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The Location of European Industry

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Introduction

Closer European integration is likely to bring with it major changes in industrial location. Industries will move to exploit differences in countries' comparative advantages and, even if such differences are small, integration may change the attractiveness of central areas relative to peripheral ones and may facilitate the clustering of activities that benefit from linkages with each other.

There are many reasons to welcome such changes. The gains from exploiting comparative advantage can only be achieved by industrial relocation, and clustering brings economic benefits as firms gain better access to suppliers and other complementary activities. But relocation will typically involve short run adjustment costs before the long run benefits are achieved. Specialisation may also make countries more vulnerable to the effects of shocks in particular industries, which will be costly if cross-country adjustment mechanisms are inadequate.

The objectives of this study are to describe the changes in industrial location that have occurred in Europe in recent decades; to establish whether these are associated with countries' economic structures becoming more or less similar, and industries becoming more or less spatially concentrated; to compare industrial location patterns in Europe and the US; and to identify the underlying forces that determine industrial location and assess the extent to which these have changed in recent years.

Our main findings are as follows.

- Most European countries showed significant convergence of their industrial structure during the 1970s, but this trend was reversed in the early 1980s. There has been substantial divergence from the early 1980s onwards, as countries have become increasingly different from the average of the rest of the EU and, in bilateral comparisons, from most of their EU partners.

- The most dramatic changes in industry structure have been the expansion of relatively high technology and high skill industries in Ireland and in Finland. However, the specialisation process has occurred more generally, with nearly all countries showing increasing difference from the early 1980s onwards.

- Many, although not all, industries have experienced significant changes in their location. Key features of these changes include:
    - A number of industries that were initially spatially dispersed have become more concentrated. These are mainly slow growing and unskilled labour intensive industries whose relative contraction has been accompanied by spatial concentration, usually in peripheral low wage economies.
    - Amongst industries that were initially spatially concentrated, around half stayed concentrated. Significant dispersion has occurred in a number of medium and high technology industries and in relatively high growth sectors, with activity typically spreading out from the central European countries.

- Econometric analysis identifies the underlying forces that determine industrial location, and we show that a high proportion of the cross-country variation in industrial structure can be explained by a combination of factor cost and geographical considerations. Four main results come from the econometrics:

  - The location of R&D intensive industries has become increasingly responsive to countries' endowments of researchers, with these industries moving into researcher abundant locations.
  - The location of non-manual labour intensive industries was, and remains, sensitive to the proportion of countries' labour forces with secondary and higher education.
  - The location of industries with strong forward and backward linkages has become increasingly sensitive to the centrality/ peripherality of countries. Thus, central locations are increasingly attracting industries higher up the value added chain (i.e. which are highly dependent on intermediate inputs).
  - Industries which have a high degree of increasing returns to scale tend to locate in central regions, but this effect has diminished markedly over the period.

- Services are in general more dispersed than manufacturing. Two trends – the general shift from manufacturing to services, and catch up by poorer countries with small initial services sectors – have reinforced this spatial dispersion of services.

- While the industrial structures of EU countries are diverging, those of US states are converging. However, in so far as it is possible to make any comparison of levels of industrial concentration between the EU and the US, we find that EU industries are still less concentrated than are those in the US.

Our results on specialization and concentration indices are broadly consistent with other studies in the area (for example, Brülhart and Torstensson (1996), Amiti (1999), OECD (1999), WIFO (1999)), although differences arise due to differences in data, time periods and measurement techniques. We go beyond existing studies in a number of different ways. First, we draw out the relationship between the characteristics of industries and the characteristics of the countries in which they are located. Thus, we trace out how the industrial composition of each EU country has become more or less biassed with respect to a set of industry characteristics, including capital intensity, skill intensity and technology intensity. Similarly, we trace out how different sorts of industries have relocated towards countries with different characteristics, including skill abundance, R&D abundance and geographical centrality. Second, we introduce a new measure of spatial dispersion that takes in to account the relative locations of clusters of industries. Using existing concentration measures, two industries may appear equally geographically concentrated, while one is predominantly located in two neighbouring countries, and the other split between Finland and Portugal. By taking in to account the relative locations of concentrations of industries our measure allows us to discriminate between these two alternatives. We use the measure to study the evolution of location patterns in the EU. It also allows us to carry out a meaningful comparison of the EU and US economic geographies, something which has not been possible with the measures available hitherto.

Our econometric analysis breaks new ground by developing a specification which systematically relates the location of production to industry and country characteristics. We developed our empirical model by constructing a simulation model which incorporates both comparative advantage and new economic geography forces and allowing that model to guide our choice of econometric specification. Estimating our empirical model using EU data allows us to show how some factors have become more important in determining location, and others less. We find that skilled and scientific labour abundance are becoming more important considerations in determining industrial location, and that the pull of centrality is becoming more important for industries that are intensive users of intermediate goods, although less important for industries with high returns to scale. This suggests that a new pattern of industrial specialisation is developing, and that the changes we map out in descriptive sections of the report are the manifestations of this change.[1]

The structure of the report is as follows. In the next section we briefly outline our data sources and the main variables that we use. Section 2 looks at EU countries, showing how their industrial structures differ, and presenting evidence of increasing difference in recent years. Section 3 turns to industries, and shows how their location patterns have changed. We present evidence that a number of sectors have become more spatially concentrated, while others have become more dispersed.

In both sections 2 and 3 we link the changes to industrial characteristics using graphical techniques and descriptive statistics. Section 4 undertakes a full multi-variate econometric analysis of the way in which characteristics of countries interact with characteristics of industries to determine the pattern of industrial location. Both factor supply and geographical variables drive location patterns, although the importance of different factors has changed markedly over time.

Sections 5 and 6 change focus, looking respectively at the location of service industries, and at a comparison of the EU with the US. We show that the available evidence shows a slight dispersion in service sector activity. The US is continuing a process of industrial de-concentration, although the data suggests that many US industries are still more concentrated than their EU counterparts.

Section 7 concludes and offers some preliminary predictions and a discussion of policy implications.

1. Data and measurement

Our main data source is the OECD STAN database. This provides production data for 13 EU countries and 36 industries, from 1970 to 1997. We combine this with production data for Ireland from the UN UNIDO database, giving us data on a set of 14 EU countries (the EU 15, excluding Luxembourg). The production data are complemented by trade data from the UN Com-Trade data base for 14 countries and 104 industries, for the years 1970 to1996. The level of aggregation provided by STAN might mask changes in national specialization and industrial concentration occurring at the intra-sectoral level. Hence, in addition we use production data from Eurostat's DAISIE database. This provides a level of disaggregation that is finer than STAN, but there are a significant number of missing observations and the data only covers the much shorter time period 1985 to 1997. We use it to cross-check the generality of our results. More detailed information on all three data sources is provided in Appendix A1.

The basic unit of analysis is the activity level – measured, when using the production data, by the gross value of output – of industry *k* in country *i* at time *t*, which we shall denote $x_i^k(t)$. We usually want to work with this expressed as a share, either of activity in the country, or total EU activity in the industry. We call these shares $v_i^k(t)$ and $s_i^k(t)$ respectively,

$$v_i^k(t) \equiv x_i^k(t) / \sum_k x_i^k(t), \qquad s_i^k(t) \equiv x_i^k(t) / \sum_i x_i^k(t). \qquad (1)$$

Thus $v_i^k(t)$ is the share of sector *k* in the total activity of country *i*, which forms the basis of our analysis of countries in Section 2. $s_i^k(t)$ is the share of country *i* in the total activity of industry *k*, which is the basis of the industry analysis of Sections 3 and 4.

Previous studies on the location of production in Europe have used value added instead of gross production value as measure of activity level. However, the use of value added makes the analysis much more vulnerable to structural shifts in outsourcing to other sectors. Over the period we study there have been large changes in outsourcing, particularly increased outsourcing of service sector intermediates, (see Section 5 for a more detailed discussion), and it is this that motivates our use of gross production value.[2]

We link industrial activity levels to industrial characteristics (such as factor intensities and returns to scale) and to country characteristics (such as factor endowments and market potential). Data for these measures were collected from a variety of sources, including the OECD and Eurostat, and are described in detail in Appendix A2.

While the major part of this study focuses on manufacturing industries, we also consider services using data from the OECD Services database. The comparison of the economic geography of Europe with that of the US, draws on US State level data for manufacturing employment, 1970-97.[3]

2. The specialization of countries

In this section we look at the production structures of EU countries, and address three questions: How specialized are countries? How similar are the industrial structures of different countries? What are the characteristics of industries located in each country? We trace out changes through time and show that the picture is one of growing differences between countries, at least from the early 1980s onwards.

2.1 How specialized are countries?

We begin by considering a key question - how specialized are EU countries? Our approach is to construct a measure which allows us to compare each country's industrial structure with that of the average of the rest of the EU. In the next section, we then use the same type of measure to compare the production structures of different countries, and report a full set of bilateral comparisons for all fourteen countries with each other country.

To construct the measure of specialization we proceed as follows. For each country, we calculate the share of industry k in that country's total manufacturing output (gross production value). As outlined in Section 1, we call this variable $v_i^k(t)$. Corresponding to this, we can calculate the share of the same industry in the production of all other countries, denoted $\bar{v}_i^k(t)$. We can then measure the difference between the industrial structure of country i and all other countries by taking the absolute values of the difference between these shares, summed over all industries,

$$K_i(t) = \sum_k abs\left(v_i^k(t) - \bar{v}_i^k(t)\right) \qquad (2)$$

with

$$\bar{v}_i^k(t) \equiv \sum_{j \neq i} x_i^k(t) / \sum_k \sum_{j \neq i} x_i^k(t)$$

We call this the Krugman specialization index, or K-spec.[4] It takes value zero if country i has an industrial structure identical to the rest of the EU, and takes maximum value two if it has no industries in common with the rest of the EU.

Values of these indices for each country are given in Table 2.1. They are calculated for four year averages[5] at the dates indicated, with bold indicating the minimum value attained by each country. The table reports them for each country and, in the bottom two rows, the average (simple, and weighted by country size).

Looking first at the averages, we see a fall between 1970/73 and 1980/83, indicating that locations became more similar. But from 1980/83 onwards there has been a more or less steady increase, indicating divergence. Turning to individual countries, we see that from 1970/73 to 1980/83 ten out of fourteen countries became less specialized, while between 1980/83 and 1994/97, all countries except the Netherlands experienced an increase in specialization. That is, they became increasingly different from the rest of the EU.[6]

Table 2.1: Krugman specialization index (Production data, 4 year averages)

	70/73	80/83	88/91	94/97	94/97 - 80/83	94/97 - PROJ
Austria	0.314	**0.275**	0.281	0.348	0.073	0.057
Belgium	**0.327**	0.353	0.380	0.451	0.099	0.088
Denmark	0.562	**0.553**	0.585	0.586	0.033	0.026
Spain	0.441	**0.289**	0.333	0.338	0.049	0.043
Finland	0.598	**0.510**	0.528	0.592	0.083	0.034
France	0.204	**0.188**	0.207	0.201	0.013	0.019
G. Britain	0.231	**0.190**	0.221	0.206	0.017	0.016
Germany	0.319	**0.309**	0.354	0.370	0.061	0.055
Greece	**0.531**	0.580	0.661	0.703	0.123	0.105
Ireland	0.701	**0.623**	0.659	0.779	0.156	0.197
Italy	**0.351**	0.353	0.357	0.442	0.089	0.119
Netherlands	**0.508**	0.567	0.547	0.517	-0.050	-0.046
Portugal	0.536	**0.478**	0.588	0.566	0.088	0.088
Sweden	0.424	**0.393**	0.402	0.497	0.103	0.110
Average	0.432	**0.404**	0.436	0.471		
Weighted ave.	0.326	**0.302**	0.330	0.354		

The magnitude of the size of the changes is also informative. For example, given production in the rest of the EU, Ireland's coefficient of K-spec in 1994/97 took a value of 0.779, indicating that 39% of total production would have to change industry to get in line with the rest of the EU (that is 0.779% divided by 2, because the measure counts positive and negative deviations for all sectors). Thus, from 1980/83 to 1994/97 (the changes given in column 5), 7.8% of Ireland's production changed to industries out of line with the rest of Europe.

This growing divergence of production structures could be due either to initial differences being magnified by industries having different EU wide growth rates (so a country with a high initial share in a fast growing industry will become more different), or to countries moving in and out of industries (which we call 'differential change'). The final column in Table 2.1 captures this differential change. It gives the difference between the actual 1994/97 specialization index, and what it would have been had production in each industry in each country grown at the EU wide rate for that industry (obtained by projecting the 1980/83 values for each industry forward at the EU average growth rate for that industry). We see that more than 80% of the actual change is 'differential change', while the remainder is due to amplification of initial differences.

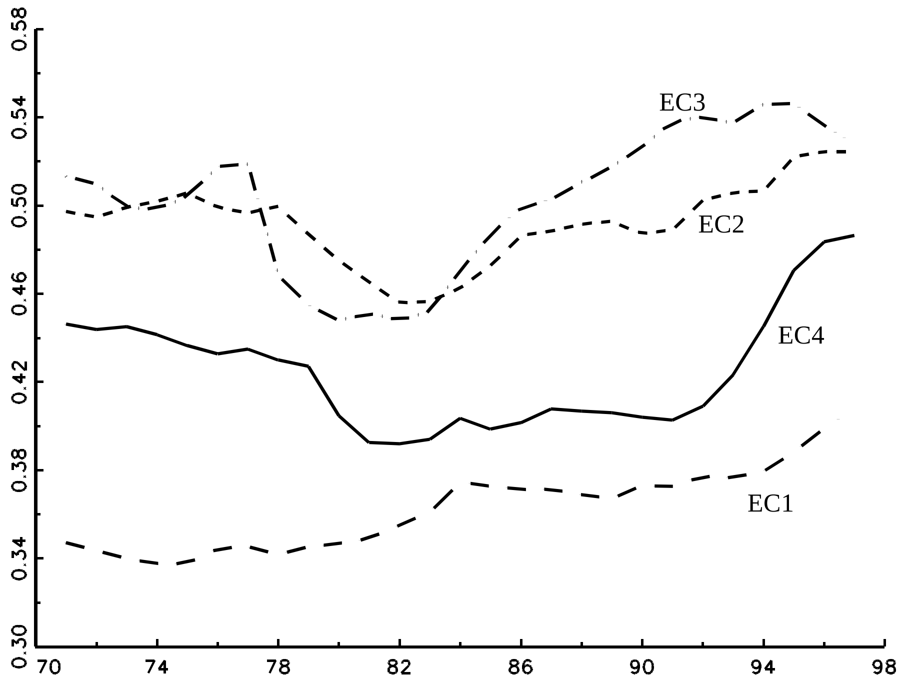

Figure 2.1: Krugman specialization indices: Countries grouped by EC entry date. (2 yr moving average, unweighted).

Table 2.1 reports outcomes for selected time points, based on a four year moving average. A figure plotting the time series for all countries and each year is confusing, but it is insightful to plot a two-year moving average for countries grouped by their EU accession date. This is done in Figure 2.1. The different heights of the curves essentially reflect different country sizes (thus EC1 is relatively low because of the predominance of Germany, France and Italy). More interesting, are the different patterns of change. For the initial entrants there is a more or less steady increase throughout the period. The 1973 and 1980s entrants (EC2 and EC3) exhibit an increase from the early 1980s. The last wave (EC4) show increasing K-spec measures from around 1992 onwards.[7]

Our findings of a general increase in specialization during the last decade, are consistent with those of a recent study by WIFO (which only considers data for 1988 to 1998). With respect to individual countries, our results do not always coincide completely. This might be partly due to the fact that WIFO (1999) is based on analysis of value added data, not gross production value data as employed here. As we suggested in Section 1, changes in value added data may partly be driven by the large changes in the degree of outsourcing that we have witnessed in the last decades. Another possible reason for the discrepancies is the fact that we use four year averaging to account for business cycle developments, while WIFO use annual data. The WIFO report differs in one other important aspect - the degree of sectoral disaggregation. Their use of the DAISIE data set allows a greater degree of disaggregation than our dataset. Appendix A3 uses this DAISIE data to calculate specialization patterns at this more disaggregate level. That appendix also provides further comparison of our results with those of the WIFO report. Two broad conclusions emerge. First, three digit sectors tend to follow their two digit counterparts suggesting that our aggregate measures are informative about movements at the more disaggregate level. Second, the DAISIE data set, with its short time span, misses many of the larger changes in specialization patterns that occurred pre -1988.

The Krugman specialization index is just one measure of specialization. However, other statistics paint the same broad picture. Here, we briefly consider results for alternative indices, beginning with the Gini coefficient. The Gini coefficient[8] is defined over the relative share measures, $r_i^k(t)$:[9]

$$r_i^k(t) \equiv v_i^k(t) / \bar{v}_i^k(t) \qquad (3)$$

We report the average Gini coefficient in Table 2.2. Just like the K-spec index, the Gini coefficient of specialization indicates a general decline in specialization from 1970/73 to 1980/83, that is followed by an increase in specialization from 1980/83 to 1994/97. Other statistics can be computed, and they reveal further features of the shape of the distribution. Thus, we also look at the first to fourth moments of the distribution of $r_i^k(t)$, pooled across countries and industries. These summary statistics are reported in Table 2.2. The most important points to note are that – from 1980/83 onwards – there has been a large increase in the variance of relative shares, once again indicating greater dispersion. The distribution has positive skew which increases over time, as would be expected if a process of clustering or extreme specialization were taking place (with a few industries becoming particularly dominant in some locations). There is also some evidence of increasing kurtosis, indicating growing weight in the tails of the distribution.

Table 2.2: Summary measures of relative shares

	70/73	80/83	88/91	94/97
Gini	0.321	0.312	0.334	0.355
Mean	1.008	0.979	1.004	1.004
Variance	0.471	0.419	0.525	0.611
Skewness	2.357	2.34	2.38	2.56
Kurtosis	13.53	13.62	12.66	14.07

Finally, a simple experiment suggests that these reported changes may reflect an unraveling of specialization patterns in the first decade, followed by a reinforcement of new patterns in the following two decades. Thus, if we regress 1980/83 log values of $r_i^k(t)$ on the 1970/73 values, we get a coefficient of 0.818 (t=39). This suggests that, on average, a country which had a comparative advantage in any given industry in 1970, saw that comparative advantage weaken over the following decade. In contrast, a regression of the 1994/97 log values of $r_i^k(t)$ on the 1980/83 log values gives a coefficient significantly greater than unity (1.071, t = 34), indicating that there has been a 'deepening' of specialization over the period. Industries that had a large share in a country tended to see this amplified.

2.2 How similar are countries' industrial structures?

The industry shares $v_i^k(t)$ for each country can be compared with the corresponding shares for the rest of the EU as a whole, as in Table 2.1, or with shares for other individual countries. Making this comparison yields a full matrix of bilateral differences between the industrial structures of pairs of countries. Tables 2.3a and 2.3b report these bilateral measures for 1980/83 and 1994/97 respectively. The tables are most easily read by selecting a country and reading across the row for that country; smaller numbers indicate similarity to the country in the column, and larger numbers indicate greater difference. We have highlighted the most different countries in bold and the most similar in bold italics.

