

Tab 2. Innovative activity in top 20 regions

(patents per 100.000 inhabitants, annual average)

Region	Nation	Period					
		1981-83		1988-90		1995-97	
		Pat pc	*ranking*	Pat pc	*ranking*	Pat pc	*ranking*
Nordwestschweiz	CH	36.3	*1*	44.3	*1*	39.6	*1*
Zürich	CH	22.1	*2*	33.4	*2*	30.2	*2*
Hessen	DE	15.3	*3*	24.6	*5*	23.3	*5*
Ostsschweiz	CH	15.3	*4*	30.9	*3*	23.5	*4*
Region Iemanique	CH	14.9	*5*	17.5	*14*	17.4	*15*
South East+London	UK	14.6	*6*	22.2	*9*	17.5	*14*
Ile De France	FR	13.8	*7*	20.0	*11*	18.9	*11*
Baden_Wurttemberg	DE	13.6	*8*	28.0	*4*	28.8	*3*
Stockholm	SE	13.4	*9*	16.9	*16*	23.1	*6*
Bayern	DE	13.0	*10*	23.5	*8*	22.9	*8*
Rheinland_Pfalz	DE	13.0	*11*	20.4	*10*	21.1	*10*
Zentralschweiz	CH	11.7	*12*	24.5	*6*	22.9	*7*
Espace Mittelland	CH	11.5	*13*	17.6	*13*	18.5	*12*
Sydsverige	SE	11.4	*14*	11.9	*22*	12.9	*22*
Zuid_Nederland	NL	11.1	*15*	23.6	*7*	22.5	*9*
Nordrhein_Westfalen	DE	10.6	*16*	18.1	*12*	15.8	*16*
Luxembourg	LU	9.4	*17*	7.0	*38*	8.4	*32*
Bruxelles_Brussel	BE	9.0	*18*	17.5	*15*	14.8	*18*
Vastsverige	SE	8.9	*19*	10.4	*24*	12.2	*23*
Berlin (West)	DE	8.2	*20*	12.0	*21*	8.9	*29*

Tab 3. Spatial autocorrelation in the innovative activity
(Moran's I test, normal approximation)

Period		1981-83		1988-90		1995-97	
Sector	contiguity	Z-value	Prob	Z-value	Prob	Z-value	Prob
Total manufacturing	1	8.083	0.00	9.734	0.00	10.022	0.00
	2	6.410	0.00	7.637	0.00	8.195	0.00
	3	2.876	0.00	3.847	0.00	4.727	0.00
Mining and energy	1	4.144	0.00	5.686	0.00	5.333	0.00
	2	7.100	0.00	6.510	0.00	5.970	0.00
	3	8.465	0.00	4.403	0.00	2.930	0.00
Food	1	3.028	0.00	4.103	0.00	2.748	0.01
	2	2.851	0.00	3.605	0.00	2.086	0.04
	3	0.237	0.81	1.603	0.11	0.624	0.53
Textile and clothing	1	7.971	0.00	7.718	0.00	8.184	0.00
	2	6.166	0.00	6.351	0.00	8.308	0.00
	3	1.785	0.07	2.652	0.01	4.450	0.00
Chemicals and plastic	1	3.254	0.00	5.126	0.00	6.159	0.00
	2	3.273	0.00	4.792	0.00	5.683	0.00
	3	0.747	0.46	2.291	0.02	3.540	0.00
Electronics	1	6.066	0.00	6.351	0.00	6.596	0.00
	2	3.662	0.00	4.034	0.00	4.215	0.00
	3	1.998	0.05	2.317	0.02	3.118	0.00
Transport equipment	1	7.388	0.00	7.750	0.00	7.965	0.00
	2	4.801	0.00	6.013	0.00	5.951	0.00
	3	3.267	0.00	3.693	0.00	2.948	0.00
Other manufacturing	1	9.748	0.00	11.292	0.00	11.299	0.00
	2	7.775	0.00	8.410	0.00	9.201	0.00
	3	4.549	0.00	4.630	0.00	5.269	0.00

Tab 4. Labour productivity in European countries

(Gross Value Added per worker)

Nation	Num. of regions	Period 1981-83 GVA pw	*ranking*	1988-90 GVA pw	*ranking*	1995-97 GVA pw	*ranking*
1 - Austria	9	34.91	*4*	40.22	*2*	44.80	*2*
2 - Belgium	3	30.62	*8*	34.13	*8*	37.18	*8*
3 - Switzerland	7	39.57	*1*	40.93	*1*	44.21	*3*
4 - Germany	17	35.22	*3*	38.09	*4*	37.06	*9*
5 - Denmark	1	29.59	*10*	33.16	*11*	37.76	*7*
6 - Spain	15	24.08	*13*	26.78	*13*	30.39	*14*
7 - Finland	1	24.21	*12*	29.08	*12*	34.98	*11*
8 - France	22	30.73	*7*	35.71	*5*	39.58	*4*
9 - Greece	13	10.00	*16*	12.04	*16*	13.26	*17*
10 - Ireland	1	19.59	*15*	26.28	*14*	32.91	*13*
11 - Italy	20	30.50	*9*	35.25	*6*	39.42	*5*
12 - Luxembourg	1	28.41	*11*	33.24	*10*	33.36	*12*
13 - Netherlands	5	31.23	*6*	33.88	*9*	35.91	*10*
14 - Portugal	5	8.22	*17*	11.32	*17*	13.65	*16*
15 - Norway	1	32.57	*5*	34.13	*7*	39.22	*6*
16 - Sweden	8	35.87	*2*	39.62	*3*	45.76	*1*
17 - United Kingdom	11	21.18	*14*	24.81	*15*	28.04	*15*
EU	**138**	**28.94**		**32.84**		**36.55**	
cv		0.33		0.31		0.31	

Tab 5. Labour productivity in top 20 regions:
(Gross Value Added per worker)