The main point to note from these tables is that, of the 91 distinct pairs, 71 exhibit increasing difference between 1980/83 and 1994/97.

Element by element study of the matrices is laborious, but it is worth drawing attention to a few of the more important features. First, France, Britain and Germany are most like each other; between Britain and France the degree of similarity has increased, but Germany has become somewhat different. They are each fairly similar to Italy, although the degree of similarity has declined; (Italy is most like Austria in both periods). France, Britain and Germany are most dissimilar to Greece and Ireland, and their dissimilarity is increasing.

Turning to the lower income countries, Greece and Portugal are most similar to each other, as well as to Spain, although becoming less so. Spain is, however, more similar to France and Great Britain, than to Greece and Portugal. This observation is most likely explained by Spain being the most advanced country out of these three cohesion countries rather than a result of country size effects. The calculations presented in Section 2.4 confirm that Spain has a very different industrial structure to the other two countries.

In 1994/97 Greece, Portugal and Spain shared the same most different economies – Finland, Sweden and Ireland. Finland and Sweden are most similar to each other. Ireland is most similar to Denmark, but very different from Finland and Sweden, and very (and increasingly) different from Greece and Portugal. The Netherlands – the only country that becomes more similar to the rest of the EU – also becomes more similar to all countries except Finland, Portugal and Sweden.

Evidently, many more comparisons can be made. The main point is that the vast majority of countries experienced a growing difference between their industrial structure and that of their EU partners.

Table 2.3a: Bilateral differences, 1980-83

	Aus	Bel	Den	Spa	Fin	Fra	Gbr	Ger	Gre	Ire	Ita	Net	Por	Swe
Aus	0.00	0.44	0.61	0.40	0.55	0.38	***0.32***	0.33	0.61	**0.67**	0.36	**0.67**	0.50	0.45
Bel	0.44	0.00	0.59	0.34	0.59	***0.34***	0.42	0.43	0.59	**0.66**	0.51	0.42	0.49	0.63
Den	0.61	0.59	0.00	0.62	0.58	0.57	0.56	0.65	**0.74**	***0.42***	0.64	0.51	0.63	0.63
Spa	0.40	0.34	0.62	0.00	0.55	***0.26***	0.37	0.40	0.42	**0.67**	0.40	0.60	0.40	0.56
Fin	0.55	0.59	0.58	0.55	0.00	0.49	0.54	0.66	0.65	**0.82**	0.65	0.62	0.62	***0.41***
Fra	0.38	0.34	0.57	0.26	0.49	0.00	***0.22***	0.31	0.57	**0.63**	0.39	0.51	0.47	0.41
GBr	0.32	0.42	0.56	0.37	0.54	***0.22***	0.00	0.25	0.61	**0.67**	0.40	0.53	0.55	0.39
Ger	0.33	0.43	0.65	0.40	0.66	0.31	***0.25***	0.00	0.73	**0.75**	0.43	0.64	0.64	0.42
Gre	0.61	0.59	0.74	0.42	0.65	0.57	0.61	0.73	0.00	**0.83**	0.62	0.64	***0.25***	0.80
Ire	0.67	0.66	***0.42***	0.67	0.82	0.63	0.67	0.75	0.83	0.00	0.67	0.72	0.71	**0.85**
Ita	***0.36***	0.51	0.64	0.40	0.65	0.39	0.40	0.43	0.62	0.67	0.00	**0.78**	0.48	0.52
Net	0.67	0.42	***0.51***	0.60	0.62	0.51	0.53	0.64	0.64	0.72	**0.78**	0.00	0.55	0.66
Por	0.50	0.49	0.63	0.40	0.62	0.47	0.55	0.64	***0.25***	**0.71**	0.48	0.55	0.00	**0.71**
Swe	0.45	0.63	0.63	0.56	0.41	0.41	***0.39***	0.42	0.80	**0.85**	0.52	0.66	0.71	0.00

Table 2.3b: Bilateral differences, 1994-97

	Aus	Bel	Den	Spa	Fin	Fra	Gbr	Ger	Gre	Ire	Ita	Net	Por	Swe
Aus	0.00	0.54	0.59	0.48	0.58	0.43	***0.39***	0.46	0.78	**0.81**	0.43	0.64	0.57	0.55
Bel	0.54	0.00	0.54	0.47	**0.76**	0.44	0.48	0.61	0.63	0.69	0.57	***0.42***	0.64	**0.76**
Den	0.59	0.54	0.00	0.61	0.69	0.57	0.58	**0.72**	0.70	0.63	0.61	***0.51***	0.68	0.66
Spa	0.48	0.47	0.61	0.00	0.78	***0.33***	0.38	0.43	0.57	**0.85**	0.53	0.58	0.50	0.63
Fin	0.58	0.76	0.69	0.78	0.00	0.62	0.58	0.66	**0.97**	0.87	0.66	0.71	0.86	***0.42***
Fra	0.43	0.44	0.57	0.33	0.62	0.00	***0.19***	0.35	0.69	**0.78**	0.51	0.46	0.55	0.51
GBr	0.39	0.48	0.58	0.38	0.58	***0.19***	0.00	0.36	0.72	**0.77**	0.47	0.46	0.59	0.51
Ger	0.46	0.61	0.72	0.43	0.66	***0.35***	0.36	0.00	**0.86**	0.82	0.49	0.61	0.74	0.49
Gre	0.78	0.63	0.70	0.57	0.97	0.69	0.72	0.86	0.00	0.91	0.76	0.62	***0.49***	**1.03**
Ire	0.81	0.69	***0.63***	0.85	0.87	0.78	0.77	0.82	0.91	0.00	0.82	0.68	**0.99**	0.88
Ita	***0.43***	0.57	0.61	0.53	0.66	0.51	0.47	0.49	0.76	**0.82**	0.00	0.77	0.56	0.60
Net	0.64	***0.42***	0.51	0.58	0.71	0.46	0.46	0.61	0.62	0.68	**0.77**	0.00	0.64	0.69
Por	0.57	0.64	0.68	*0.50*	0.86	0.55	0.59	0.74	***0.49***	**0.99**	0.56	0.64	0.00	0.84
Swe	0.55	0.76	0.66	0.63	***0.42***	0.51	0.51	0.49	**1.03**	0.88	0.60	0.69	0.84	0.00

2.3 Evidence from the trade data

Trade data offers a view of the process at a more sectorally disaggregate level. With the data available it is possible to go to a very fine commodity disaggregation, and here we present results for 104 industrial sectors. However, care needs to be taken in interpreting these results, as trade flows are only an indirect measure of the underlying production changes that we are interested in. Rapid growth of trade flows (both inter and intra-industry) make it difficult to infer the underlying changes in production patterns from changes in the trade data alone.

Tables 2.4a and 2.4b are analogous to Table 2.1, but are based on export and import data respectively. Looking first at the export data, we see a dramatic decline in the difference between countries' export vectors between 1970/73 and 1980/83, this flattening out in the later periods. Like the production data, this suggests a qualitative change in the early 80s, although the growing dissimilarity of later years is largely absent in the export data. One reason for this may be that rapid growth in trade – particularly intra-industry trade – has tended to make trade vectors more similar. To control for this we separate out the change due to growth of trade in each industry from each country's 'differential change'. The final column of Table 2.4a gives the actual 1993/96 measure minus the measure if all countries had experienced the same sectoral export growth rates. We see that this differential change measure reports growing dissimilarity for 8 of the 14 countries. In addition, the averages show increasing dissimilarity.

On the import side, the picture is similar, except that the growing similarity seems to last through to the late 80s, only being arrested (and possibly reversed) in the period 1988/91-93/96, in which seven of the fourteen countries experienced growing dissimilarity, and the means of the measures started to increase.

Table 2.4a: Krugman specialization index: Exports (4 year averages)

	70/73	80/83	88/91	93/96	93/96 - 80/83	93/96 - PROJ
Austria	0.557	0.503	0.514	0.496	-0.007	-0.004
Belgium	0.618	0.620	0.639	0.605	-0.015	0.019
Denmark	0.710	0.648	0.675	0.694	0.046	0.065
Spain	0.771	0.568	0.529	0.556	-0.012	0.010
Finland	0.294	0.259	0.276	0.267	0.008	0.019
France	1.140	0.984	0.932	0.951	-0.033	-0.048
G. Britain	0.294	0.259	0.276	0.267	0.008	0.019
Germany	0.403	0.347	0.339	0.345	-0.002	0.014
Greece	1.270	1.220	1.310	1.150	-0.063	-0.043
Ireland	0.828	0.797	0.948	1.080	0.280	0.280
Italy	0.466	0.590	0.619	0.642	0.052	0.076
Netherlands	0.594	0.576	0.490	0.523	-0.052	-0.014
Portugal	1.08	0.992	0.986	0.920	-0.072	-0.028
Sweden	0.304	0.334	0.286	0.305	-0.029	-0.020
Average	0.666	0.621	0.630	0.629	0.008	0.024
Weighted ave.	0.561	0.522	0.514	0.521	0.00	0.014

Table 2.4b: Krugman specialization index: Imports (4 year averages)

	70/73	80/83	88/91	93/96	93/96 - 80/83	93/96 - PROJ
Austria	0.386	0.330	0.255	0.290	-0.040	-0.008
Belgium	0.363	0.390	0.346	0.357	-0.032	-0.012
Denmark	0.291	0.369	0.318	0.297	-0.072	-0.036
Spain	0.565	0.448	0.255	0.259	-0.190	-0.170
Finland	0.249	0.190	0.121	0.117	-0.073	-0.046
France	0.405	0.334	0.238	0.316	-0.018	0.026
G. Britain	0.249	0.190	0.121	0.117	-0.073	-0.046
Germany	0.304	0.270	0.212	0.201	-0.069	-0.048
Greece	0.614	0.609	0.436	0.398	-0.210	-0.130
Ireland	0.379	0.389	0.376	0.504	0.120	0.130
Italy	0.347	0.352	0.325	0.296	-0.056	-0.035
Netherlands	0.297	0.269	0.246	0.258	-0.011	0.019
Portugal	0.454	0.487	0.419	0.342	-0.140	-0.140
Sweden	0.296	0.289	0.242	0.267	-0.022	0.013
Average	0.371	0.351	0.279	0.287	-0.064	-0.034
Weighted ave.	0.334	0.301	0.238	0.249	-0.053	-0.024

What do these changes in trade patterns really tell us about the underlying changes in production patterns? First, it appears that we have a fairly robust finding of decreasing specialization in the 1970s. Further, the results for exports and imports suggest that our results for production data would most likely carry over to a more disaggregated classification. From 1980 on, the data present a more mixed picture, with growing specialization in production patterns not reflected in changing patterns of trade. Although it is possible that the disaggregate production structure is becoming more similar even while the aggregate production structure diverges, it is more likely that the trade results do not accurately reflect underlying changing production patterns. The main reason for this is the growing volume of intra-industry trade (widely documented, eg CEPII 1997), which will tend to make countries' trade vectors more similar. European integration, and the corresponding trade liberalisation, has – as trade theory would predict – vastly increased trade flows between European economies. To the extent that this is growth of intra-industry trade, it could have occurred without any changes in production patterns. Increasing integration also allows countries to specialize along (say) comparative advantage lines, changing production patterns as well as increasing trade volumes. If the former effect dominates, trade vectors will become more similar, even if production structures are unchanged or diverging. It seems likely therefore that changes in trade flows are not an accurate way of measuring changes in production patterns. Since we are primarily interested in the latter, trade data are at best an imperfect, and perhaps a misleading source of information.

2.4 What is the industrial specialization of countries?

In the previous two sections we have compared the industrial structures of countries, and considered whether or not countries are becoming more or less different, and more or less specialized. We would also like to know in what sort of industries countries are specializing.

We address this, not by listing the industries that have moved to and from different countries, but instead by identifying key characteristics of industries and seeing how the characteristics embodied in each country's industrial structure have changed. This allows us to consider whether, say, France has come to have more industries that are, on average, highly capital intensive?

Formally, we have a set of industry characteristics, $\{z^k\}$, which are listed in Box 2.2. These are unchanging over time, and details of these characteristics are given in Appendix A2.[10] We compute, for each country, the average score on each characteristic, where each industry characteristic is weighted by the share of that industry in the country's production. Thus, for each characteristic, we define the Industry Characteristic Bias (ICB) of country *i* as

$$ICB_i(t) \equiv \sum_k v_i^k(t) z^k \qquad (4)$$

Figures 2.2 - 2.4 report these ICBs for selected characteristics, and illustrate how they have evolved over time. Each figure has a panel for each country (all drawn to the same scale), and the right- and left-hand edges of each panel give the 1980/83 and 1994/97 values respectively.

Box 2.2: Industry Characteristics

Economies of scale	– Measures of minimum efficient scale (MES)
Technology level	– High, Medium, Low, (OECD classification)
R&D intensity	– R&D expenditures as share of value added
Capital intensity	– Capital stock per employee (K/L)
Share of labour	– Share of labour compensation in value added
Skill intensity	– Share of non manual workers in workforce (S/L)
Higher skills intensity	– Share of higher educated workers in workforce
Agricultural input intensity	– Use of primary inputs as share of value of production
Intermediates intensity	– Total use of intermediates as share of value of production
Intra-industry linkages	– Use of intermediates from own sector as share of value of production
Inter-industry linkages	– Use of intermediates from other sectors as share of value of production.
Final demand bias	– Percentage of sales to domestic consumers and exports
Sales to industry	– Percentage of sales to domestic industry as intermediates and capital goods
Industrial growth	– Growth in value of production between 1970 and 1994

A full description of the data and sources is given in Appendix A2.

The first figure, Figure 2.2, gives each country's ICB for technology levels and increasing returns to scale. As is apparent, the lines tend to move together, and we see some countries experiencing dramatic change, and others not. France, Britain and Germany are all countries with, on average, high technology and high returns to scale industry, but a slight decline in scores (in contrast to Sweden). Finland and Ireland are the two countries for which the composition of industry has changed the most in favour of high technology and increasing returns to scale industries. In contrast, Greece and Portugal started low and have declined somewhat.[11]

Figure 2.3 reports the ICBs for factor intensities. Looking first at capital-labor ratios, we see high (and continuing high) levels in Finland and the Netherlands, and moderate levels increasing significantly in Greece and Portugal. Declines occurred in Ireland, Denmark and Germany – the last of these, curiously, from a low initial level. The industrial composition of the Netherlands, France and Britain, and then Austria, Germany and Sweden supports a high share of non-manual employees, while this is lowest in Portugal and Greece. For employees with higher education, the Netherlands is top, followed by France, Britain and Germany, with Portugal and Greece again the lowest. The dramatic change in Ireland is of course the most outstanding feature.

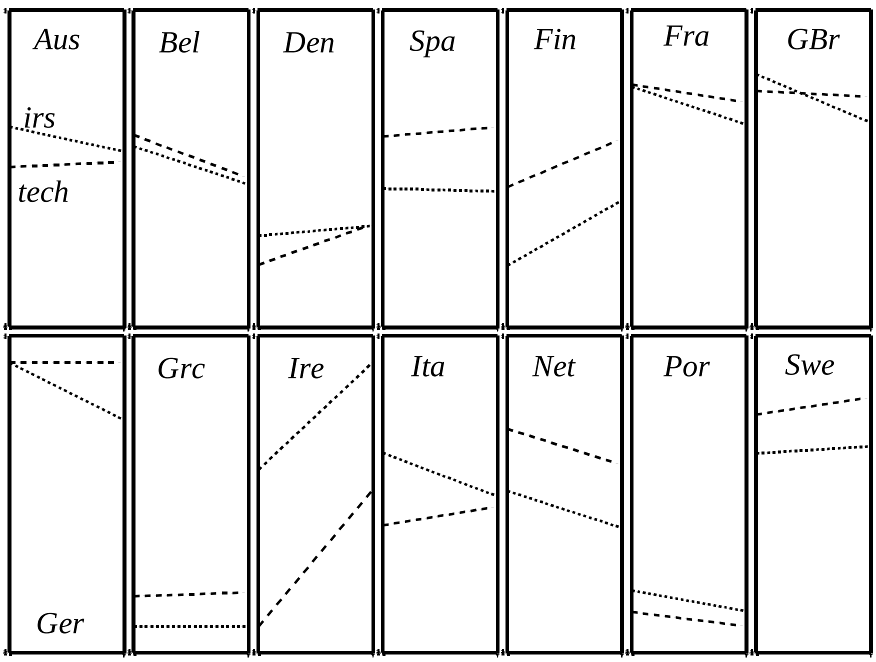

Figure 2.2: Industry characteristic bias of countries:
------- *Increasing returns* .... *Technology*

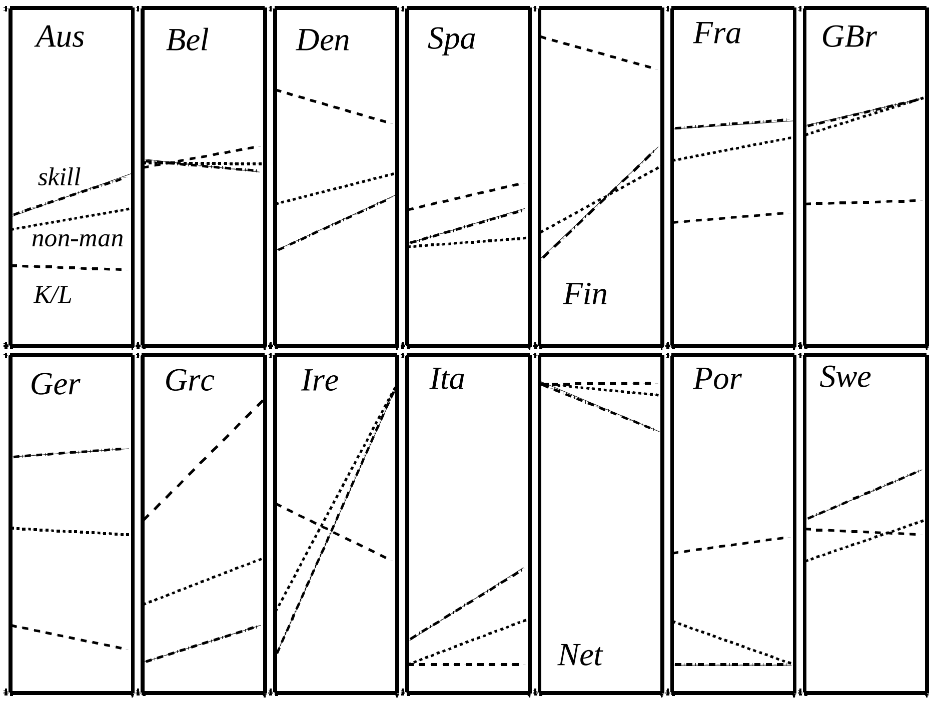

Figure 2.3: Industry characteristic bias of countries:

Capital/labour Non-manual Higher skill

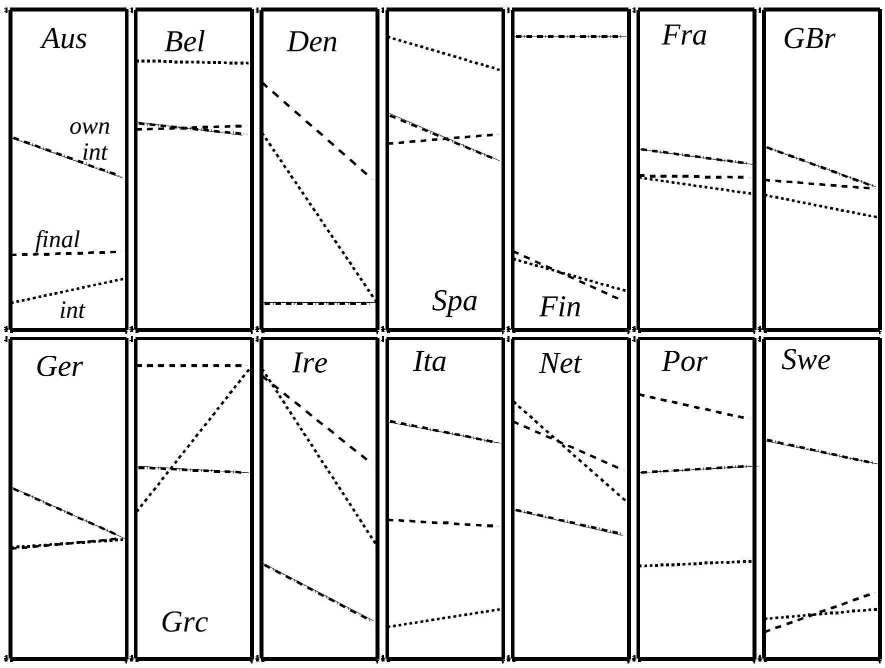

Figure 2.4: Industry characteristic bias of countries:

Final demand bias Share of intermediates Share of own intermediate

The characteristics reported in Figure 2.4 are intermediate goods usage and functional destination of industry output. Final demand bias (measuring the final consumer orientation of the industry) is highest in Greece and Portugal, and originally high but falling fast in Ireland and Denmark. Spain and Belgium (and increasingly Greece) have industries with a high intermediate goods input, while Finland and Italy have industries with a high share of intermediates from their own sector.