		Period					
		1981-83		1988-90		1995-97	
Region	Nation	va pw	*ranking*	va pw	*ranking*	va pw	*ranking*
ZÜRICH	CH	44.8	*1*	45.9	*3*	48.8	*6*
HAMBURG	DE	44.2	*2*	47.8	*1*	55.5	*1*
REGION IEMANIQUE	CH	41.9	*3*	44.3	*4*	45.3	*19*
NORDWESTSCHWEIZ	CH	41.7	*4*	41.5	*16*	47.4	*9*
NOORD_NEDERLAND	NL	41.1	*5*	44.1	*5*	45.7	*17*
ZENTRALSCHWEIZ	CH	41.0	*6*	42.7	*8*	46.7	*13*
STOCKHOLM	SE	39.2	*7*	44.1	*6*	53.0	*3*
ILE DE FRANCE	FR	39.2	*8*	46.6	*2*	54.8	*2*
BREMEN	DE	38.5	*9*	38.8	*33*	42.9	*33*
ESPACE MITTELLAND	CH	38.1	*10*	39.2	*30*	40.8	*46*
MELLERSTA NORRLAND	SE	37.7	*11*	41.4	*17*	45.8	*16*
LIGURIA	IT	37.6	*12*	41.7	*15*	47.3	*11*
OSTSSCHWEIZ	CH	37.4	*13*	38.8	*34*	42.4	*38*
BERLIN (WEST)	DE	37.3	*14*	40.4	*20*	37.0	*70*
HESSEN	DE	36.9	*15*	42.2	*12*	50.7	*4*
OVRE NORRLAND	SE	36.7	*16*	40.4	*21*	45.2	*20*
TIROL	AT	36.6	*17*	40.4	*22*	43.4	*29*
LOMBARDIA	IT	36.1	*18*	42.3	*11*	48.5	*7*
WIEN	AT	36.1	*19*	43.8	*7*	49.9	*5*
LAZIO	IT	36.0	*20*	42.3	*10*	47.4	*10*

Tab 6. Spatial autocorrelation in the production activity
(Moran's I test, normal approximation)

Period		1981-83		1988-90		1995-97	
Sector	contiguity	Z-value	Prob	Z-value	Prob	Z-value	Prob
Total manufacturing	1	8.289	0.00	8.944	0.00	9.109	0.00
	2	6.238	0.00	7.189	0.00	9.277	0.00
	3	5.102	0.00	5.222	0.00	7.175	0.00
Mining and energy	1	1.305	0.19	1.846	0.06	2.447	0.01
	2	-0.259	0.80	-0.677	0.50	0.784	0.43
	3	-0.157	0.87	-0.090	0.93	0.375	0.71
Food	1	6.057	0.00	5.996	0.00	5.563	0.00
	2	2.806	0.01	2.967	0.00	4.326	0.00
	3	1.859	0.06	1.051	0.29	3.317	0.00
Textile and clothing	1	6.047	0.00	6.084	0.00	8.059	0.00
	2	4.193	0.00	4.393	0.00	5.153	0.00
	3	1.813	0.07	1.612	0.11	2.284	0.02
Chemicals and plastic	1	7.998	0.00	8.735	0.00	9.564	0.00
	2	3.969	0.00	5.997	0.00	8.375	0.00
	3	2.922	0.00	5.034	0.00	6.115	0.00
Electronics	1	10.384	0.00	10.383	0.00	9.557	0.00
	2	8.862	0.00	9.107	0.00	9.915	0.00
	3	6.761	0.00	6.490	0.00	7.255	0.00
Transport equipment	1	5.487	0.00	5.335	0.00	7.656	0.00
	2	4.512	0.00	3.341	0.00	4.938	0.00
	3	4.073	0.00	3.908	0.00	3.718	0.00
Other manufacturing	1	9.878	0.00	9.943	0.00	10.136	0.00
	2	9.256	0.00	9.348	0.00	10.229	0.00
	3	6.689	0.00	6.600	0.00	7.662	0.00

Tab 7. Correlation coefficients between productive and innovative specialization

		Pearson				Pearson		
Period		81-83	88-90	95-97	Sector (133 obs)[c]	81-83	88-90	95-97
Europe		.080	.132	.185	1 mining and energy	.019	-.010	.174
(931 observations)	[a]	*(.007)*	*(.000)*	*(.000)*		*(.414)*	*(.453)*	*(.021)*
DE		.213	.155	.217	2 food	.016	.026	.026
(77 observations)	[b]	*(.031)*	*(.089)*	*(.011)*		*(.429)*	*(.382)*	*(.382)*
ES		.146	.163	.072	3 textiles and clothing	-.172	.165	.211
(105 observations)		*(.069)*	*(.049)*	*(.233)*		*(.024)*	*(.029)*	*(.006)*
FR		.501	.495	.181	4 chemicals and plastic	.068	.223	.136
(154 observations)		*(.000)*	*(.000)*	*(.012)*		*(.219)*	*(.005)*	*(.056)*
GR		.159	-.194	.037	5 electronics	.437	.126	.260
(91 observations)		*(.066)*	*(.033)*	*(.364)*		*(.000)*	*(.074)*	*(.001)*
IT		.195	.183	.373	6 transport equipment	.045	.342	.465
(140 observations)		*(.010)*	*(.015)*	*(.000)*		*(.302)*	*(.000)*	*(.000)*
UK		.504	.206	.400	7 other manufacturing	.217	.300	.289
(77 observations)		*(.000)*	*(.036)*	*(.000)*		*(.006)*	*(.000)*	*(.000)*
Other		.074	.191	.291				
(294 observations)		*(.104)*	*(.001)*	*(.000)*				