In table 2.5 the Industry characteristic bias of the EU countries are summarised for 1994/97. The selected characteristics are the same as those used in Figures 2.2-2.5: final demand bias (FINAL), total use of intermediates (INTM), use of intermediates from own sector (INTRA), economies of scale (IRS), technology level (TECH), share of non-manual workers in workforce (S/L), capital-labour ratio (K/L), share of higher educated in workforce. H (high) indicates that a country ranks among the five countries with highest ICB scores, M (medium) indicates a rank among the four countries with medium ICB scores, while L (low) denotes a rank among the five countries with lowest scores.

We see that the industrial structures of France, Germany and Great Britain are characterised by high returns to scale, high technology, and a relatively high educated workforce. This is distinctly different from Greece and Portugal, which are biased towards industries with low returns to scale, low technology and a workforce with relatively little education, that have a high final demand bias and a low share of non-manual workers.

A comparison of the ICBs for Spain, Portugal and Greece reveals that Portugal's and Greece's industrial compositions are significantly more similar to each other than they are to that of Spain. This is in line with the findings on greater bilateral similarity between Greece and Portugal than between Spain and each of these countries (cf. section 2.2): on average, Spain has industry with higher returns to scale and higher technology than Portugal and Greece.

Table 2.5: Industry characteristic bias 1994/97

	FINAL	INTM	INTRA	IRS	TECH	S/L	K/L	HS
Austria	L	L	M	M	M	L	L	M
Belgium	H	H	H	L	M	H	H	M
Denmark	M	L	L	L	L	M	H	L
Spain	H	H	M	H	M	L	M	L
Finland	L	L	H	M	L	M	H	M
France	M	H	M	H	H	H	L	H
Great Britain	M	M	L	H	H	H	M	H
Germany	L	M	L	H	H	M	L	H
Greece	H	H	M	L	L	L	H	L
Ireland	H	M	L	M	H	H	L	H
Italy	L	L	H	L	M	L	L	L
Netherlands	M	H	L	M	L	H	H	H
Portugal	H	M	H	L	L	L	M	L
Sweden	L	L	H	H	H	M	M	M

2.5 Country analysis: conclusions

The evidence presented in this section supports the idea that a quantitative change in the behaviour of EU countries' relative industrial structures occurred around 1980. A process of growing similarity was replaced by slowly increasing dissimilarity and industrial specialization. The process affected almost all countries, relative to the rest of the EU as a whole and relative to other countries individually.

Inspection of the industry characteristics of each country indicates significant cross-country differences, broadly along the lines that would be expected. Some dramatic changes stand out (notably for Ireland and Finland), while for other countries (France, the UK and Germany) the changes are much less significant. In Section 4 we undertake a formal econometric analysis linking the characteristics of industries to the characteristics of countries in order to understand better the forces driving these changes.

3. The location and concentration of industries

In the previous section we looked at patterns of national specialization in Europe, outlining the changes in individual country industrial structures and the extent to which these structures are diverging. We now switch the focus from countries to industries and ask: How is the location of different industries evolving? Which industries are becoming more or less spatially concentrated, and where are they concentrating?

3.1 How concentrated are manufacturing industries?

Table 3.1 shows the structure of the European manufacturing sector as a whole. In the beginning of the 1970s, 63% of all EU manufacturing was located in the UK, France and Germany (countries accounting for around 52% of Europe's population). Over the last three decades, this share has fallen, reaching 58.7% in 1994/97. Southern European countries (Italy, Greece, Portugal and Spain) raised their share gradually, from 19.9% in the early 70's to 24.6% in 1994/97 (compared to a population share of 32%). The smaller countries -- Austria, Finland and Ireland -- have also seen a steady increase in their share of European manufacturing, from 3.8% in the early 70s to 5.3% in 1994/97.

Has the concentration of manufacturing as a whole increased or decreased? To measure the degree of concentration, we report the Gini coefficient of concentration in the bottom row of the table (the Gini coefficient of the variable $s_i^k(t)$ for k = all manufacturing).[12] If all countries have the same amount of manufacturing this measure is zero; if all manufacturing is in a single economy it would take value 1.[13] We see that according to this measure there has been a small decrease in concentration of the overall manufacturing sector.

Table 3.1: Regional structure of European manufacturing
($s_i^k(t)$, k = all manufacturing)

	70/73	82/85	88/91	94/97
Austria	2.1 %	2.4 %	2.5 %	2.4 %
Belgium	3.9 %	3.3 %	3.4 %	3.8 %
Denmark	1.4 %	1.4 %	1.3 %	1.6 %
Spain	5.8 %	6.3 %	6.3 %	6.5 %
Finland	1.3 %	1.8 %	1.8 %	1.7 %
France	16.9 %	16.4 %	15.6 %	15.1 %
UK	16.9 %	15.5 %	14.3 %	13.9 %
Germany	29.4 %	27.7 %	28.8 %	30.0 %
Greece	0.7 %	1.0 %	0.7 %	0.7 %
Ireland	0.4 %	0.7 %	0.7 %	1.2 %
Italy	12.5 %	14.5 %	16.4 %	14.5 %
Netherlands	4.3 %	4.3 %	3.9 %	4.3 %
Portugal	0.9 %	1.2 %	1.2 %	1.4 %
Sweden	3.6 %	3.3 %	3.2 %	3.1 %
	100.0 %	100.0 %	100.0 %	100.0 %
UK+GER+FRA	63.2 %	59.6 %	58.7 %	59.0 %
ESP+ITA+GRC+PRT	19.9 %	23.0 %	24.6 %	23.1 %
Gini coefficient	0.576	0.549	0.56	0.549

What about individual industries? Table 1 in Appendix A4 reports the Gini coefficient of concentration by industry for selected time periods. The pattern of change is summarized in Table 3.2. We see a majority of industries experiencing decreasing concentration during the 1970s and early 1980s followed by a majority showing increasing concentration in the later 1980s. During the 1990s the performance is more evenly balanced, although a majority became slightly less concentrated.

Table 3.2: Change in sectoral Gini coefficients of concentration

	Number of industries (average change)	
Period	Gini increase	Gini decrease
1970/73-82/85	11 industries (5.6%)	25 industries (-5.0%)
1982/85-88/91	23 industries (2.5%)	13 industries (-3.0%)
1988/91-94/97	15 industries (2.9%)	21 industries (-3.4%)

Is there any clear evidence here of increasing or decreasing average concentration? A number of authors have found increasing average concentration of EU manufacturing in the 1980s (Brülhart (1998) and WIFO (1999)). We find that the (unweighted) average of the industry gini coefficients decreases slightly from 1970/73 to 1982/85, followed by a slight increase in concentration through to the early 90s and reverse thereafter (see the 'average' line on Figure 3.1). However, these changes in the average are minuscule, and little weight should be attached to them.

How do we reconcile this with the changes in national specialization observed in section 2?

First, as emphasized by WIFO (1999), the combination of both increased specialization and constant or declining concentration is not necessarily a paradox; the two trends can indeed be reconciled as the EU member states are not equal sized, nor are the industries[14]. Second, the experience of industries is much more heterogeneous than the experience of countries. Increasing average specialization from the early 1980s (Table 2.1) reflects the experience of (almost) all countries. But, as is clear from Table 3.2, the experience of industries is much more mixed, and attempts to produce an average measure of concentration correspondingly less useful.

Since some industries are clearly concentrating and others dispersing, we look industry by industry, and ask which industries have become more or less concentrated. To answer this we divide the 36 manufacturing sectors into 5 groups according to the following criteria: first we took the twelve most concentrated industries in 1970/73; then we divided this group between those that were still among the twelve most concentrated in 1994/97, and those that had left the top 12. Similarly, we took the 12 least concentrated industries in 1970/73 and divided them into those which remained among the 12 least concentrated in 1994/97, and those which had left this group. Industries that meet none of these criteria form a residual group. Table 3.3 lists the industries that form each group, and Figure 3.1 plots the Gini coefficients for the first four of these groups, together with the average over all 36 industries. The differences in the behavior of the selected groups is clear, and we now look at each of them in detail.

Table 3.3: Industries grouped by levels and changes in concentration.

Concentrated industries that have remained concentrated over time; (CC)	*Concentrated industries that have become less concentrated; (CD),*
Motor Vehicles Motor Cycles Aircraft Electrical Apparatus Chemical Products NEC Petroleum & Coal Products	Beverages Tobacco Office & Computing Machinery Machinery & Equipment Radio-TV & Communication Professional Instruments
Dispersed industries that have become more concentrated over time; (DC)	*Dispersed industries that have stayed dispersed; (DD)*
Textiles Wearing Apparel Leather & Products Furniture Transport Equipment NEC	Food Wood Products Paper & Products Printing & Publishing Metal Products Non-Metallic Minerals NEC Shipbuilding
Residual group (R).	
Footwear Industrial Chemicals Drugs & Medicines Petroleum Refineries Rubber Products Plastic Products	Pottery & China Glass & Products Iron & Steel Non-Ferrous Metals Railroad Equipment Other Manufacturing

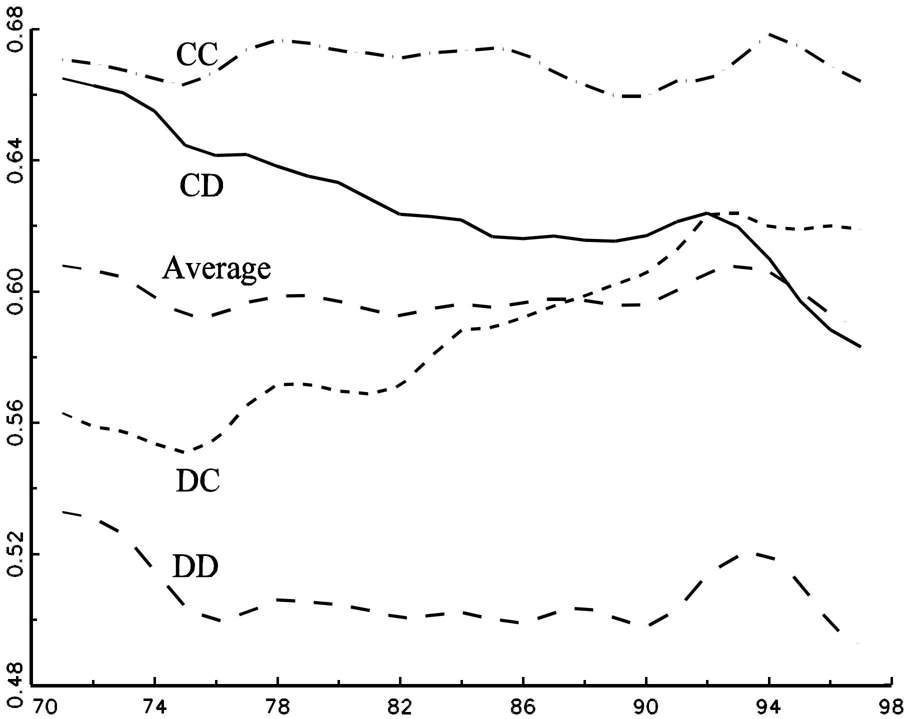

Figure 3.1: Industry Gini coefficients: Industries grouped by performance. (2 year moving average)

(CC) Concentrated industries

The six industries in this group, Motor Vehicles, Motorcycles, Aircraft, Electrical Apparatus, Chemicals NEC and Petroleum & Coal Products were among the most concentrated industries in 1970/73 and have remained so through to 1994/97. There are, however, some differences within the group. Thus, while Motor Vehicles, Motorcycles and Petroleum & Coal Products experienced a slight increase in concentration after 1991, Aircraft, Electrical Apparatus and Chemicals have recently become slightly more dispersed.

The increased concentration observed in the Motor Vehicles and Motorcycles sectors reflects the fact that Germany has reinforced its position in both industries at the expense of both France and the UK. Although the overall pattern for the industry is dominated by this increased concentration in Germany, this is slightly offset by the increases in shares of production occurring in Portugal, Austria, and Spain. For Aircraft, Germany, the UK and France remain the dominant countries with a 78% share of EU Aircraft production in 1997. The UK and Sweden experienced tiny decreases in their share, while Belgium, France and Spain reported small increases.

Austria and Italy increased their share in Electrical Apparatus, but apart from this there was little relocation. Looking at the Petroleum & Coal industry, the most noticeable fact is that the UK's position has declined strongly, although not enough to make a significant impact on the figures for geographical concentration. In Chemicals NEC, the UK, Germany and France remain dominant despite Spain and Ireland capturing around 6% of the industry.

(CD) Concentrated & Dispersing industries

There is also a group of industries that were initially very concentrated, but which have become more dispersed over time. This group comprises Office & Computing Machinery, Machinery & Equipment, Radio-TV & Communication Equipment, Professional Instruments, Beverages and Tobacco.

In Office & Computing and in Radio-TV & Communication Equipment the major decline in geographical concentration is observed between 1991 and 1997. The increased geographical dispersion is primarily driven by decreasing German dominance and reinforced by shrinking shares in the UK and France. In Office & Computing, Machinery & Equipment, Radio-TV & Communication Equipment and in Professional Instruments, between 7% and 17% of the EU production left Germany, France and the UK. Countries that strengthened their positions in some, or all, of these industries, were small countries such as Austria, Finland, Ireland and Sweden; and also the Southern European countries Italy, Portugal, and Spain. Most astonishing is perhaps the Irish performance: Ireland increased its share of EU production in all four industries. Also noteworthy is Finland, which increased its share in all except Professional Instruments.

For Beverages and Tobacco the patterns of relocation we observe are similar to those above, but relocation takes place between a slightly different set of countries. Germany and the UK loose, while Spain, Austria and the Netherlands gain.

(DC) Dispersed & Concentrating Industries

Textiles, Wearing Apparel, Leather & Products, Furniture and Transport Equipment form the third group of industries. In 1970/73 they were all among the most dispersed industries in Europe, but have become increasingly geographically concentrated up till 1994/97. Most of the increase took place prior to 1991. The first three industries are those where European integration appears to have allowed the Southern European countries to exploit their comparative advantage.

France, Germany and the UK experienced reduced shares in Textiles, Wearing Apparel and Leather & Products, while the Southern European countries showed growing shares. The same patterns of relocation applied to Furniture, but the extent of the shift was much smaller. The Southern performance was however, surprisingly non-uniform. Italy reinforced its position in each of the four industries; particularly in Leather & Products, where it increased its share of EU production from 22% to 48%. This is also the industry that exhibits the largest rise in concentration. Spain got a slightly higher share of EU production in Textiles and Wearing Apparel, although it experienced a decline in its share of Leather & Products. Portugal increased its shares in all four industries. Greece also obtained a slightly higher share of EU textiles production, but decreased its shares in Wearing apparel and Leather & Products.

Transport Equipment NEC exhibits a clear increase in geographical concentration over time. But, in contrast to the other DC sectors, this did not reflect North-South movements. Instead, we see that Germany increased its share by 10% points, while the UK and Spain experienced a combined decrease of 7% points.

(DD) Dispersed industries

Food Products, Wood Products, Paper & Products, Printing & Publishing, Non-Metallic Minerals

NEC, Metal Products, and Shipbuilding were initially among the 12 least concentrated EU manufacturing industries, and have remained so throughout the 1980s and 90s. These are industries with production spread out in the North, as well as the South, of the EU. One possible explanation for the continued dispersion of such activities is national differences in tastes (food), culture, non-tariff barriers (food), as well as national industrial policies (shipbuilding)

(R) The residual
The residual group contains the industries that were the 12 medium concentrated industries in 1970. A number of these industries, like Railroad Equipment, Glass & Products, Iron & Steel and Plastic Products have remained in this medium concentrated group up till 1997. However, there are also industries that have experienced rather significant changes in the degree of geographical concentration. Drugs & Medicines and Industrial Chemicals are industries that had around average concentration in 1970/73, but had moved down to the group of the 12 least concentrated industries in 1994/97. While Drugs & Medicines experienced the most significant decline in concentration before 1990, in Industrial Chemicals the main decline happened after 1990. 12% of Drugs & Medicines production moved out of Germany and Italy and this production was primarily absorbed by Denmark, the UK, Ireland and Sweden. 10% of Industrial Chemicals left France, Germany and the UK – while Belgium, Ireland and Italy gained shares in the industry.

Footwear is an interesting example of a medium concentrated industry showing the opposite trend, where relocation has lead to a large increase in concentration. In this sector, the three major manufacturing economies showed declining shares, while Italy reinforced its position from 29% to 46%, and Portugal also gained a considerably larger share.

3.2 Characteristics of concentrated and dispersed industries

We would like to identify the characteristics of industries associated with the different concentration patterns that we have discussed in detail above. To do this, we show, in Table 3.4, how the five groups of industries differ in some of the industry characteristics listed in Box 2.2. For each industry characteristic, H (High) indicates an industry ranked among the top 12, M (Medium) indicates an industry ranked among the middle 12, and L (Low) indicates an industry ranked among the bottom 12. The following industry characteristics are included in the table: Economies of Scale (IRS), technology level (TECH), Intra-industry linkages (INTRA), Inter-industry linkages (INTER), Capital intensity (K/L), Skill intensity (S/L), Industrial growth (Δ), Final demand bias (Final), and use of agricultural inputs (AGRI).

Table 3.4 Industry Characteristics

		IRS	TECH	INTRA	INTER	K/L	S/L	Δ	FINAL	AGRI
CC	Motor Vehicles	H	M	H	M	M	L	L	H	L
CC	Motorcycles	H	M	L	H	M	L	L	L	L
CC	Aircraft	H	H	H	L	M	H	M	H	L
CC	Chemicals nec	H	M	H	L	H	H	H	M	M
CC	Electric Apparatus	M	H	M	M	L	M	H	M	M
CC	Petro & Coal Products	H	L	L	H	H	H	M	H	L
CD	Beverages	L	L	M	H	H	H	M	H	H
CD	Tobacco	L	L	M	H	H	M	L	H	H
CD	Office & Computing	M	H	M	H	L	H	H	L	L
CD	Machinery & Equipment	M	M	M	M	M	H	M	L	M
CD	Radio,TV& Com.	M	H	M	L	L	H	H	M	L
CD	Professional instruments	M	H	L	M	L	H	H	M	M
DC	Textiles	L	L	H	L	M	L	L	H	H
DC	Wearing Apparel	L	L	H	L	M	L	L	H	H
DC	Leather & Products	L	L	H	L	M	L	L	H	H
DC	Furniture	L	L	M	M	L	L	M	M	H
DC	Transport Equipment	H	M	L	H	M	M	L	L	L
DD	Food	L	L	M	H	H	M	M	H	H
DD	Wood Products	L	L	M	M	L	L	M	M	H
DD	Paper & Products	M	L	H	L	H	M	M	L	M
DD	Printing & Publishing	M	L	H	L	H	H	H	L	H
DD	Non-Metallic Minerals	M	L	M	M	L	M	M	L	M
DD	Metal Products	M	L	M	M	M	L	H	L	L
DD	Shipbuilding	H	L	L	H	M	L	L	M	M
R	Footwear	L	L	H	L	M	L	L	H	H
R	Industrial Chemicals	H	M	H	L	H	H	M	M	M
R	Drugs & Medicines	H	H	L	H	H	H	H	H	M
R	Petro Refineries	H	L	L	M	H	H	H	H	L
R	Rubber Products	L	M	L	H	L	M	L	M	H
R	Plastic Products	L	M	L	H	L	M	H	M	H
R	Pottery	M	L	L	M	L	M	M	L	M
R	Glass & Products	M	L	M	M	L	L	H	L	M
R	Iron & Steel	M	L	H	L	H	M	L	L	L
R	Non-Ferrous Metals	H	M	H	L	H	M	M	M	L
R	Railroad Equipment	H	M	L	H	M	M	L	L	L
R	Other Manufacturing	L	M	L	M	L	L	H	M	M
Beta coefficient Gini70/73		.004*	.039*	-0.08	0.102	0	.161*	0.048	-0.02	-0.05
Beta coefficient Gini94/97		0	0.019	0.03	-0.06	0	-0.03	-0.04	0	-0.256

Note: * = significant at 5% level.

Table 3.4 shows that geographically concentrated (CC) industries are typically high increasing returns, high/medium tech and have a high/medium final demand bias. Half the industries in the group use a high share of intermediates from their own sector, while most use little agricultural inputs. Most of the industries are capital intensive, and also relatively skill intensive.

What distinguishes the initially concentrated industries that have grown less concentrated over time (CD) from the former group? These CD industries tend to have lower increasing returns to scale, are less reliant on intra-industry linkages, but slightly more reliant on inter-industry linkages, have higher skill intensity, and less significant final demand bias. On average, the CD industries are also the industries that have shown the most rapid growth over the last three decades.

Turning to the initially dispersed industries that have concentrated over time (DC), we see that these are industries that are clearly different from those in the two previous groups. They are characterised by low increasing returns to scale, low tech, a high share of agricultural inputs, and low skill intensity. They are also industries that have grown relatively slowly.

The fourth group, the dispersed industries (DD), are more diverse. However, all seven industries in the group appear to be low tech and six use agricultural inputs intensively.

We can summarize the effect of these characteristics on industrial concentration by running some simple univariate regressions. The bottom two rows of Table 3.4 report the results from regressions of the Gini coefficients of concentration from 1970/73 and 1994/97 on each of the characteristics in turn. The fit is generally poor, and many of the industry characteristics are not significant in determining the extent of concentration. Studies that try to evaluate the forces driving location using summary indices as dependent variables, and industry characteristics as independent variables have encountered similar problems.[15] Mostly, these problems arise from two sources. First, the small number of data points (there are 36 observations; one for each industry). Second, the fact that theory is virtually silent on how different industry characteristics should affect summary measures of industrial concentration. Still, there are a few things that are worth noting. In the early seventies, industry gini coefficients are significantly correlated with industry increasing returns, technology level and skill intensity. By the mid-nineties, these factors appear to have become insignificant. This suggests that high IRS, high tech and skill intensive industries are, on average, not as concentrated as they once were, although, this is obviously not the case for the most concentrated industries.

The main drawback of these types of econometric exercise, is that they take as dependent variables summary measures of concentration, when in fact we have data on the complete distribution. In contrast, the econometric specification that we present in Section 4 uses information on the entire distribution.

3.3 What characterizes the countries where industries locate?

In the previous section, we considered whether particular industry characteristics were associated with particular levels of concentration. In this section, we ask an important related question: Are particular types of industries concentrated in particular types of countries? Box 3.1 gives a number of country characteristics, $\{ y_i \}$, including factor endowments, market potential and total industrial and regional aid, that we think may be important in helping us understand industrial location patterns.

Box 3.1: Country characteristics

Market potential	– Indicators of proximity to market, based on NUTS 2 incomes inversely weighted by distance.
Capital labour ratio	– Capital stock / total employment
Average manufacturing wage	– Labour compensation per employee in manufacturing
Relative wages	– Wages for non production / production workers
Researcher and Scientists	– Researchers per 10,000 labour force
Education	– % of population with at least secondary education
Agricultural production	– Agriculture share in GDP
Regional aid	– State aid classified as regional aid
Total state aid	– Total state aid

A full description of the data and sources is given in Appendix A2.

In Section 2.3, we computed the industry characteristic bias of each country, ICB_i, which summarized industrial characteristics for each country. Now, we want to compute a similar index, but one that summarises country characteristics for each industry. We do this as follows. For each industry, we compute the average of the characteristics of the countries in which the industry is located, weighting each country characteristic by the share of the industry's output located in that country. We call this the Country Characteristic Bias of industry *k*, and it is formally defined by:

$$CCB^{k}(t) \equiv \sum_i s_i^k(t) z_i \qquad (5)$$

Since there are thirty six industries we do not report results for each. Instead, we group them by technology (high, medium, low); returns to scale; capital/labour ratio; and by the 'convergence' pattern (the CC, CD etc groupings of section 3.1). We look at just three country characteristics: market potential, average manufacturing wage, and endowment of researchers and scientists.

Figure 3.2a shows how the market potential CCB varies across the different industry groupings. The vertical axis reports market potential which captures the 'centrality' of different countries, so high values correspond to the core and lower values to the periphery of the EU. Values are given for three dates, 1980/83, 1988/91, and 1994/97, represented on the horizontal axis. We see that industries that are high tech, high-medium returns to scale, and capital intensive tend to locate in the core. The CC and CD industries (industries that originally were most concentrated) were generally located in core countries, while the initially dispersed industries, DC and DD, had a bias towards more peripheral locations. Over time CC and CD industries have started to move out of the core; conversely, dispersed industries (DD and DC), have moved towards locations with higher market potential.

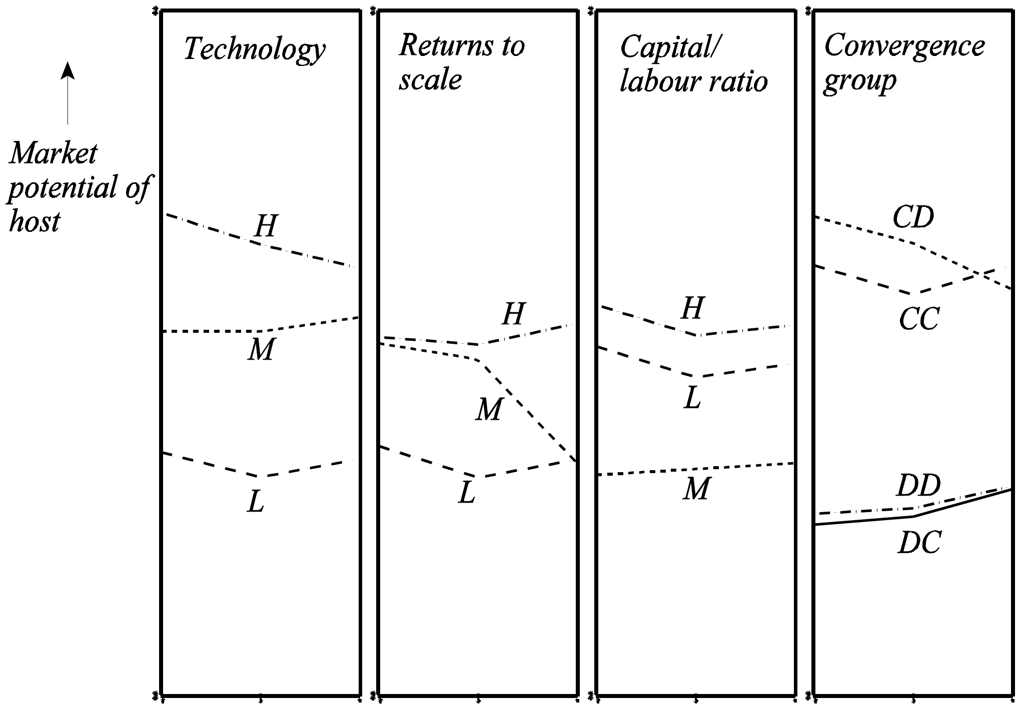

Figure 3.2a: Country characteristic bias of industries: Market potential: (industries grouped by technology, scale, K/L, convergence)

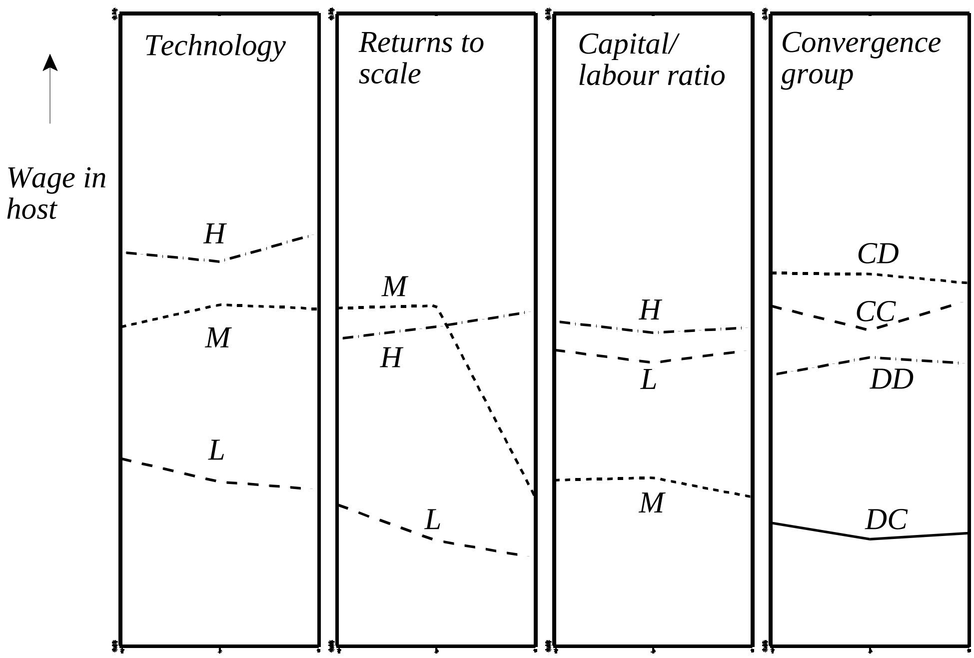

Figure 3.2b: Country characteristic bias of industries: Wage: (industries grouped by technology, scale, K/L, convergence)

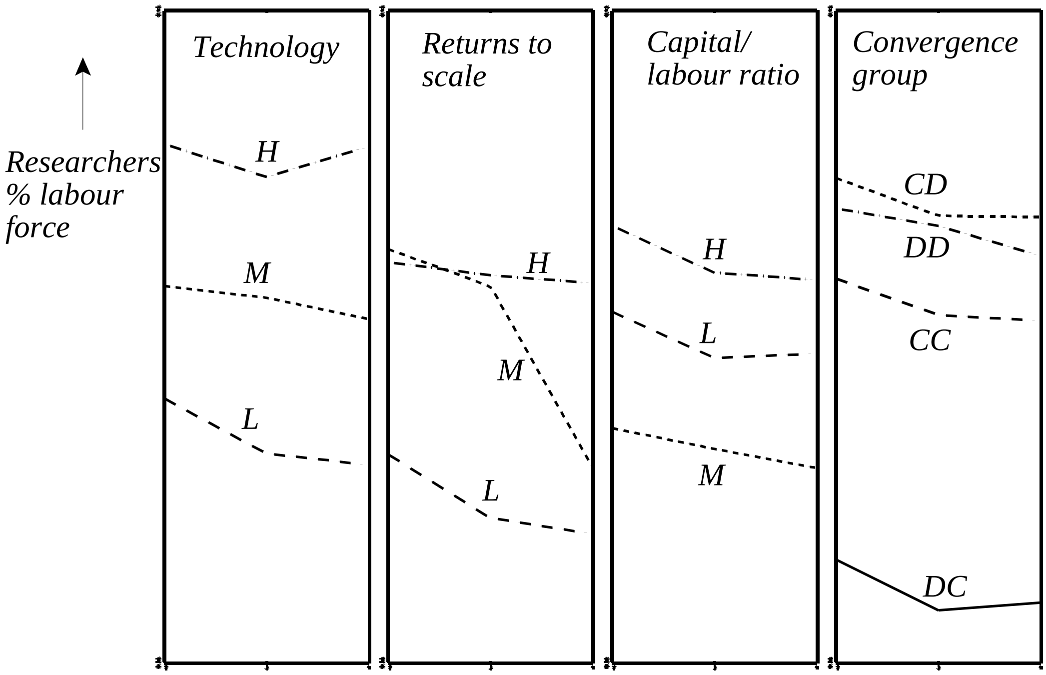

Figure 3.2c: Country characteristic bias of industries: High skills (industries grouped by technology, scale, K/L, convergence)

Figure 3.2b reports results for the wage CCB. Since wages are highly correlated with centrality, it is not surprising that this figure tells a similar story to the preceding one. The most noticeable difference between Figures 3.2a and 3.2b concerns the country bias of low and medium returns to scale industries. We see from Figure 3.2b that these industries are more biassed towards low wage economies than towards peripheral countries.

Figure 3.2c considers countries' endowments of researchers. Grouping industries by technology level yields what would be expected. Looking by convergence grouping, the most significant difference is that between the DC and DD groups, both composed predominantly of low tech sectors (table 3.4). Surprisingly, the DD industries are biassed towards researcher abundant locations. This is because some of the locations abundantly endowed with researchers also have common access to certain natural resources (cf. Wood and Paper products) and a long historical tradition for shipbuilding. Typical locations here are Northern European countries like Sweden, Finland, and the Netherlands.

Finally, notice that low and high capital/labour-ratio industries tend to be biassed towards similar locations, with high market potential, high wages and a large number of researchers. This illustrates the fact that in an integrated Europe with a high degree of capital mobility, capital intensity is not likely to be a driving force behind choice of location.

This sort of analysis has allowed us to understand some of the broad factors that may be driving location patterns. However, this partial analysis shows that multidimensional industry characteristics appear to interact with multidimensional country characteristics in determining the distribution of industries. What is clear, is that to disentangle the effects, we need to move beyond these partial correlations to a full multivariate econometric analysis. We will do this in Section 4. However, before proceeding to that analysis, we want to consider one other interesting dimension of changing EU location patterns.

3.4 Spatial separation

The concentration index employed so far provides information about the extent to which each industry is concentrated in a few countries, but does not tell us whether these countries are close together or far apart. Using this measure, two industries may appear equally geographically concentrated, while one is predominantly located in two neighbouring countries, and the other split between Finland and Portugal. Distinguishing such patterns will provide additional insights on the geography of individual industries, about cross industry differences and about the driving forces of economic geography.

Hence, as a complement to the traditional concentration indices, we propose an index of spatial separation, that can be thought of as a supra-national index of geographical location. We define the spatial separation of industry k, (SP^k) as follows:

$$SP^{k} \equiv C \sum_i \sum_j (s_i^k s_j^k \delta_{ij}) \tag{6}$$

where δ_{ij} is a measure of the distance between *i* and *j*, s_i^k is the share of industry k in location *i*, and C is a constant. For a given location i, $\sum_j (s_j^k \delta_{ij})$ is the average distance to other production in industry *k*. The first summation adds this over all locations *i*, weighted by their share in the industry, s_i^k. The interpretation of $\sum_i \sum_j (s_i^k s_j^k \delta_{ij})$ is therefore a production weighted sum of all the bilateral distances between locations. The measure is zero if all production occurs in a single place, and *increases* the more spatially separated is production.

In the appendix we provide a complete table of spatial separation indices for all industries in the four periods 1970/73, 1982/85, 1988/91, and 1994/97. (See Table 2 in Appendix A4). Figure 3.3 reports the time series for manufacturing as a whole and for selected industry groups (high technology industries, high returns to scale industries, and industries with high capital-labour ratios).