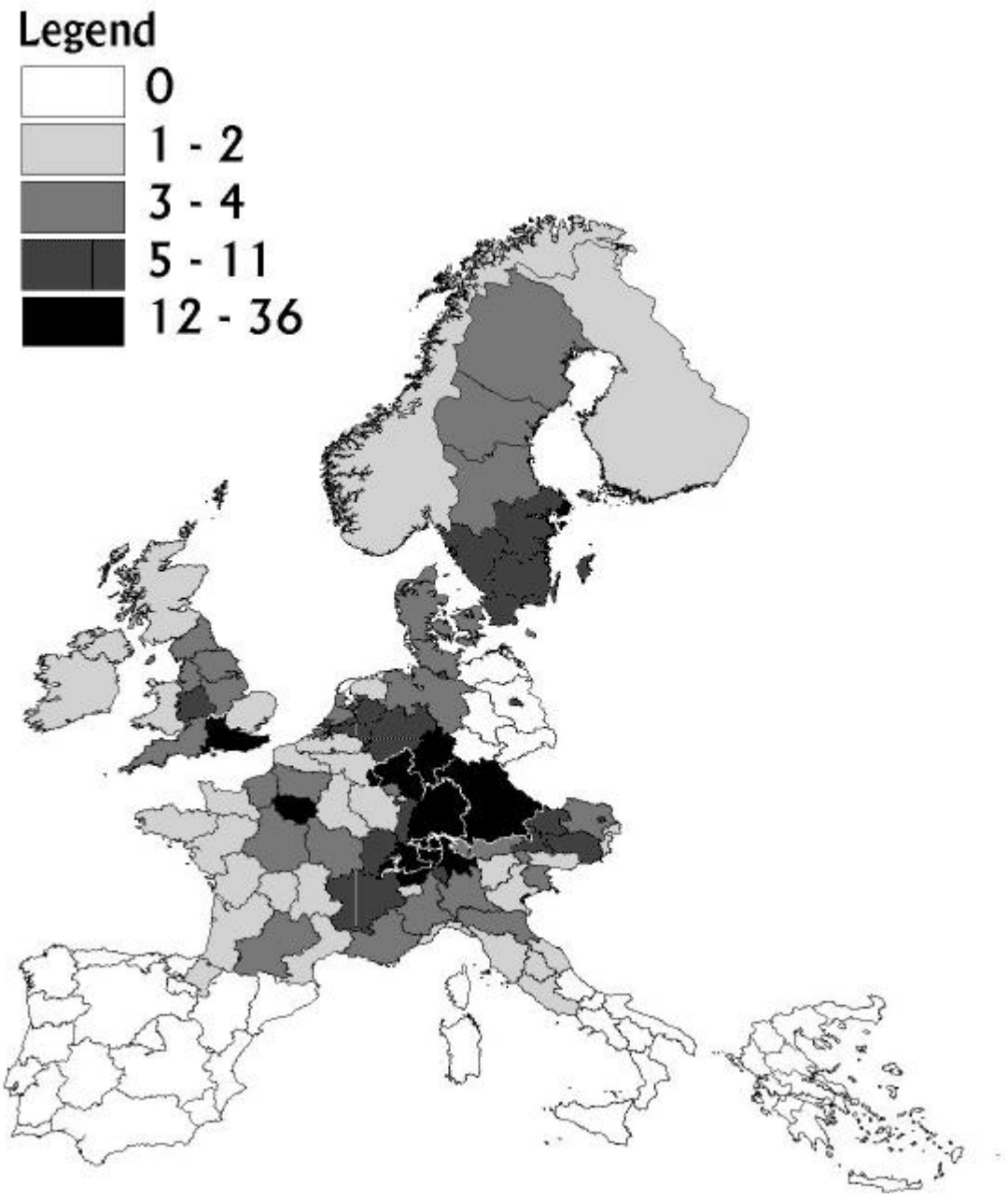
a = 966 obs for 3rd period

b = 112 obs for 3rd period

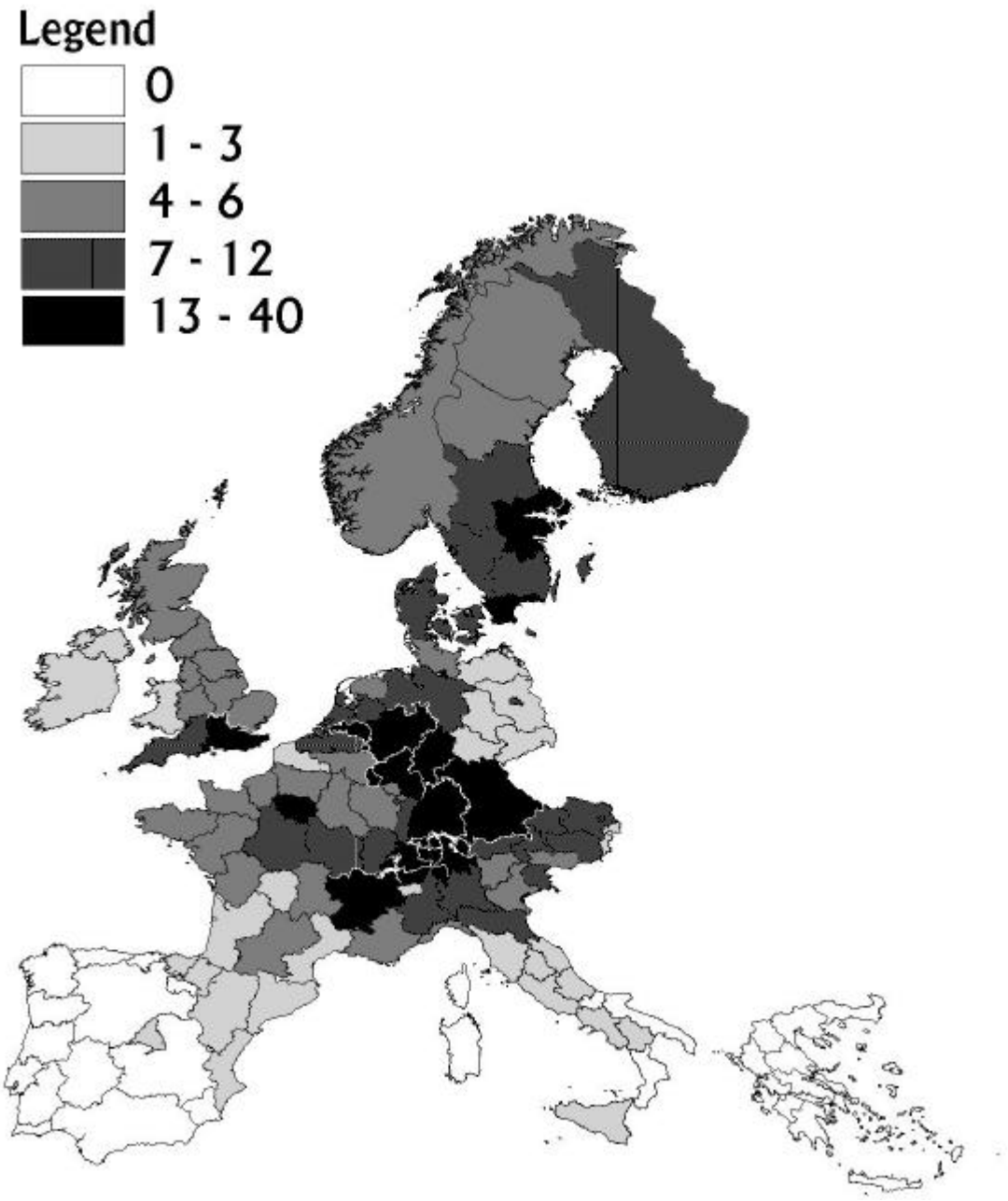
c = 138 obs for 3rd period

Note: Two-tailed significance in parentheses

Map 1. Distribution of innovative activity in the European regions, 1981-1983 (patents per capita, annual average)

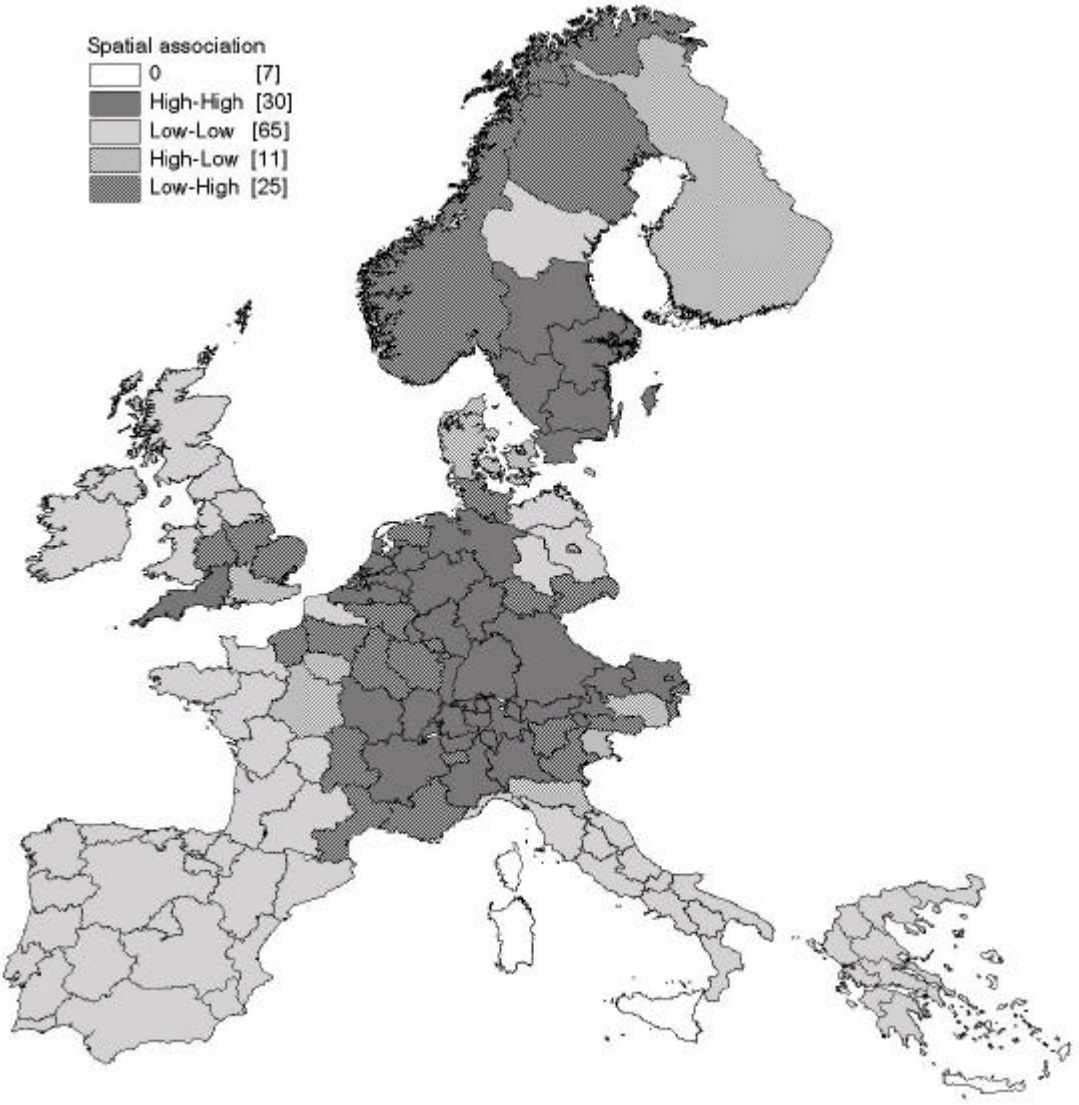


Map 2. Distribution of innovative activity in the European regions, 1995-1997
(patents per capita, annual average)

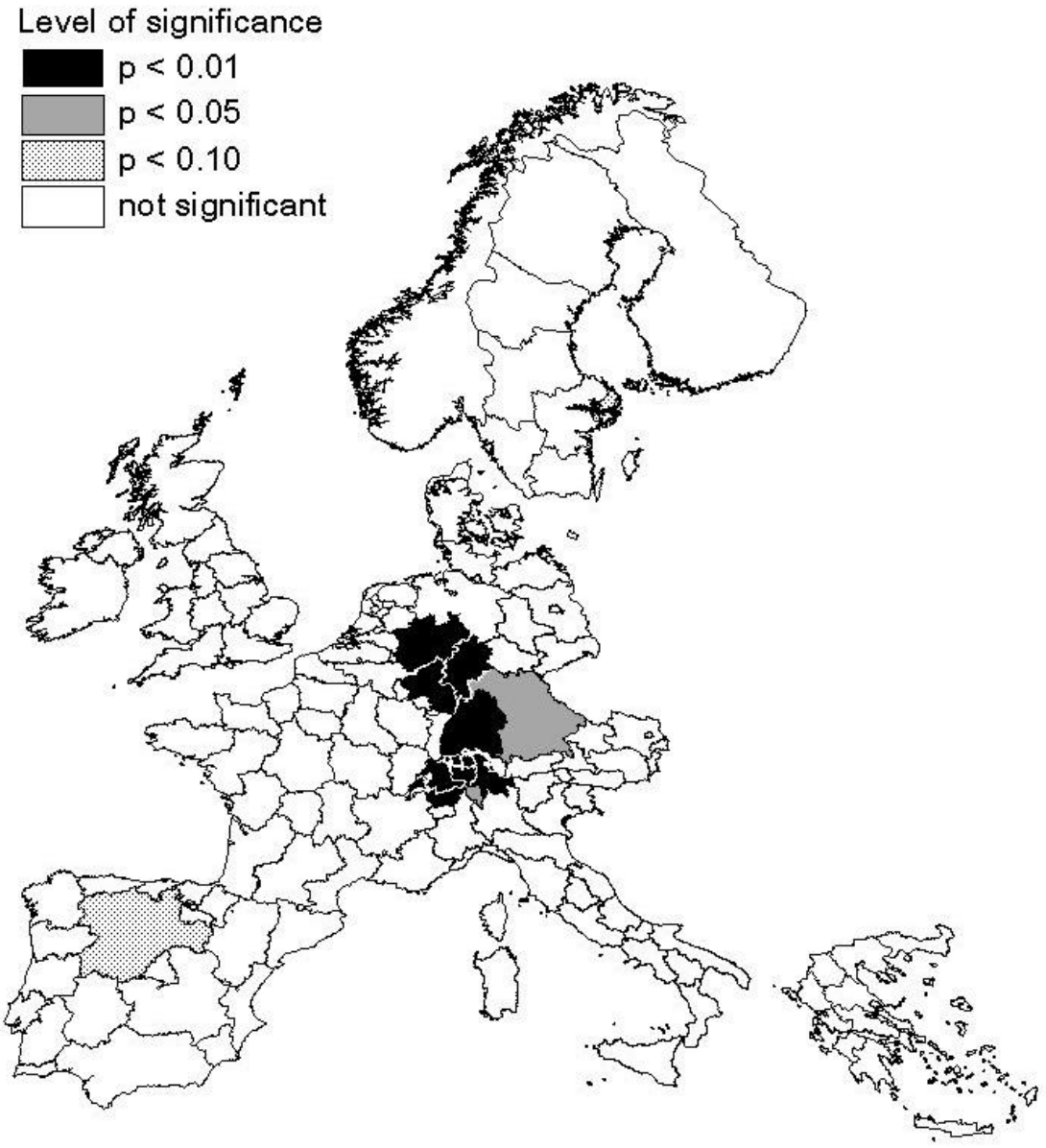


Map 3. Scatter for innovative activity in the European regions, 1995-1997

(patents per capita, annual average; number of regions in parenthesis)