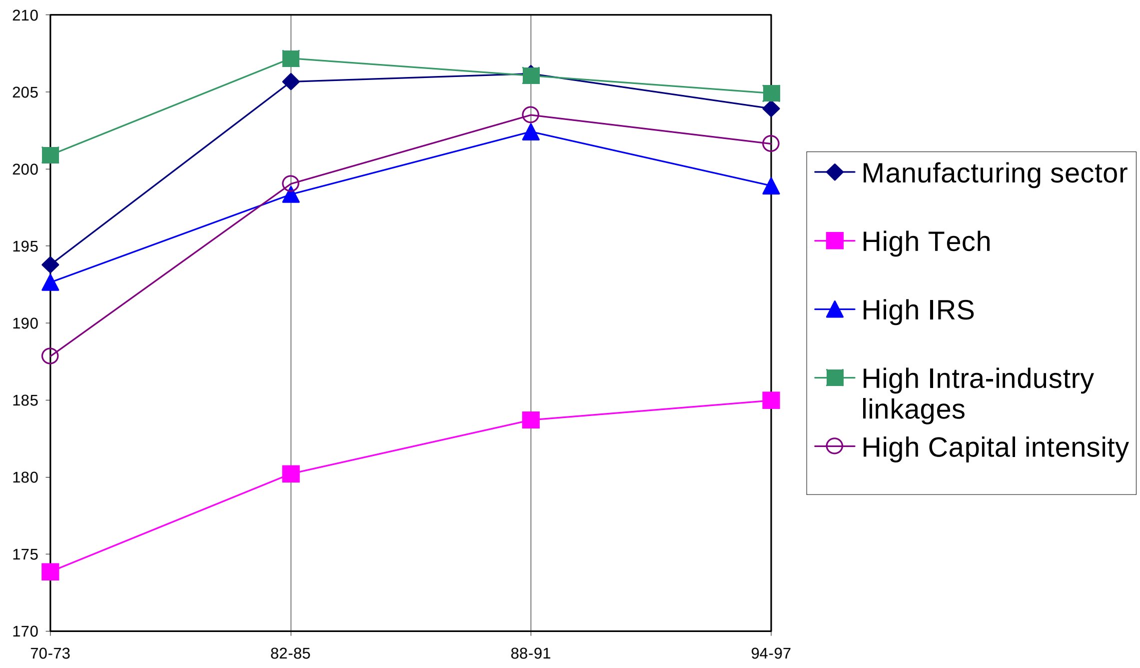

Figure 3.3: Spatial separation of manufacturing industries

For manufacturing activity as a whole, we find an inverse-U shape. There was a substantial increase in spatial separation between 1970/73 and 1982/85. The increase in separation then slowed down in the mid 80s before reversing in the 1990s.

There are two things to note about the spatial separation of overall manufacturing. First, the geographical separation in activity that took place during the 1970s was of far greater magnitude than the clustering that took place in the 1990s. Second, the reported changes in the spatial distribution of European manufacturing appears to be largely driven by developments in Southern Europe (and possibly Ireland). Comparing the changes of the Southern European countries' total share of EU manufacturing (see Table 3.1) with the changes in spatial separation of manufacturing, we see that EU manufacturing dispersed as Southern Europe experienced a significant increase in its manufacturing share (1970/73 - 1982/85). In the mid 1980s further increases in Southern European manufacturing appear to be reflected in continued increasing spatial separation of EU manufacturing. However, in the 1990s, this trend was reversed as Southern Europe's share in EU manufacturing declined slightly, which again increases the extent of spatial clustering.

The graph also shows that high technology industries are the least separated throughout the entire time period. However, they exhibit an ongoing increase in separation, consistent with the slight movement out of central regions that we saw in Figure 3.2a. Five out of the six high technology industries experienced movements out of the core at the same time as they became more separated. Thus, Drugs & Medicines, Office & Computing, Radio-TV & Communication, Electrical Apparatus NEC, and Professional Instruments moved out of the core and separated geographically. Aircraft is the exception, moving in to the core and becoming slightly less separated.

The five high tech industries that became increasingly spatially dispersed, are also industries that became less geographically concentrated (see Table 1, Appendix A4). The evidence on spatial separation of these sectors tells us that the decline in geographical concentration reported on the basis of Gini coefficients, is not only a story about the major EU countries trading shares, but about real geographical dispersion of economic activity.

High returns to scale and high capital intensity industries are initially more spatially separated than high tech industries, and exhibit a similar pattern to manufacturing as a whole – increasing separation in the 1970s and 1980s followed by increasing clustering in the last period. Thus, different groups of industries also show increasing dispersion of economic activity in Europe between 1970 and 1990 in line with the increasing spatial dispersion of aggregate manufacturing.

There is significant cross industry, and within-group variation in spatial separation. Overall, between 1970/73 and 1994/97, the general trend towards spatial dispersion is reflected in 29 out of 36 industries. In contrast, over the same period only 23 out of the 36 industries report declining Gini coefficients of concentration. Hence, moving beyond traditional measures of industrial concentration to an index that takes the relative location of countries into account, strengthens the impression of a spreading out of European manufacturing activity.

Finally, one may note that most industries for which we report declining Gini coefficients, are also found to be spatially separating, and vice versa. However, a couple of industries illustrate well, that this need not necessarily always be the case. Textiles, Wearing Apparel, Rubber Products, Motor vehicles, Motorcycles & Bicycles all became more concentrated between 1970/73 and 1994/97. But, during the same period, they also became more spatially separated. This suggests that these industries are witnessing a pattern of increasing concentration in a smaller number of countries at the same time as they see a break-up of trans-national clusters in central Europe.

3.5 Industry analysis: conclusions

Taking the economic geography of the EU as a whole, Section 3.4 shows that, on average industries became somewhat more dispersed until the late 1980s, although there is now some evidence of a reversal of this trend. The aggregate picture masks substantial changes in the location of individual industries. Dividing industries into groups according to their concentration, we see that of those industries that were initially concentrated, a group — largely consisting of high returns to scale industries — have remained concentrated; others, including some relatively high tech, high skill, fast growing industries, have become more dispersed. Of those industries that were initially dispersed, the slower growing and less skilled labour intensive ones have become concentrated in low wage and low skill abundant economies.

4. Econometric Analysis

In Sections 2 and 3 we drew out the broad trends of country specialisation and industry concentration, and offered descriptive material on the changing industrial characteristics of countries, and locational characteristics of industries. This descriptive material considered just one country/industry characteristic at a time. In reality, location and specialisation patterns are driven by multivariate interactions between industry and country characteristics. Countries differ across a number of dimensions. Some are relatively abundant in physical capital, some relatively human capital abundant; some are larger, some smaller; some are core locations - with easy access to many markets, others are peripheral. Industries also differ across a whole host of dimensions. They differ in their factor intensities; in the proportion of their output that is sold to final consumers as opposed to other producers; in their reliance on inputs from other producers; in the extent of their returns to scale. All of these different country and industry characteristics should interact to determine the pattern of location across the EU. In this section we evaluate which of these interactions are most important in driving the observed location patterns.

4.1 Hypotheses and econometric specification

Hypotheses about the location of production all take the form of interaction between an industry characteristic and a country characteristic. To see why it is the *interaction* of these characteristics that is important, it is simplest to take a specific example. Thus, for example, if countries vary in their endowment of scientists, all industries might want to locate where scientists are more plentiful. However, in equilibrium, all industries cannot be in the same place, so it is industries that most value scientists that will produce where scientists are most plentiful, while industries in which scientists are less valued will be under-represented in such locations.[16] This will be true more generally. Industries that are particularly intensive in any given 'factor' will be drawn to countries that are relatively abundant in that 'factor'. This means that, if we want to understand the forces driving industrial location patterns, we must consider the interaction of industry characteristics (listed in box 2.2) with the appropriate country characteristics (drawn from box 3.1) when seeking to explain those patterns.

Theory tells us which country characteristics should be interacted with which industry characteristics. Our initial econometric specifications included a large number of interaction variables. However, for the results we present here, we focus on just four country characteristics and six industry characteristics, giving the six interactions listed in Table 4.1. Two facts drive our choice of these particular interactions. First, they are emphasised by theory. Second, they all have a significant effect at some point in the time period that we are considering. Other variables were tried, including some policy variables, but the results were inconclusive. We return to these issues in our discussion of results.

Table 4.1: Interaction variables

	Country Characteristic	Industry Characteristic
j = 1	Market Potential	Sales to industry, % of output
j = 2	Market Potential	Intermediate goods, % of total costs
j = 3	Market Potential	Economies of scale
j = 4	Agricultural production % GDP	Agricultural input, % of total costs
j = 5	Secondary and higher education % pop	Non-manual workers relative to manual
j = 6	Researchers and Scientists % labour force	R&D share in value added

We first briefly consider the interaction variables. The last three pairs of variables are factor abundance and factor intensity measures. Theory dictates the obvious pairing of each quantity measure of factor abundance with a measure of the share of that factor in each industry. Since we are focussing only on the structure of manufacturing, we take agricultural production as an exogenous measure of 'agriculture abundance' (rather than going back to an underlying endowment such as land). The education variable (characteristic *j=5*) is interacted with the ratio of non-manual workers to manual workers, times the labour-share in the sector; this captures the skilled labour intensity of the sector. We do not have a separate interaction for capital endowments and intensities, because of the high degree of capital mobility within the EU.

The first three pairs of variables are interactions suggested by some of the work on new economic geography. Market potential measures the centrality of each location, and the three corresponding industry characteristics capture the following arguments. In reverse order, interaction between market potential and economies of scale (*j* = 3) captures the idea that industries with higher economies of scale (and perhaps also, therefore, less intense competition) may tend to concentrate in relatively central locations. Interaction between market potential and the share of intermediates in costs (*j* = 2) captures a forwards linkage; we hypothesise that firms which are highly dependent on intermediate goods will tend to locate close to other producers, i.e. in regions of high market potential. Finally, (*j* = 1), the interaction between market potential and the share of sales going to industrial users captures a backwards linkage; firms will want to be near their customers to minimise transport costs on final sales. We focus on industrial customers by taking the share of output going to industrial users although, a priori, the sign of this interaction is not clear; it depends on the importance of proximity to industrial customers relative to proximity to final consumers.

While this gives the forces that we believe are important in determining industrial location, the specific form of an estimating equation remains to be resolved. The first point is that our data requires that we estimate a single relationship over all industries and countries. Estimating industry by industry is ruled out, since there are only 14 country observations; we cannot increase the number of observations by pooling across time, because we believe that increasing EU integration has changed the importance of different country characteristics over time (a belief that is confirmed by our empirical results). The second point is that, when it comes to estimating such a relationship for a general trade model (as opposed to one that tests a particular theory, such as Heckscher-Ohlin), the literature gives essentially no guidance on how to proceed. Unfortunately, it is just such a general trade model, incorporating both comparative advantage and new economic geography effects, that we believe is driving location patterns across the European Union.[17]

To resolve this specification issue, we constructed a very general simulation model which nests within it both factor abundance and new economic geography models, and simulated the way in which interactions between the variables listed in box 4.1 determined the pattern of industrial location. We then used the simulation output to inform our choice of functional form for estimation, and settled on the following specification:

$$\ln(s_i^k) = \alpha \ln(pop_i) + \beta \ln(man_i) + \sum_j \beta[j] \left(y[j]_i - \gamma[j]\right)\left(z[j]^k - \kappa[j]\right)$$

where s_i^k is the share of industry k in country i, (as defined in section 1); pop_i is the share of EU population living in country i; man_i is the share of total EU manufacturing located in country i; $y[j]_i$ is the level of the jth country characteristic in country i; $z[j]^k$ is the industry k value of the industry characteristic paired with country characteristic j (see Table 4.1). Finally, α, β, $\beta[j]$, $\gamma[j]$ and $\kappa[j]$, are coefficients.

Before presenting the results we give the intuition behind this particular functional form. The first two variables capture country size effects; all else equal, we would expect larger countries to have a larger industrial share in any given industry. The remaining terms in the summation capture the interaction of country and industry characteristics. To understand the specification, it is easiest to think about one particular characteristic, say j = R&D, so $z[R\&D]^k$ is then the R&D intensity of industry k and $y[R\&D]_i$ is the R&D abundance of country i. The specification says;

i) There exists an industry with R&D intensity κ[R&D], the location of which is independent of the R&D abundance of countries.

ii) There exists a level of R&D abundance, γ[R&D], such that the country's share of each industry is independent of the R&D intensity of the industry.

iii) If β[R&D] > 0, then industries with R&D intensity greater than κ[R&D] will be drawn into countries with R&D abundance greater than γ[R&D], and out of countries with R&D abundance less than γ[R&D].

When we estimate the equation, we derive estimates of the three key parameters for each interaction variable - that is, estimates of κ[j], γ[j] and β[j]. We also derive estimates for the impact of the two scale variables - that is, estimates of α and β. In the discussion of our results, we concentrate on the β[j]'s which measure the sensitivity of *all* industries to variations in the location characteristics. Returning to the example of R&D, if R&D abundance is an important determinant of location patterns, then we should see a high value of β[*R&D*]. The estimate of κ[*R&D*] tells us the level of R&D intensity which separates industries in to 'high' and 'low' R&D intensive industries. The estimate of γ[*R&D*] tells us the level of R&D abundance that separates countries in to 'abundant' and 'scarce' R&D countries. Industries which are highly intensive (relative to κ[*R&D*]) will be attracted to countries that are relatively abundant (relative to γ[*R&D*]). Likewise, industries that have low intensity (again, relative to κ[*R&D*]) will be attracted to countries where R&D factors are scarce (again, relative to γ[*R&D*]). To emphasise, this need to consider both high and low intensities and high and low abundance is a result of the general equilibrium nature of the system which makes estimating these relationships so complex. It is also the general equilibrium nature of the system that stops us from guessing at the cut-off points $\kappa[R\&D]$ and $\gamma[R\&D]$ that define intensity and abundance. For example, there is little reason to think that the mean or median are the correct cut-off points, however intuitive these values might be. Finally, after adjusting for industry intensity and country abundance we can directly compare the importance of different country characteristics by considering the relative sensitivity of all industries to those characteristics as captured through the estimates of $\beta[j]$.

Estimation

In this section, we deal with some important estimation issues. First we do not estimate our specification directly, but instead, expand the relationship to give the estimating equation:

$$\ln(s_i^k) = c + \alpha\ln(pop_i) + \beta\ln(man_i) + \sum_j \Big(\beta[j]\,y[j]_i z[j]^k - \beta[j]\gamma[j]\,z[j]^k - \beta[j]\,\kappa[j]\,y[j]_i\Big)$$

For each time period, this equation was estimated by OLS, pooling across industries. The left hand side is a four year average of the industrial share of country *i* in the total output of industry *k*. Population and manufacturing data are also calculated as four year averages. Getting data on country characteristics that are comparable across countries involved a large data collecting exercise. Often, it proved impossible to get data on country characteristics that vary across time and are still comparable across countries. For consistency, all the results presented here use country characteristics from a single time period (usually close to 1990) that *are* comparable across countries. Time series variations must matter, although the most important variations at the EU wide level must surely be cross-sectional. Robustness checks using time varying data (where available) suggest that our conclusions would be strengthened if cross-section time-series data on endowments were more generally available. Similarly, getting data on industry characteristics is not simple, so again, we use information on intensities that is not time-varying. Additional details on endowments and intensities are provided in the appendix. This includes information on the relative position of countries with respect to the different endowment measures. Information on the relative position of industries with respect to the intensity measures is provided in Section 3.

We omit three sectors - petroleum refineries, petroleum and coal products, and manufacturing not elsewhere classified (essentially a residual component). This leaves us with around 455 observations - the exact number of observations for each year are reported in the table. There are potentially two important sources of heteroscedasticity - both across countries and across industries. Because we cannot be sure whether these are important, or which would dominate, we report White's heteroscedastic consistent standard errors. We use these consistent standard errors for all hypothesis testing[18].

4.2 Results

Results are given in table 4.2. The first three rows give results for the constant, and the two size variables - measures of population share (share in total EU population) and manufacturing share (share in total EU manufacturing). The next four rows (**country chars.**) give the estimated coefficients on $y[j]$, the country characteristics. From the estimating regression, we see that this is an estimate of $-\beta[j]\kappa[j]$. If we divide through by the estimate of $\beta[j]$ this will provide an estimate of the cut-off point defining high and low intensity. The next six rows (**industry intens.**) give the estimated coefficients on $z[j]$, the industry intensities. Again, from the estimating regression, we see that this is an estimate of $-\beta[j]\gamma[j]$. Now, if we divide through by the estimate of $\beta[j]$ we get an estimate of the cut-off point defining high and low 'abundance'[19]. Finally, the next six rows (**interactions**) give the coefficients on the interaction variables. From the estimating equation, we see that this is an estimate of $\beta[j]$ - the sensitivity of industry location to the various country characteristics. In the discussion that follows we concentrate on these sensitivity estimates, which capture the changing importance of the various factors driving industrial location patterns.

Table 4.2: Regression results

Variable	1970	1980	1985	1990	1997
CONSTANT	2.913* (1.425)	2.232* (1.24)	2.615* (1.308)	3.950* (1.425)	4.037* (1.524)
Size variables					
$ln(Pop_i)$	0.646* (0.234)	0.261 (0.231)	0.181 (0.163)	0.253** (0.169)	0.239** (0.166)
$ln(Man_i)$	0.468* (0.22)	0.851* (0.223)	0.950* (0.159)	0.892* (0.169)	0.901* (0.175)
Country chars.					
Market potential	-0.811** (0.512)	-0.538 (0.461)	-0.672** (0.478)	-1.048* (0.501)	-1.026* (0.523)
Agriculture % GDP	-0.166* (0.079)	-0.113* (0.066)	-0.127* (0.075)	-0.159* (0.084)	-0.171* (0.087)
Secondary + educ % labour force	-0.048 (0.074)	-0.124* (0.071)	-0.139* (0.076)	-0.156* (0.081)	-0.218* (0.083)
Researchers, % labour force	0.012 (0.056)	-0.088** (0.056)	-0.153* (0.055)	-0.172* (0.059)	-0.205* (0.066)
Industry intens.					
Sales to industry % output	-0.184* (0.102)	-0.022 (0.085)	-0.023 (0.094)	-0.103 (0.105)	-0.128 (0.112)
Intermediates % costs	-0.154* (0.087)	-0.246* (0.08)	-0.229* (0.092)	-0.105 (0.104)	-0.103 (0.109)
Economies of scale	-0.059 (0.067)	-0.030 (0.067)	-0.021 (0.067)	0.000 (0.068)	-0.028 (0.073)
Agric inputs % costs	-0.263* (0.104)	-0.148** (0.089)	-0.181* (0.097)	-0.263* (0.106)	-0.194* (0.103)
Non-manual to manual workers	-0.182** (0.112)	-0.249* (0.098)	-0.315* (0.114)	-0.342* (0.13)	-0.462* (0.125)
R&D % value added	-0.137 (0.11)	-0.067 (0.097)	-0.072 (0.101)	-0.167** (0.107)	-0.171** (0.114)
Interactions					
Market potential * sales to industry	0.255* (0.131)	0.072 (0.115)	0.084 (0.128)	0.194** (0.143)	0.247** (0.151)
Market potential * interm % costs	0.494 (0.49)	0.220 (0.447)	0.303 (0.459)	0.632** (0.475)	0.648** (0.494)
Market potential * econs of scale	0.209* (0.105)	0.304* (0.1)	0.281* (0.11)	0.180** (0.12)	0.134 (0.128)
Agric % GDP * agric % costs	0.068 (0.063)	0.050 (0.061)	0.068 (0.064)	0.080 (0.064)	0.114** (0.073)
Educ * non-man/ man.	0.322* (0.117)	0.294* (0.103)	0.382* (0.116)	0.478* (0.128)	0.474* (0.127)
Researchers *R&D % VA	0.06 (0.107)	0.141 (0.096)	0.195* (0.11)	0.215* (0.125)	0.349* (0.124)
Diagnostics					
Adjusted R^2	0.833	0.83	0.804	0.784	0.764
Dependent variable	$\ln(s_i^k)$	$\ln(s_i^k)$	$\ln(s_i^k)$	$\ln(s_i^k)$	$\ln(s_i^k)$
Number of obs	455	455	455	455	454

Note: Standard errors reported in brackets; * = significant at 5% level; ** = significant at 10%. We report the results of one sided tests where appropriate. All regressions are overall significant according to the standard F-test.

Regression Results - Discussion

In discussing results, we initially focus on years from 1980 onwards.

The variables *ln(pop)* and *ln(man)* soak up country size differences, as expected. In particular, coefficients on *ln(man)* are close to unity. Country and industry characteristics all have negative coefficients, as expected. But, given the general equilibrium nature of the economic system, these coefficients are of little direct interest. We concentrate on the coefficients β[*j*], which measure the effect of the interactions and capture the sensitivity of location patterns to the various country and industry characteristics.

1) Market potential * sales to industry: The coefficient on this interaction is positive, increasing in magnitude and becoming significant. This says that backward linkages between industrial sectors are becoming increasingly important determinants of location. Industries which sell a high share of output to industry are, other things being equal, increasingly likely to locate in countries with high market potential.

2) Market potential * share of intermediates in costs: This interaction is positive and becoming significant at the 10% level. The interpretation is that forward linkages are becoming increasingly important. Industries which are heavily dependent on intermediate goods are coming to locate in central regions with good access to intermediate supplies. Another way of putting this, is that central locations are moving up the value added chain.

3) Market potential * economies of scale: The coefficient on this interaction is positive, but steadily declining and becoming insignificant in later years. Theory predicts that the forces pulling increasing returns to scale industries into central locations are strongest at 'intermediate' levels of transport costs. The fact that this force is weakening supports the view that trade barriers in Europe may now have declined beyond these intermediate values.

4) Agricultural production * share of agriculture in costs: This interaction has the correct sign and increases slightly in strength, although at very low levels of significance.

5) Educational level of the population * non-manual workers relative to manual workers: This interaction is positive, highly significant, and slightly increasing throughout the period. It suggests the enduring importance of a skilled labour force in attracting skilled labour intensive industries.

6) Researchers in labour force * R&D intensity: This interaction is positive, increasing in strength and becoming highly significant. It points to the increasing importance of the supply of researchers in determining the location of high technology industries.

The discussion above focuses on results from 1980 onwards. As we have seen in earlier sections of the paper, going back to 1970 gives a somewhat different picture, and suggests a turning point in behaviour around 1980. For example, looking at the time series of the β[*j*] coefficients, five of the six have a turning point in 1980.

Summarising then, the econometrics paints a fascinating (and seemingly robust) picture of the changing interaction between factor endowment and economic geography determinants of location. The results indicate an increasing importance of forward and backward linkages and of the availability of skilled labour and researchers in determining the location of industry from 1980 onwards. At the same time, high increasing returns industries became better able to serve markets from less central locations.

Regression results - policy implications

What do our regression results tell us with respect to policy interventions aimed at affecting the location of industry? For example, why has Ireland been more successful than Portugal at attracting high-tech investments (as suggested by our analysis in Section 2). Is it due to the fact that Ireland offered greater financial incentives, or did the Irish economy already have the inherent characteristics required for an expansion of the high-tech sector?

It is hard to use our results to talk about policy for individual sectors because we do not have data on policy measures by country *and* sector.[20] Using country level data on policy expenditures, the coefficient just tends to reflect the relationship between these expenditures and the share of manufacturing in each country. If these are negatively related we get a negative (insignificant) effect of policy expenditures, reflecting the fact that less industrial countries are recipients of greater amounts of EU regional aid.

Can we say anything positive about the role of policy in explaining the location of industry across the European Union? First, and most importantly, our results suggest that it doesn't seem to have done too much harm. At the EU wide level, specialisation according to comparative advantage and the forces identified by new economic geography, are beneficial. That is, specialisation driven by these forces increases *aggregate* welfare. Our results suggest that comparative advantage and new economic geography forces are becoming increasingly significant in explaining location patterns of industries. Second, and related, individual policies do not seem to be generally distorting the location of industrial activity. If they were generally distorting the location of industry, then we would not find that country characteristics and industry intensities were growing in importance.

To summarise, our regression results suggest that economic fundamentals are generally driving location patterns. Industrial policies may distort this picture, but they are not distorting the overall picture too much. Thus, Ireland's high-tech policy may well bias high-tech firms towards locating in Ireland. But, relative to Portugal, Ireland has twice the number of 25-59 year olds with at least upper secondary education (see the table in the Appendix A2). If the availability of the correctly skilled labour force is important in determining location patterns (and our regression results suggest that it is), then the difference between the Portuguese and Irish experiences is likely as much explained by this last fact as it is by the existence of Ireland's high-tech policy.

Finally, to emphasise, our results suggest that ongoing specialisation in the European Union is driven by factors that will increase aggregate welfare. Individual countries may gain from policies that distort these forces, but theoretical reasoning suggests that the EU as a whole loses. We return to some of these issues in the conclusions.

5. Service industries in the European Union

So far, we have concentrated purely on manufacturing industries. There are several good reasons for so doing. First, in general, manufacturing products are inherently more tradeable than service sector products, so we would expect to see the largest relocation effects of European integration in manufacturing. Second, current data availability severely restricts our ability to describe location patterns of services and to study the forces driving the location of those services. For example, we only have employment data for five very aggregate service sectors, and we cannot classify these service industries according to the industry characteristics that we used in Section 2. However, as service industries account for around 60% of EU employment, the geography of those services must be increasingly important. In this section, we use the available data to discuss the distribution of service sectors. Our conclusions are that demand shifts can explain most of the changing scales of service sector activity, although we cannot rule out the possibility that trade and specialization changes may be occurring at more disaggregate levels of service sector activity.

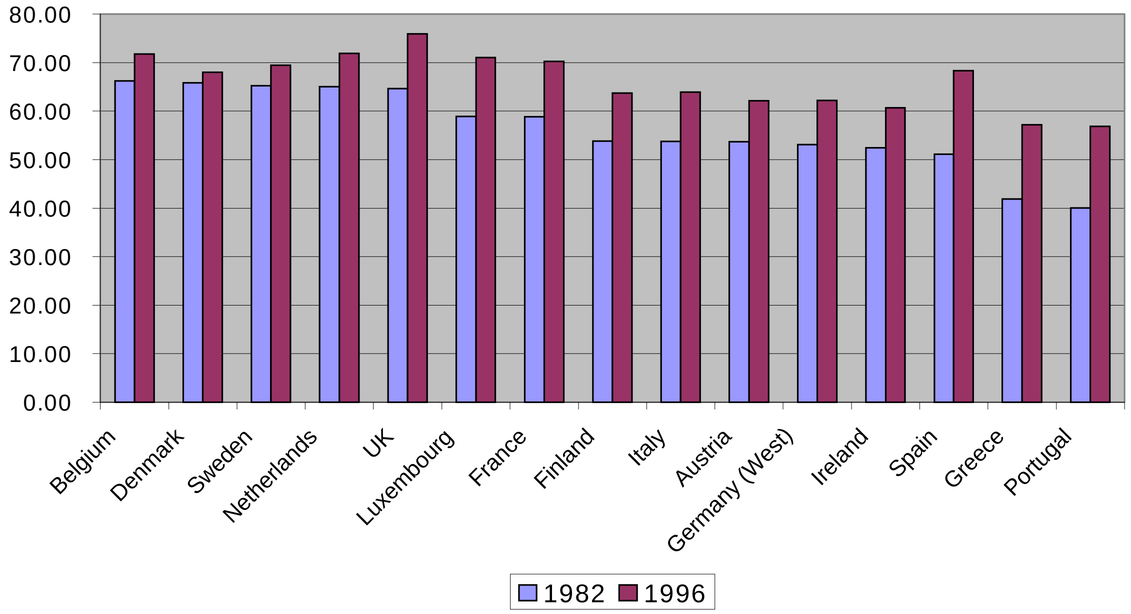

Figure 5.1: Share of employment in the service sector

Aggregate trends

EU countries differ substantially in the relative sizes of their service sectors.[21] In 1982, the share of service employment in total employment ranged from 40% (Portugal) to 66% (Belgium). By 1996 service employment shares had risen in all countries and ranged from a low of 57% (Portugal) to a high of 76% (UK). The full picture is given in table 5.1, and we see that the increase was largest for the three countries with the smallest service sectors initially, namely Greece, Portugal, and Spain, and correspondingly smallest for the three countries with the biggest sectors initially, Belgium, Denmark and Sweden.[22]

Turning to individual service sectors, Figure 5.2 gives the time series of the Gini coefficient of concentration for five major sectors (Financial services, Insurance, Real Estate and Business Services (FIRE); Wholesale and Retailing; Restaurants and Hotels; Transport; and Communication).[23] Among these sectors, FIRE is the most concentrated and remains so from 1982 to 1996, even though its level of concentration decreases slightly. Transport services are least concentrated. The ranking of industries according to degree of concentration does not change over time, and all five service industries are less concentrated than manufacturing production as a whole.

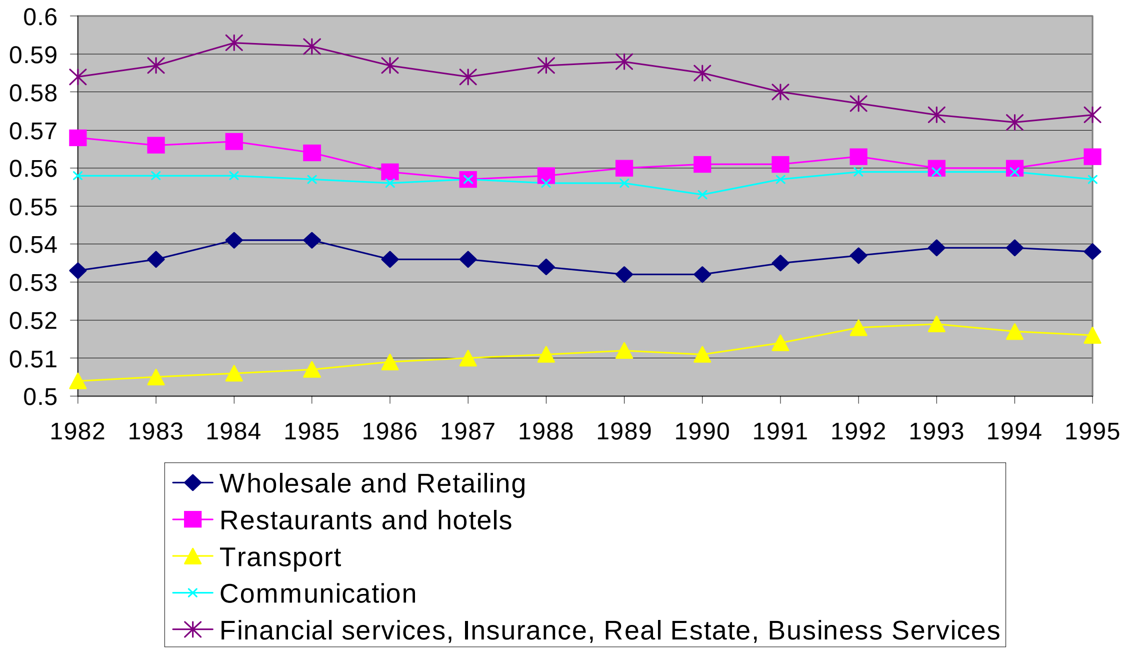

Figure 5.2: Gini coefficient of concentration – EU services

We briefly consider the relocation patterns that have caused the decrease in geographical concentration of the FIRE sector, by considering country shares, $s_i^k(t)$, for 1982 and 1995. From Table 5.1, we see that the UK and Italy more or less kept their dominant positions, while Germany experienced a slight decline in position. The countries that gained shares were Spain, Portugal and Greece and also the Netherlands. Hence, it seems that the decrease in concentration was indeed due to genuine geographical dispersion, and not just caused by relocation among the core countries in Europe.

Table 5.1 Country shares of the EU Financial, Insurance, Real Estate and Business service sector (FIRE).

	1982	1995
Austria	2.62 %	2.55 %
Belgium	1.33 %	0.98 %
Denmark	2.09 %	1.82 %
Spain	3.21 %	4.84 %
Finland	1.50 %	1.26 %
France	18.78 %	17.84 %
UK	26.17 %	25.88 %
Germany	8.24 %	6.75 %
Greece	1.38 %	1.72 %
Ireland	0.80 %	0.82 %
Italy	25.13 %	25.10 %
Luxembourg	0.10 %	0.13 %
Netherlands	4.47 %	5.35 %
Portugal	1.14 %	2.01 %
Sweden	3.04 %	2.95 %
	100 %	100 %

The evidence presented above points to three broad trends in the service sectors:

- Service activity is expanding across the EU as part of a general shift from manufacturing to services;
- Poorer countries, with small initial services sectors, are catching up;
- Indices of concentration for services sectors confirm this general picture - services are in general more dispersed than the average manufacturing sector and, to the extent that we see any trends, we see increased dispersion over time.

The main reason for these changes lie in changing patterns of demand for services.

Changing demand

Demand for services comes from final consumers and from use of services as intermediate goods, both of which have risen through time. A number of points can be made.

First, rising income levels across EU countries would lead us to predict an increasing share of services in consumption (because the income elasticity of demand with respect to services is known to be high). This, coupled with convergence of income levels goes a long way to explain the catch-up by countries with smaller initial service sectors.

Second, most manufacturing sectors have become more intensive users of services as intermediates in production. This may be a real shift, or may simply reflect the outsourcing of activities that were previously undertaken within manufacturing sector firms. The effects of this are quite large, as is clear from inspection of input-output tables. For the UK, the share of service inputs in the gross value of manufacturing output has risen from 12% to 19% over the last two decades. Focussing on specific sectors, the trend towards outsourcing becomes even more significant: Office & Computing, Electrical apparatus, Radio, TV & Communication, Motor Vehicles and Professional instruments all report increases in services inputs as a share of output of around 9-13% percentage points. Input-output tables for other countries tell a similar story. For example, French manufacturing industries increased the share of service inputs in output from 13% to 21 %.

Third, manufacturing industries vary in their service intensity, and highly service intensive industries have been amongst the fastest growing. From input-output tables we rank industries according to their total use of services (exclusive of electricity, gas and water) as a share of gross output, and report the 8 most intensive industries in table 5.2; the service input shares in these industries range from 30% to 21% of the gross value of output.[24] 5 of these 8 industries are in the fastest growing third of EU industries and none in the slowest growing third (see Table 3.4).

Table 5.2: Service Intensive Industries

ISIC	Service intensive industries
3825	Office & computing
3610	Pottery
3620	Glass & Products
3690	Non-metallic minerals
3832	Radio, TV & Communication
3522	Drugs & Medicines M
3410	Paper & Products
3420	Printing & Publishing

These arguments indicate rising demand for intermediate usage of services across the EU as a whole. However, in addition, some of the most service intensive industries are also those that have become increasingly dispersed. 7 out of the 8 industries listed in table 5.2 became more dispersed between 1970/73 and 1994/97 (Table 1, Appendix A4). These sectors are especially intensive in the use of Finance & Insurance, Real Estate & Business Services, and Communication. Changing location of manufacturing industries therefore goes some way to explain the increasing dispersion of service sector employment.

Conclusion

Changes in demand – driven by increased income, increased outsourcing, and the changing sizes and locations of service intensive industries – probably explain most of the changing pattern of service sector employment. However, two other possibilities must be mentioned. The first is the possibility that there has been increasing international trade in services, and consequent relocation. For most service activities this is unlikely, because of the inherent non-tradability of the service. For other activities – notably FIRE – it is a greater possibility. Data limitations make it difficult to measure trade in this sector, but the employment data provides no indications that concentration is taking place. From table 5.2 we see that the FIRE sector is the one that is *de*concentrating most.

Finally, the five service sectors we work with are highly aggregated – they are each much larger than any of our manufacturing sectors. It is possible that more disaggregate data would reveal a different story of changing concentration and dispersion, and possibly of specialization and agglomeration with their attendant efficiency gains. However, identifying such effects requires much more detailed data than are currently available.

6. An EU-US Comparison

It has often been remarked that industries in the US are much more spatially concentrated than they are in Europe. Unfortunately, it is difficult to find a way in which this statement can be made precise. The US and Europe are different sizes and geographical shapes, and there is no correct way to aggregate US states to mirror the geography of countries in Europe. Nevertheless, in this section we perform three exercises to shed some light on the similarities and differences between the EU and the US. The first is simply to look at the time series of regional specialization and industrial concentration in the two continents; this reveals quite different patterns of change, but makes no comparison of levels. The second is a comparison of the location patterns of the motor vehicle industry in the two continents. The third uses our spatial separation index (section 3.4) to make a comparison on levels.

6.1 The evolution of specialization and concentration.

US geography is different, and units of observation (states) smaller than the European counterpart. The likely effect of using smaller geographical units is to increase the value of measures both of specialization and of concentration (because, for example, random variations in industry shares will show up more). This creates difficulties for direct comparison of levels of specialization and concentration measures, although time trends of the series can be compared.

We have updated the work of Kim (1995) using employment data from US states. These data allow a comparison of the broad trends in the US with those in Europe. As EU and US data are collected at different levels of industry aggregation, the 36 EU industries are aggregated up to the 21 US industries before measures of specialization and concentration are calculated and compared.

First, let us consider the specialisation of locations. Table 6.1 shows the Gini coefficients of specialization for the EU and the same statistics for the US.[25] The obvious point is that there has been a steady decrease in the specialization of US states, in contrast to the U shaped performance of the European measures.

Table 6.1: Gini coefficients of specialization: US and EU

	70/73	80/83	88/91	94/97
US average	0.45	0.413	0.391	0.372
EU average	0.248	0.234	0.249	0.261

We now turn to the concentration of industries. Table 6.2 reports the (unweighted) average Gini coefficients of concentration for the EU and the US (see Table 3 in Appendix 4 for a complete set of gini coefficients over time and industries). We see that there has been a sharp decline in industrial concentration in the US between the early 1970s and the mid-eighties, consistent with the findings of Kim (1995). Our time series extend those of Kim for a further ten years, and we see that the trend of dispersion continues into the nineties and up till 1994/97. Relative to the magnitude of the changes in concentration that have taken place in the US, neither the slightly "waved" shaped patterns of European industrial concentration, nor the decline in concentration between 70/73 and 94/97 in Europe industries, are very significant.