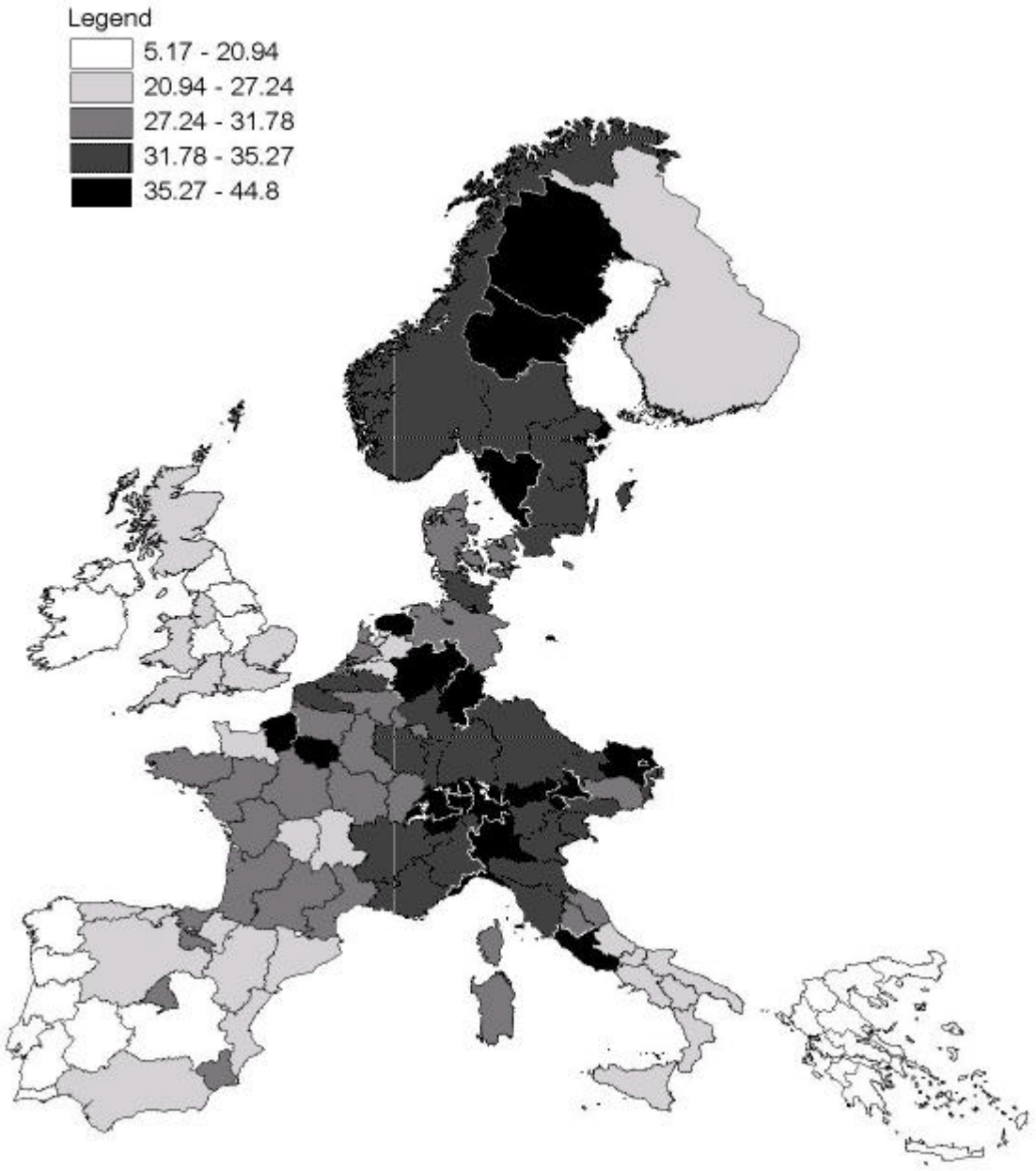


Map 4. LISA for innovative activity in the European regions, 1995-1997
(patents per capita, annual average)



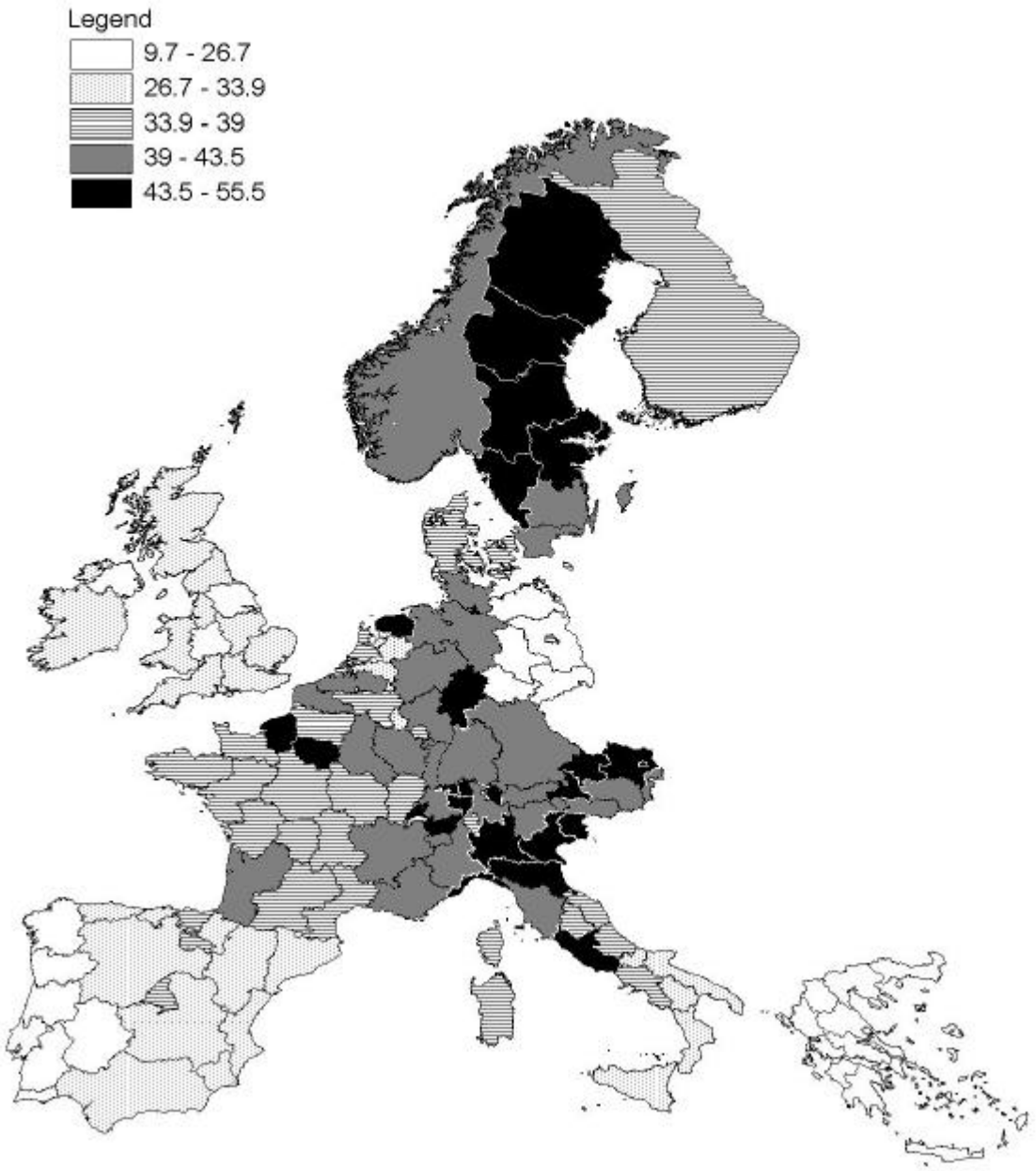
Map 5. Distribution of production activity in the European regions, 1981-1983

(Value added per worker, annual average)



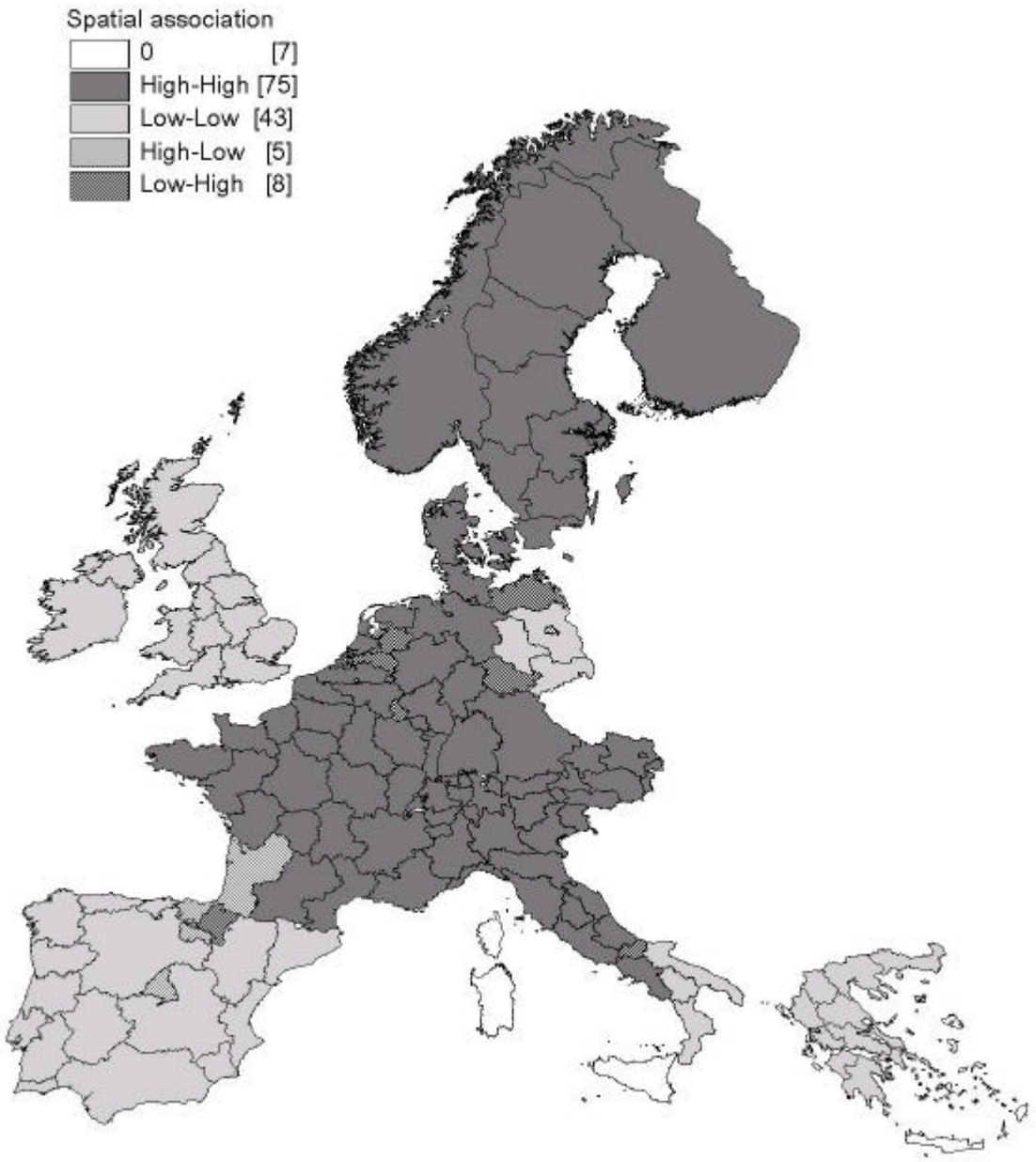
Map 6. Distribution of production activity in the European regions, 1995-1997

(Value added per worker, annual average)



Map 7. Scatter for production activity in the European regions, 1995-1997

(Value added per worker, annual average; number of regions in parenthesis)



Map 8. LISA for production activity in the European regions, 1995-1997

(Value added per worker, annual average)