Table 6.2: Gini coefficient of concentration: US and EU

	70/73	82/85	88/91	94/97
US average	0.675	0.648	0.636	0.618
EU average	0.591	0.574	0.584	0.577

What are the industries driving the dispersion taking place in the US? Only two out of 21 US manufacturing industries do not record a decrease in concentration between 70/73 and 94/97; they are Tobacco products and Textile mill products. The industries that dispersed the most are Motor Vehicles and equipment, Miscellaneous manufacturing industries, Electronics, Industrial machinery and equipment, Primary metal industries, Instruments, and Leather & products. In Europe 14 out of 21 industries show a decrease in concentration during the same interval, and the industries that dispersed the most were: Industrial machinery and equipment, Tobacco, Instruments, Chemicals, and Electronics (Office & computing, Radio, TV & communication). Hence, Electronics, Machinery and Instruments appear to be driving the industrial dispersion in the US as well as in Europe.

6.2 The motor vehicle industry: A US-EU comparison

Despite the difficulty in making cross country comparisons, more detailed study of the motor vehicle industry is instructive. For three time periods we have selected the top 2 and the top 4 European countries in terms of the value of motor vehicles produced. The shares of these countries in vehicle production and in manufacturing as a whole are given in the top two rows of Table 6.3. We see the top two countries increasing their share of vehicle manufacturing (from 58% to 62%), with little change in their share of manufacturing as a whole. The share of the top four declines (from 86% to 82%), with a larger fall in their share of manufacturing as a whole.

We then select the top US states in terms of motor vehicle manufacture, choosing the number of states to be just sufficient to give a similar share of vehicle production as the top 2 and top 4 EU countries. Thus, in 1970, just 2 US states produced 56% of vehicles (similar to top 2 EU producing 58%) and the top 10 states produced 87% (similar to top 4 EU countries producing 86%). The spread of the US industry is apparent, since we see that by 1996 it took 6 US states to produce the same share of output as did the top 2 EU countries, and 13 states to match the share of the EU top 4.

Table 6.3 European and US motor vehicle production

1970			1982			1996		
	Share vehicle	Share manuf		Share vehicle	Share manuf		Share vehicle	Share manuf
Eur 2	58%	46%	Eur 2	59%	44%	Eur 2	62%	45%
Eur 4	86%	76%	Eur 4	84%	74%	Eur 4	82%	65%
US 2	56%	13%	US 4	61%	25%	US 6	63%	33%
US 10	87%	56%	US 12	84%	61%	US 13	82%	61%

As the US industry has dispersed, so the states in which it is concentrated have become much less specialised. In 1970 the 2 top vehicle producers, responsible for 56% of the US vehicle production, only had 13% of total manufacturing. The analogous number for the 1996 top 6, responsible for 63% of US vehicle production, was 33%. However, notice that these states are still more specialised than the equivalent European countries. Thus, whereas these top 6 states account for 63% of vehicle production and 33% of total manufacturing, the four European countries account for 62% of vehicle production and 45% of the supply of total manufactures. However, this concentration of vehicles relative to manufacturing as a whole is much less marked at the next level: the top 13 US states, producing 82% of US vehicles, supply 61% of manufactures as a whole, while the equivalent European countries, producing 82% of EU vehicles, supply 65% of manufactures.

6.3 Spatial separation.

The problem with direct comparison of the EU with the US is both that their geographies are inherently different, and that there are different size units of observation in the US. We can go some way to addressing these issues by using our index of spatial separation (section 3.4). It simply gives a measure of distance between production units in each industry. We have computed this index for each of the 21 industries, for the EU and for the US (49 states, excluding Alaska and Hawaii). We find the spatial separation index generally larger for the US than for the EU.

This difference simply reflects the greater geographical size of the US. To control for this we want to condition each value on a measure of geographical size, and for this we use the index of spatial separation for manufacturing as a whole on each continent. We therefore define the *conditional spatial separation* index as the spatial separation index for each industry divided by that for manufacturing as a whole. Finally, we compared these conditional spatial separation indices, taking the ratio of the EU measure to the US measure for each industry.

Results are given in Table 6.4. Consider lumber and wood products from 82/85 onwards. The numbers say that, conditional on the relative sizes of the US and the EU, this industry is more spatially separated in the EU than in the US. Looking at motor vehicles we see much more marked EU spatial separation, although the margin is declining. On the other side, electronic equipment is less spatially separated in the EU than in the US, presumably reflecting the fact that the two US clusters of this industry are on opposite sides of the continent.

Table 6.4: EU conditional spatial separation / US conditional spatial separation

Industry	70/73	82/85	88/91	94/97
413 Lumber and wood products	0.917	1.07	1.11	1.12
417 Furniture and fixtures	1.06	1.06	1.08	1.05
420 Stone, clay, and glass products	1.03	1.09	1.09	1.07
423 Primary metal industries	1.26	1.23	1.2	1.22
426 Fabricated metal products	1.01	1.04	1.04	1.02
429 Industrial machinery and equipment	0.918	0.951	0.975	1.03
432 Electronic and other electric equipment	0.829	0.814	0.843	0.848
435 Motor vehicles and equipment	1.46	1.44	1.42	1.3
438 Other transportation equipment	0.856	0.811	0.763	0.797
441 Instruments and related products	0.99	0.868	0.835	0.889
444 Miscellaneous manufacturing industries	1.06	1.04	1.03	0.986
453 Food and kindred products	0.949	1.01	1.03	1.01
456 Tobacco products	1.63	2.08	2.27	2.19
459 Textile mill products	1.91	2.14	2.1	2.03
462 Apparel and other textile products	1.17	1.2	1.14	1.04
465 Paper and allied products	1.2	1.3	1.29	1.33
468 Printing and publishing	1	1.02	1.03	0.965
471 Chemicals and allied products	1.04	1.01	1.06	1.07
474 Petroleum and coal products	0.737	0.919	0.885	0.853
477 Rubber and misc. plastics products	1.07	1.03	1.07	1.05
480 Leather and leather products	1.46	1.35	1.29	1.24
Average	1.12	1.16	1.16	1.14

The conclusion, is that on average, the EU is more conditionally spatially separated than the US. This has not changed much over time. In 1982/85, 17 out of 21 industries were more spatially separated in the EU than in the US, a number which fell to 15 of the 21 industries by 1994/97. Thus, we see little evidence of convergence.

7. Conclusions

It seems clear from the analysis of this paper that, from the early 1980s onwards, the industrial structures of EU economies have become more dissimilar. This is as would be predicted by trade theory (old and new) during a period of economic integration. What are the main features of this process of divergence?

First, it is slow. Over a fourteen year period, most economies have only seen a few percent of their industrial production move out of line with that of the rest of the EU. Of course, more activity might be expected to show up in more disaggregate data, but nothing in our results suggest that the process is particularly rapid. We see no marked effect on location and specialisation patterns of the completion of the Single Market Programme.

Second, it is driven by a combination of forces. Some industries are becoming more geographically concentrated, others more dispersed. This fact alone tells us that there is no single process driving all industries in the same direction. This is perhaps surprising, since trade theory (old and new) generally predicts that falling trade barriers should make all, not just some, industries become more geographically concentrated.

Our analysis sheds light on the mechanisms that are at work. Some of the forces encouraging medium and high increasing returns to scale industries to locate in central regions are diminishing. At the same time industrial linkages are encouraging some industries - for example those with high shares of intermediate goods in production - to move into central locations. And in addition, the supply of skilled workers and researchers is becoming increasingly important in moving some industries into countries well endowed with these types of workers.

Third, the process is in the opposite direction from the one we observe in the US. The US saw states becoming increasingly dissimilar from 1860 until around 1940, but a considerable amount of convergence has occurred since. Despite recent work in the area it is still not clear what forces drive these trends for the US.[26]

Is the process of growing dissimilarity in the EU likely to continue, or is it reaching some limit? We see no evidence that it is reaching a limit. In so far as any direct comparisons with the US are possible, it is likely that EU industry remains more dispersed than that of the US. The time series record for Europe indicates no evidence of a slow down. And as we have seen, the process is slow; economies are nowhere near pressing against the limits of complete specialization.

Finally, is the process to be welcomed? Our results suggest that the rate of structural change is sufficiently slow for it not to be associated with major adjustment costs. And if it is driven by a combination of comparative advantage and industrial linkages, then analysis suggests that it will lead to real income gains.

Appendix A1: Data

1. MANUFACTURING PRODUCTION DATA

The data set is based on production data from two sources: OECD STAN database and the UNIDO database.

OECD STAN (Structural Analysis) database
Data: National industrial data on value of output.
Period: 1970-1997, annual data.
Countries: 13 European countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom.
Sectors: 36 industrial sectors specification as per Table 1 in Appendix A4.

UNIDO database
Data: National industrial data on value of output.
Period: 1970-1997, annual data.
Countries: Ireland.
Sectors: 27 industrial sectors; the specification have been adjusted to be consistent with the classification employed in the STAN database, see notes on changes made to the data below.

NB: Some 3 digit data is missing in various years for various sectors. Where possible we break down 2 digit data using information on 3 digit shares from close time periods; if not possible, we break down 3 digit sectors by EU share. Approximately 7% of the three digit data needs to be estimated in this way. Details are available on request.

2. TRADE DATA

UN Com Trade database
Data: Manufacturing trade data on total exports to the world.
Period: 1970-1997, annual data.
Countries: EU 15: Austria, Belgium/Luxembourg, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom
Sectors: 104 manufacturing sectors.

3. SERVICE DATA

Service data are based on OECD Services database.

OECD Services database
Data: Services employment and GDP data.
Period: 1982-1995, annual data.

Countries: EU 15: Austria, Belgium/Luxembourg, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom.
Sectors: Total services; 5 individual service sectors.

4. US DATA

US data are based on regional manufacturing employment data, provided by Gordon Hanson.

Data: Manufacturing employment data
Period: 1970-1997, annual data
US states: 51
Sectors: 21 manufacturing sectors

Appendix A2: Intensities, Endowments and Interactions

(A) Industry Intensities

- *Economies of scale*
  Indicators of economies of scale, source: Pratten (1988)
- *Technology level*
  High, Medium Low, OECD classification, source: OECD (1994)
- *R&D intensity*
  R&D expenditures as share of value added, source: ANBERD and STAN, OECD
- *Capital intensity*
  Capital stock per employee, source: COMPET, Eurostat
- *Share of labour*
  Share of labour compensation in value added, source: STAN, OECD
- *Skill intensity*
  Share of non manual workers in workforce, source: COMPET, Eurostat
- *Higher skills intensity*
  Share of employment with higher education, source: COMPET, Eurostat
- *Industrial growth*
  Growth in gross production value between 1970 and 1994, source: STAN, OECD
- *Agricultural inputs intensity*
  Use of primary inputs as share of value of production
- *Intermediates intensity*
  Total use of intermediates as a share of value of production
- *Intra-industry linkages*
  Use of intermediates from own sector as share of value of production
- *Inter-industry linkages*
  Use of intermediates excl. of inputs from own sector, as share of value of production.
- *Final demand bias*
  Percentage of sales to domestic consumers and exports
- *Sales to industry*
  Percentage of sales to domestic industry as intermediates and capital goods

Agricultural inputs intensity, intermediates intensity, intra-industry linkages, inter-industry linkages, final demand bias, and sales to industry are all calculated using the OECD Input-Output tables database. EU average intensities are constructed on the basis of the Input Output Tables for Denmark, France, Germany and the UK in 1990.

(B) Country characteristics

- *Market potential*
  Indicators of market potential based on GDP, source: European Commission, DGII.
- *Labour force*
  Total labour force, source: Eurostat
- *Capital stock*
  source: PennWorld Tables
- *Average manufacturing wage*
  For all countries except Ireland, annual labour compensation per employee in total manufacturing, source: STAN, OECD. For Ireland we use the labour cost survey by Eurostat (1996) and COMPET (CMPT3110), Eurostat. Due to lack of data on Ireland, we assumed that number of hours worked per week is the same in Ireland as in the UK.
- *Relative wages*
  Wages for non production / production workers, source: United Nations (1993) and (1998): Industrial Statistics Yearbook 1991, Vol. 1: General Industrial Statistics, UN, New York 1993. UNISD does not give data for Belgium, France, Netherlands and Portugal. For these countries we used Eurostat (1992), and COMPET (CMPT 3110), Eurostat, and assumed 4 weeks of work per month.
- *Agricultural production*
  Agriculture share in GDP
- *Researcher and Scientists (RSE)*
  Researchers per 10 000 labour force, 1996, source: OECD
- *Education of population*
  Share of population aged 25-59 with at least secondary education, 1997, source: Eurostat
- *Regional aid*, source: European Commission (1995)
- *Total aid***,** source: European Commission (1995)

The following table details the value of the four country characteristics that are used in the econometric specification that we report in Section 4.

Table 2 - Country characteristics

	Market potential	Agricultural production % GDP	Secondary & higher education % population	Researchers & Scientists % labour force
Austria	12303.0	3.2	75.1	34
Belgium	13263.8	1.9	60.6	53
Denmark	6627.8	4.5	82.1	58
Spain	4993.2	5.4	35.1	32
Finland	3642.1	6.6	72.6	67
France	12380.2	3.5	62.7	60
G.Britain	12225.8	2	55.3	50
Germany	13072.8	3	82.1	59
Greece	2335.7	12.5	49.3	20
Ireland	3791.5	9.6	51.3	58
Italy	8715.1	4.1	41.4	32
Netherlands	12839.9	4	65.9	46
Portugal	3193.8	7.3	23.8	31
Sweden	5810.5	3.4	76.7	78

Appendix A3: DAISIE

The Daisie database, divides the manufacturing sector into 100 3-digit industries for the period 1985-97, allowing us to study geographical concentration at a finer level of disaggregation. (See Table 4 in Appendix A4). We can use this disaggregated data to check the robustness of some of our earlier results. However, the data is not ideal. Much of the 3-digit data must be estimated and the data on Portugal is lacking for the period 1985-89 leaving us with a rather short time series. We follow the WIFO report and fill missing data as follows:

Estimating missing Daisie data

1. If 3 digit missing at beginning or end: constant share of 2 digit
2. If 3 digit never reported: share of 2 digit in EU
3. If 3 digit missing in some years: interpolation
4. If 2 digit missing at begin or end: constant share in recent year
5. If 2 digit always missing: share of 2 digit in EU for each year
6. If difference between EU total and sum of industries on 2 digit, 3 digit level the later was taken

A significant proportion of the data must be estimated. Thus, for the period 1985-1990 around 30% of the data must be estimated. For the total period around 25% of the data must be estimated.

The WIFO report presents detailed findings on specialisation patterns using this data. We do not replicate this analysis here, but use their findings for comparison. They find that, for the period 1985 to 1997 there is evidence that production specialisation at the two digit sectoral level increased marginally. This period splits in to two sub-periods. Between 1985 and 1990, specialisation decreased slightly, before increasing again between 1990 and 1997. They find that for both periods, three digit industrial specialisation patterns broadly followed those of their more aggregate two digit counterparts. This would suggest that, even if the three digit data had been available for longer time periods, our broad results for 1970-1997 would have been replicated. However our results suggest that the short time span of the three digit data means that an analysis based on Daisie misses most of the fundamental changes in specialisation patterns, many of which occurred pre-1985. (See, for example, Figure 2.2 and Table 2.3). Further, as at least 25% of the three digit data for the pre-1990 period needs to be estimated using assumptions on industry shares and secondary data sources, we would be wary about drawing any detailed conclusions for three digit industries for that period.

Concentrating on the period for which we have a full data set, we find that the results on geographical concentration at the three digit level remain broadly similar to our earlier more aggregated results. Table 5 in Appendix A4 reports the Gini coefficient of concentrations for each 3 digit industry for the period 1990-1997.

Grouping the one hundred 3-digit industries according to the 36 sector STAN classification, we can look at mean concentration levels as well as the within-group variation. Comparing average concentration of groups of industries with the degree of concentration of the respective STAN sectors, generally confirms the results based on the more aggregated data. Industries belonging to sectors with below average concentration also typically show below average concentration, and the same applies for industries above average. Turning to the within group variation, we see that within most sectors, there is very little variation in the degree of geographical concentration of the component industres. Professional instruments and Motor vehicles are typical examples, where we see above average concentration both at the sector and the industry level, and where a decline in concentration is reported at both levels. There are some exceptions. For example, for the Radio, TV & Communication sectors and for Electrical apparatus nec, we see some variation across the industries in each sector, both with respect to levels and changes.

To summarize, for the periods that we have data, three-digit industries tend to follow the broad trends of the two digit sectors of which they are a part. This is true for both specialisation and location patterns. Given the poor quality of the three-digit data, and the relatively short time period, we think that studying industrial location at the two digit level is more appropriate. Particularly as the EU appears to have undergone significant changes in industrial structure pre-1985.