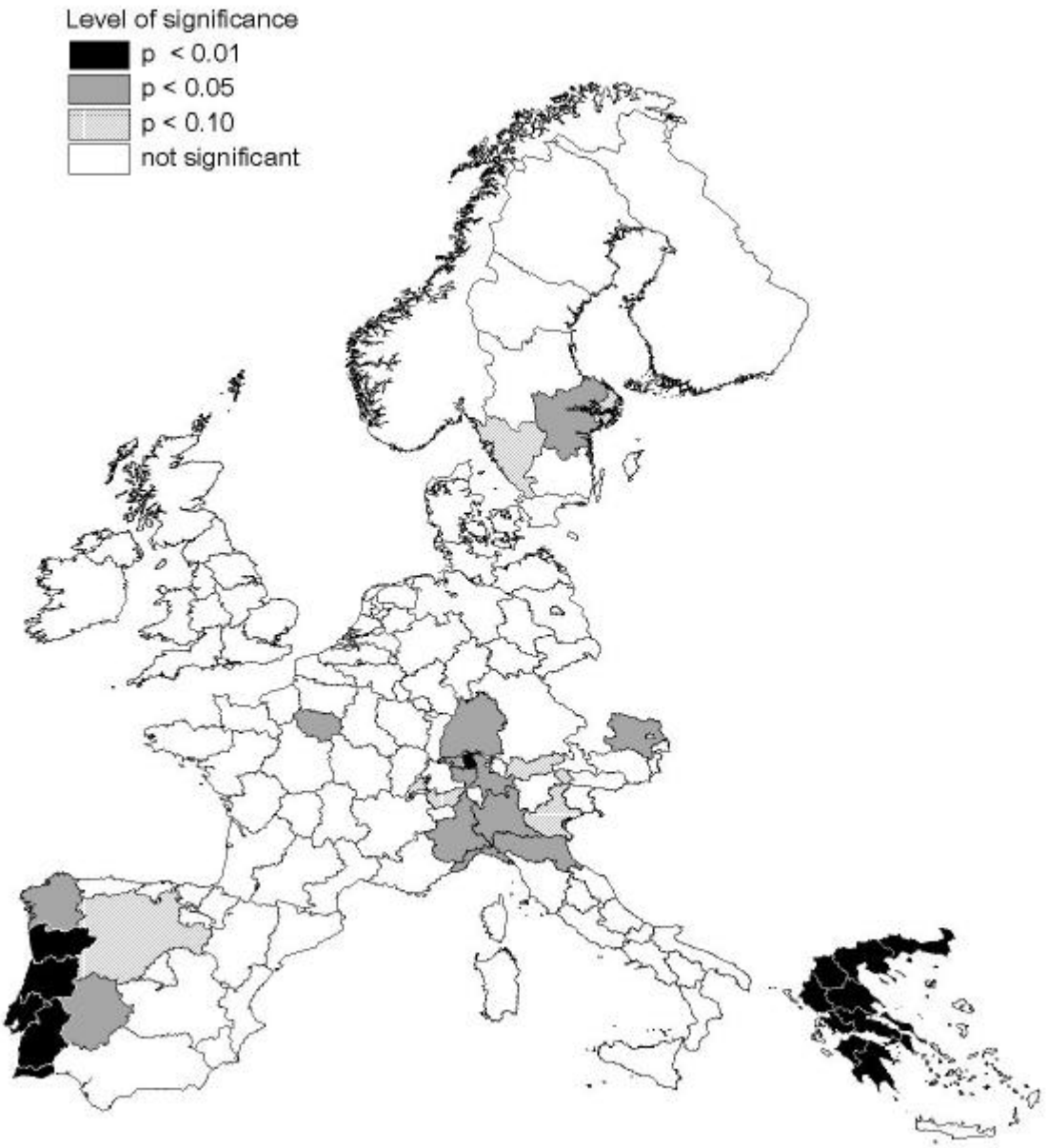


Figure 1. Kernel density function for innovation activity.

(patent per capita annual average)

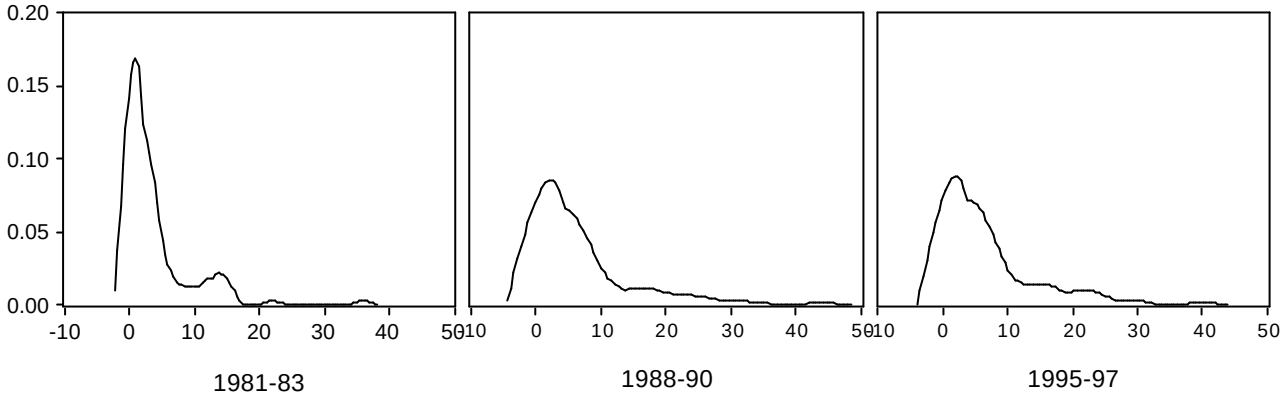


Figure 2. Kernel density function for production activity

(Value added per worker, annual average)

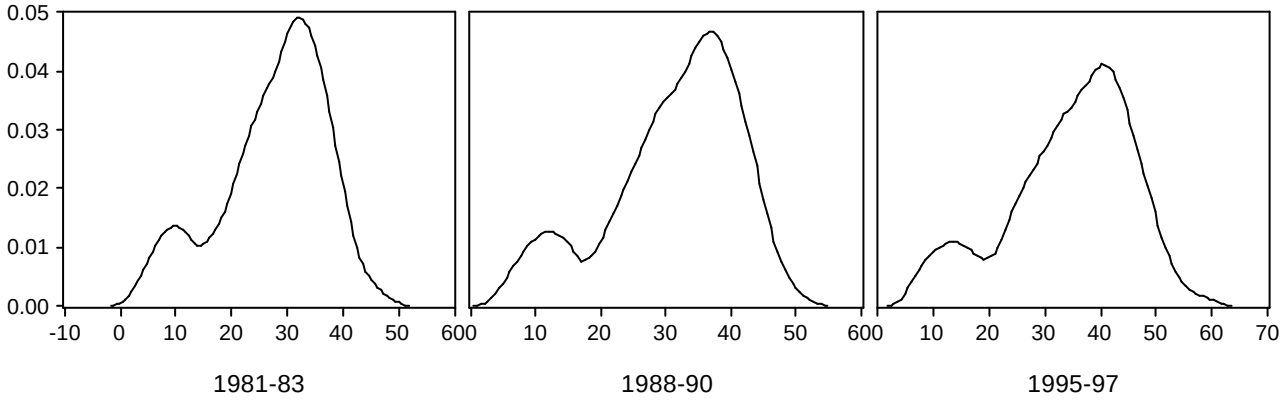
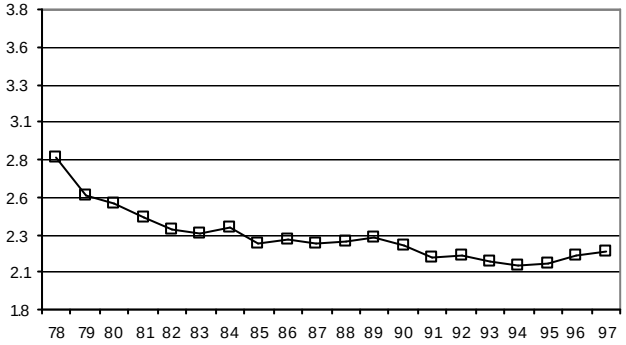
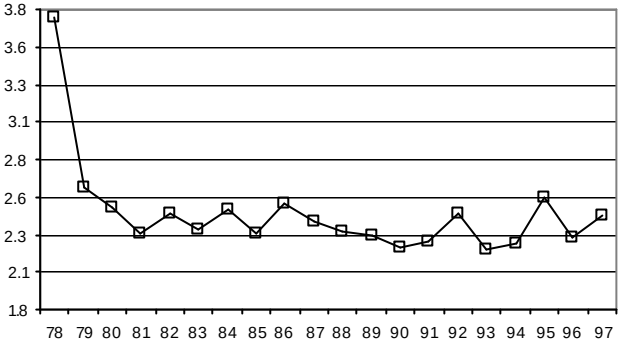


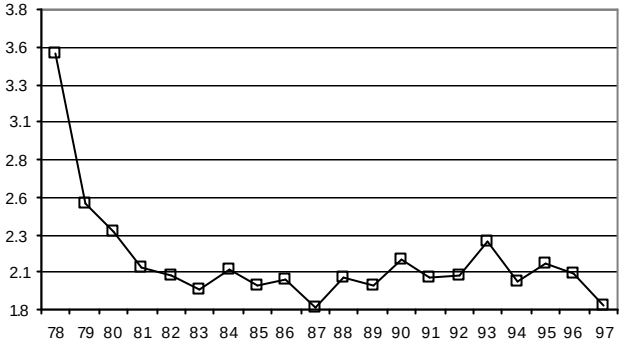
Figure 3. Coefficient of variation for innovation activity across European regions (1981-97)



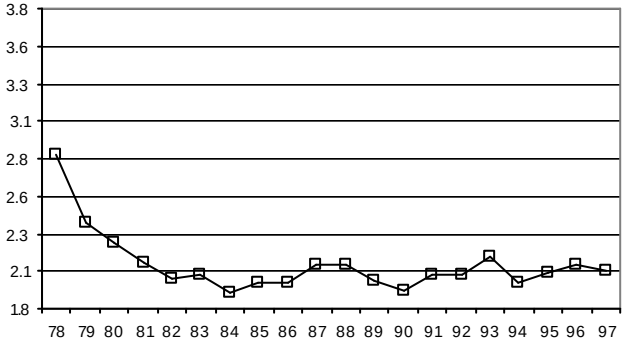
a. total energy and manufacturing



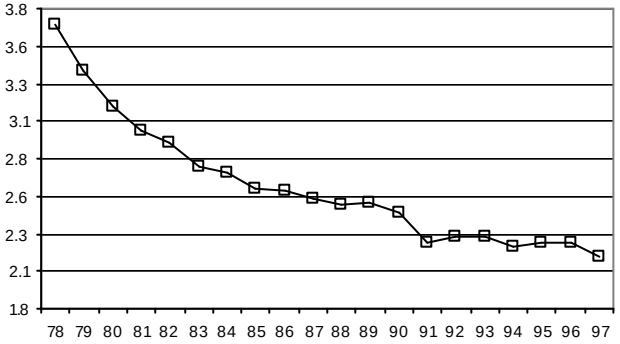
b. mining and energy supply



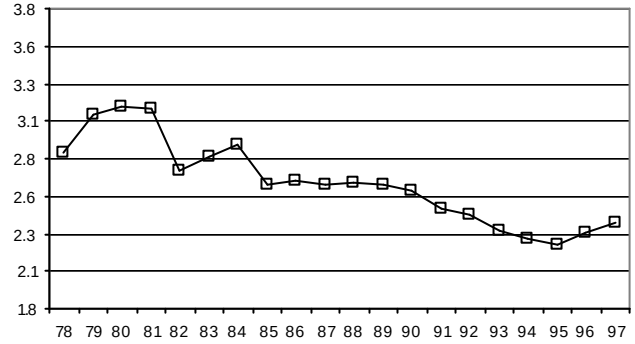
c. food, beverages and tobacco



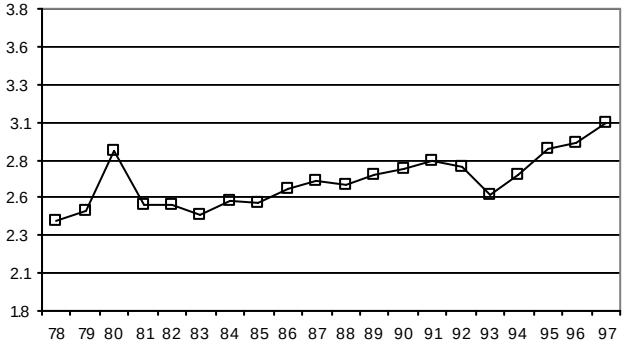
d. textiles and clothing



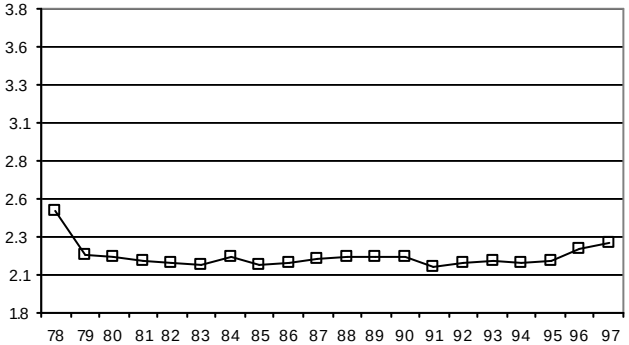
e. fuels, chemicals, rubber



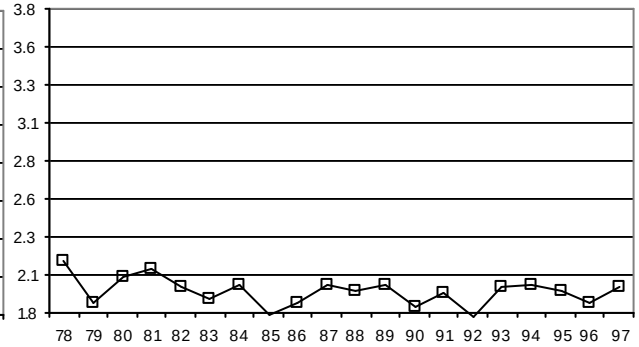
f. electronics



g. transport equipment



h. other manufacturing



i. construction

Figure 4. Coefficient of variation for production activity across European regions (1981-97)