Appendix A4: Tables

Table 1: Gini Coefficient of Concentration (EU14)

NO	NAME	ISIC	70/73	82/85	88/91	94/97
1	Food	3110	0.503	0.471	0.464	0.46
2	Beverages	3130	0.647	0.592	0.576	0.557
3	Tobacco	3140	0.662	0.622	0.624	0.592
4	Textiles	3210	0.554	0.561	0.589	0.566
5	Wearing Apparel	3220	0.575	0.587	0.61	0.613
6	Leather&Products	3230	0.547	0.62	0.668	0.685
7	Footwear	3240	0.594	0.641	0.672	0.669
8	Wood Products	3310	0.533	0.477	0.482	0.498
9	Furniture & Fixtures	3320	0.568	0.584	0.59	0.596
10	Paper & Products	3410	0.504	0.483	0.488	0.479
11	Printing & Publishing	3420	0.539	0.524	0.514	0.515
12	Industrial Chemicals	3510	0.613	0.582	0.571	0.546
13	Pharmaceuticals	3522	0.597	0.572	0.553	0.519
14	Chemical Products nec	3528	0.658	0.615	0.629	0.622
15	Petroleum refineries	3530	0.631	0.541	0.586	0.621
16	Petroleum & Coal Products	3540	0.673	0.7	0.658	0.682
17	Rubber Products	3550	0.619	0.608	0.616	0.624
18	Plastic Products	3560	0.602	0.591	0.598	0.6
19	Pottery & China	3610	0.624	0.699	0.728	0.695
20	Glass & Products	3620	0.616	0.601	0.611	0.569
21	Non-Metallic minerals nec	3690	0.576	0.537	0.532	0.542
22	Iron & Steel	3710	0.625	0.6	0.622	0.611
23	Non-Ferrous Metals	3720	0.581	0.607	0.609	0.623
24	Metal Products	3810	0.576	0.555	0.569	0.567
25	Office & Computing Machinery	3825	0.68	0.634	0.631	0.608
26	Machinery & Equipment nec	3829	0.663	0.609	0.619	0.592
27	Communication equipment	3832	0.654	0.625	0.623	0.589
28	Electrical Apparatus nec	3839	0.668	0.64	0.655	0.645
29	Shipbuilding & Repairing	3841	0.467	0.452	0.457	0.445
30	Railroad Equipment	3842	0.639	0.618	0.559	0.591
31	Motor Vehicles	3843	0.694	0.689	0.686	0.703
32	Motorcycles & Bicycles	3844	0.642	0.689	0.64	0.671
33	Aircraft	3845	0.677	0.704	0.704	0.693
34	Transport Equipment nes	3849	0.551	0.567	0.582	0.628
35	Professional Instruments	3850	0.665	0.634	0.636	0.597
36	Other Manufacturing	3900	0.577	0.567	0.572	0.552
	Unweighted Average		0.605	0.594	0.598	0.593

Table 2: Spatial Separation (EU14)

NO	NAME	ISIC	70/73	82/85	88/91	94/97
1	Food	3110	204.8	213.9	217.2	211.0
2	Beverages	3130	180.8	200.4	205.8	206.8
3	Tobacco	3140	160.3	181.6	180.3	184.7
4	Textiles	3210	218.7	232.6	227.6	230.7
5	Wearing Apparel	3220	208.1	226.9	226.8	222.1
6	Leather&Products	3230	233.7	232.5	224.8	217.9
7	Footwear	3240	236.2	233.5	229.2	233.9
8	Wood Products	3310	229.6	253.2	256.4	248.0
9	Furniture & Fixtures	3320	201.7	207.8	206.9	199.1
10	Paper & Products	3410	233.0	247.1	243.4	249.6
11	Printing & Publishing	3420	196.9	210.2	214.7	202.0
12	Industrial Chemicals	3510	174.8	176.0	187.7	191.4
13	Pharmaceuticals	3522	200.6	195.6	207.3	201.9
14	Chemical Products nec	3528	176.5	186.9	181.8	184.5
15	Petroleum refineries	3530	160.4	199.1	188.4	175.0
16	Petroleum & Coal Products	3540	172.5	177.5	217.5	209.9
17	Rubber Products	3550	191.1	197.9	203.2	200.0
18	Plastic Products	3560	184.8	185.8	192.4	186.2
19	Pottery & China	3610	229.0	209.0	198.4	210.4
20	Glass & Products	3620	179.4	199.2	204.4	207.5
21	Non-Metallic minerals nec	3690	200.5	224.4	227.9	216.4
22	Iron & Steel	3710	198.2	210.3	206.9	212.1
23	Non-Ferrous Metals	3720	195.3	190.0	191.1	190.9
24	Metal Products	3810	185.4	201.5	195.8	191.3
25	Office & Computing Machinery	3825	164.7	169.6	178.7	175.5
26	Machinery & Equipment nec	3829	163.6	192.2	192.0	201.8
27	Communication equipment	3832	157.5	166.3	168.0	177.8
28	Electrical Apparatus nec	3839	173.7	195.9	193.5	192.9
29	Shipbuilding & Repairing	3841	236.6	242.4	235.2	251.6
30	Railroad Equipment	3842	207.4	228.1	243.2	230.3
31	Motor Vehicles	3843	168.8	179.4	183.3	172.6
32	Motorcycles & Bicycles	3844	210.4	209.0	223.7	217.1
33	Aircraft	3845	170.5	160.8	155.6	151.1
34	Transport Equipment nes	3849	237.9	235.5	214.2	210.5
35	Professional Instruments	3850	176.2	193.1	199.1	210.7
36	Other Manufacturing	3900	202.1	217.7	219.7	220.1
	Unweighted Average		195.1	205.1	206.7	205.4

Table 3: Gini Coefficient of Concentration (US51)

	Industry	70/73	82/85	88/91	94/97
413	Lumber and wood products	0.561	0.524	0.512	0.503
417	Furniture and fixtures	0.658	0.651	0.644	0.622
420	Stone, clay, and glass products	0.584	0.552	0.538	0.522
423	Primary metal industries	0.721	0.659	0.635	0.617
426	Fabricated metal products	0.654	0.611	0.601	0.586
429	Industrial machinery and equipment	0.663	0.606	0.586	0.569
432	Electronic and other electric equip	0.658	0.621	0.587	0.567
435	Motor vehicles and equipment	0.826	0.773	0.743	0.725
438	Other transportation equipment	0.661	0.681	0.68	0.647
441	Instruments and related products	0.736	0.684	0.68	0.653
444	Miscellaneous manufacturing industries	0.653	0.603	0.562	0.532
453	Food and kindred products	0.516	0.502	0.5	0.487
456	Tobacco products	0.902	0.908	0.923	0.915
459	Textile mill products	0.817	0.825	0.828	0.817
462	Apparel and other textile products	0.67	0.667	0.663	0.659
465	Paper and allied products	0.576	0.548	0.539	0.533
468	Printing and publishing	0.614	0.571	0.557	0.541
471	Chemicals and allied products	0.632	0.607	0.605	0.604
474	Petroleum and coal products	0.747	0.747	0.738	0.707
477	Rubber and misc. plastics products	0.636	0.588	0.579	0.566
480	Leather and leather products	0.709	0.689	0.665	0.617
	US unweighted average	0.676	0.648	0.636	0.619

Table 4: DAISIE (EU 14), industry classification

r151	Production, processing and preserving of meat and meat products
r153	Processing and preserving of fruit and vegetables
r154	Manufacture of vegetable and animal oils and fats
r155	Manufacture of dairy products
r156	Manufacture of grain mill products, starches and starch products
r157	Manufacture of prepared animal feeds
r158	Manufacture of other food products
r159	Manufacture of beverages
r16	Manufacture of tobacco products
r171	Preparation and spinning of textile fibres
r172	Textile weaving
r173	Finishing of textiles
r174	Manufacture of made-up textile articles, except apparel
r175	Manufacture of other textiles
r176	Manufacture of knitted and crocheted fabrics
r177	Manufacture of knitted and crocheted articles
r181	Manufacture of leather clothes
r182	Manufacture of other wearing apparel and accessories
r183	Dressing and dyeing of fur; manufacture of articles of fur
r191	Tanning and dressing of leather
r192	Manufacture of luggage, handbags and the like, saddlery and harness
r193	Manufacture of footwear
r201	Sawmilling and planing of wood, impregnation of wood
r202	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards
r203	Manufacture of builders' carpentry and joinery
r204	Manufacture of wooden containers
r205	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials
r211	Manufacture of pulp, paper and paperboard
r212	Manufacture of articles of paper and paperboard
r221	Publishing
r222	Printing and service activities related to printing
r223	Reproduction of recorded media
r231	Manufacture of coke oven products
r232	Manufacture of refined petroleum products
r233	Processing of nuclear fuel
r241	Manufacture of basic chemicals
r242	Manufacture of pesticides and other agro-chemical products
r243	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
r244	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
r245	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
r246	Manufacture of other chemical products
r247	Manufacture of man-made fibres
r251	Manufacture of rubber products
r252	Manufacture of plastic products
r261	Manufacture of glass and glass products
r262	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products
r263	Manufacture of ceramic tiles and flags
r264	Manufacture of bricks, tiles and construction products, in baked clay
r265	Manufacture of cement, lime and plaster
r266	Manufacture of articles of concrete, plaster and cement
r267	Cutting, shaping and finishing of stone
r268	Manufacture of other non-metallic mineral products
r271	Manufacture of basic iron and steel and of ferro-alloys (ECSC)
r272	Manufacture of tubes

r273	Other first processing of iron and steel and production of non-ECSC ferro-alloys
r274	Manufacture of basic precious and non-ferrous metals
r275	Casting of metals
r281	Manufacture of structural metal products
r282	Manufacture of tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers
r283	Manufacture of steam generators, except central heating hot water boilers
r284	Forging, pressing, stamping and roll forming of metal; powder metallurgy
r285	Treatment and coating of metals; general mechanical engineering
r286	Manufacture of cutlery, tools and general hardware
r287	Manufacture of other fabricated metal products
r291	Manufacture of machinery for the production and use of mechanical power, except aircraft, vehicle and cycle engines
r292	Manufacture of other general purpose machinery
r293	Manufacture of agricultural and forestry machinery
r294	Manufacture of machine-tools
r295	Manufacture of other special purpose machinery
r296	Manufacture of weapons and ammunition
r297	Manufacture of domestic appliances n.e.c.
r300	Manufacture of office machinery and computers
r311	Manufacture of electric motors, generators and transformers
r312	Manufacture of electricity distribution and control apparatus
r313	Manufacture of insulated wire and cable
r314	Manufacture of accumulators, primary cells and primary batteries
r315	Manufacture of lighting equipment and electric lamps
r316	Manufacture of electrical equipment n.e.c.
r321	Manufacture of electronic valves and tubes and other electronic components
r322	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy
r323	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods
r331	Manufacture of medical and surgical equipment and orthopaedic appliances
r332	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment
r333	Manufacture of industrial process control equipment
r334	Manufacture of optical instruments and photographic equipment
r335	Manufacture of watches and clocks
r341	Manufacture of motor vehicles
r342	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
r343	Manufacture of parts and accessories for motor vehicles and their engines
r351	Building and repairing of ships and boats
r352	Manufacture of railway and tramway locomotives and rolling stock
r353	Manufacture of aircraft and spacecraft
r354	Manufacture of motorcycles and bicycles
r355	Manufacture of other transport equipment n.e.c.
r361	Manufacture of furniture
r362	Manufacture of jewellery and related articles
r363	Manufacture of musical instruments
r364	Manufacture of sports goods
r365	Manufacture of games and toys
r366	Miscellaneous manufacturing n.e.c.

Table 5: DAISIE (EU 14)

	1990	1991	1992	1993	1994	1995	1996	1997
r151	0.463	0.478	0.473	0.473	0.477	0.483	0.537	0.485
r153	0.511	0.523	0.527	0.52	0.513	0.491	0.532	0.489
r154	0.529	0.527	0.522	0.509	0.493	0.533	0.565	0.583
r155	0.496	0.502	0.499	0.484	0.488	0.474	0.523	0.467
r156	0.47	0.456	0.453	0.455	0.462	0.462	0.51	0.465
r157	0.497	0.495	0.497	0.514	0.498	0.491	0.556	0.499
r158	0.511	0.524	0.522	0.523	0.522	0.509	0.506	0.509
r159	0.544	0.545	0.54	0.532	0.515	0.523	0.52	0.518
r16	0.662	0.663	0.675	0.556	0.569	0.631	0.644	0.63
r171	0.586	0.583	0.591	0.594	0.605	0.582	0.579	0.579
r172	0.586	0.617	0.616	0.624	0.634	0.621	0.619	0.619
r173	0.621	0.622	0.609	0.61	0.623	0.595	0.587	0.589
r174	0.542	0.517	0.516	0.515	0.508	0.519	0.512	0.505
r175	0.509	0.546	0.544	0.541	0.525	0.496	0.489	0.482
r176	0.513	0.508	0.523	0.507	0.53	0.517	0.521	0.527
r177	0.647	0.663	0.659	0.669	0.66	0.639	0.639	0.654
r181	1.277	1.175	0.971	0.815	0.767	0.637	0.641	0.645
r182	0.584	0.585	0.585	0.59	0.602	0.593	0.595	0.6
r183	0.634	0.652	0.601	0.634	0.652	0.645	0.65	0.661
r191	0.609	0.618	0.616	0.638	0.676	0.677	0.683	0.679
r192	0.668	0.683	0.695	0.703	0.719	0.696	0.689	0.685
r193	0.626	0.624	0.622	0.631	0.651	0.668	0.671	0.669
r201	0.52	0.524	0.524	0.533	0.535	0.52	0.523	0.534
r202	0.49	0.511	0.521	0.525	0.537	0.524	0.51	0.511
r203	0.487	0.501	0.518	0.511	0.491	0.507	0.502	0.49
r204	0.57	0.585	0.581	0.57	0.557	0.554	0.55	0.546
r205	0.605	0.627	0.625	0.627	0.631	0.588	0.586	0.581
r211	0.5	0.503	0.511	0.521	0.512	0.494	0.501	0.517
r212	0.574	0.582	0.578	0.575	0.576	0.544	0.545	0.536
r221	0.546	0.539	0.544	0.537	0.547	0.562	0.571	0.556
r222	0.536	0.536	0.537	0.531	0.546	0.531	0.516	0.494
r223	0.677	5.026	0.638	0.631	0.667	0.674	0.686	0.67
r231	0.903	0.808	15.821	2.183	1.048	0.739	0.732	0.729
r232	0.613	0.617	0.627	0.594	0.62	0.61	0.6	0.609
r233	0.859	0.825	0.804	0.82	0.804	0.784	0.778	0.775
r241	0.607	0.593	0.594	0.584	0.577	0.581	0.576	0.587
r242	0.588	0.583	0.591	0.594	0.763	0.596	0.596	0.589
r243	0.657	0.644	0.637	0.628	0.629	0.575	0.571	0.565
r244	0.582	0.576	0.568	0.564	0.559	0.545	0.535	0.514
r245	0.632	0.624	0.624	0.622	0.626	0.64	0.632	0.631
r246	0.527	0.557	0.578	0.575	0.585	0.571	0.576	0.531
r247	0.555	0.56	0.562	0.566	0.569	0.597	0.605	0.576
r251	0.635	0.643	0.643	0.639	0.634	0.63	0.634	0.64
r252	0.604	0.611	0.609	0.608	0.606	0.583	0.57	0.57
r261	0.571	0.573	0.573	0.565	0.571	0.568	0.564	0.564
r262	0.617	0.604	0.597	0.596	0.592	0.572	0.566	0.555
r263	0.752	0.752	0.752	0.752	0.75	0.749	0.746	0.743

r264	0.558	0.567	0.573	0.568	0.569	0.568	0.557	0.543
r265	0.523	0.531	0.531	0.527	0.525	0.538	0.526	0.517
r266	0.549	0.57	0.588	0.587	0.58	0.56	0.55	0.534
r267	0.628	0.632	0.637	0.638	0.64	0.613	0.604	0.605
r268	0.578	0.56	0.556	0.569	0.563	0.564	0.554	0.542
r271	0.54	0.546	0.537	0.52	0.51	0.53	0.524	0.53
r272	0.638	0.679	0.685	0.693	0.691	0.656	0.648	0.647
r273	0.528	0.573	0.595	0.588	0.595	0.551	0.579	0.556
r274	0.541	0.547	0.55	0.541	0.535	0.553	0.544	0.546
r275	0.635	0.641	0.638	0.621	0.636	0.654	0.643	0.646
r281	0.532	0.549	0.551	0.554	0.545	0.53	0.52	0.513
r282	0.607	0.617	0.622	0.623	0.621	0.592	0.585	0.579
r283	0.767	0.763	0.756	0.754	0.736	0.716	0.712	0.705
r284	0.662	0.652	0.652	0.675	0.676	0.679	0.673	0.679
r285	0.637	0.641	0.633	0.624	0.617	0.563	0.558	0.561
r286	0.67	0.661	0.663	0.647	0.635	0.625	0.616	0.613
r287	0.602	0.606	0.605	0.61	0.602	0.582	0.566	0.565
r291	0.669	0.668	0.671	0.651	0.643	0.644	0.638	0.64
r292	0.648	0.655	0.656	0.641	0.626	0.599	0.595	0.598
r293	0.597	0.607	0.614	0.615	0.589	0.571	0.576	0.579
r294	0.729	0.736	0.73	0.711	0.704	0.72	0.72	0.719
r295	0.689	0.696	0.697	0.686	0.673	0.622	0.616	0.617
r296	0.625	0.628	0.627	0.68	0.636	0.625	0.633	0.651
r297	0.637	0.659	0.666	0.667	0.661	0.657	0.649	0.644
r300	0.626	0.675	0.666	0.639	0.627	0.6	0.6	0.619
r311	0.625	0.624	0.627	0.566	0.581	0.591	0.577	0.589
r312	0.803	0.81	0.812	0.802	0.801	0.778	0.779	0.776
r313	0.525	0.525	0.538	0.521	0.533	0.475	0.458	0.456
r314	0.598	0.597	0.6	0.588	0.622	0.61	0.61	0.612
r315	0.626	0.613	0.615	0.61	0.602	0.583	0.573	0.568
r316	0.65	0.652	0.65	0.69	0.696	0.646	0.646	0.649
r321	0.622	0.629	0.613	0.599	0.608	0.618	0.614	0.621
r322	0.505	0.52	0.526	0.542	0.524	0.512	0.53	0.542
r323	0.62	0.601	0.604	0.582	0.593	0.596	0.581	0.565
r331	0.619	0.632	0.627	0.609	0.598	0.565	0.563	0.548
r332	0.718	0.718	0.714	0.663	0.665	0.669	0.661	0.664
r333	0.72	0.729	0.727	0.804	0.808	0.682	0.669	0.684
r334	0.686	0.675	0.674	0.667	0.649	0.656	0.661	0.653
r335	0.794	0.788	0.774	0.763	0.76	0.743	0.752	0.726
r341	0.684	0.698	0.698	0.709	0.689	0.67	0.678	0.671
r342	0.601	0.627	0.643	0.646	0.624	0.597	0.573	0.567
r343	0.69	0.697	0.685	0.68	0.693	0.685	0.687	0.693
r351	0.534	0.523	0.518	0.532	0.528	0.507	0.504	0.5
r352	0.582	0.569	0.624	0.637	0.637	0.654	0.651	0.653
r353	0.691	0.693	0.686	0.691	0.694	0.687	0.702	0.697
r354	0.642	0.651	0.663	0.682	0.698	0.668	0.664	0.672
r355	0.599	0.593	0.689	0.712	0.687	0.636	0.613	0.606
r361	0.583	0.584	0.589	0.589	0.578	0.57	0.559	0.552
r362	0.581	0.639	0.629	0.651	0.662	0.59	0.556	0.568
r363	0.765	0.686	0.68	0.673	0.729	0.79	0.779	0.881

r364	0.591	0.588	0.594	0.612	0.643	0.707	0.66	0.945
r365	0.669	0.546	0.535	0.538	0.566	0.648	0.645	0.735
r366	0.616	0.638	0.633	0.624	0.633	0.58	0.56	0.561
Average	0.61646	0.66114	0.76679	0.62699	0.61757	0.60145	0.6003	0.60054

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Endnotes

1. Our econometric approach is innovative. It is closest to that of Ellison and Glaeser (1999). Previous econometric studies of industrial location in Europe, such as Brülhart et al (1996), have looked at changes in summary measures of industrial location as a function of industry characteristics. Our approach uses the full measure of industry production by country, as determined by the interaction between country and industry characteristics.

2. Gross value of output measures are preferred if changes in outsourcing are primarily to other sectors, rather than own sectors. This appears to be the case from inspection of input-output matrices.

3. The US regional data on manufacturing employment have been provided by Gordon Hanson.

4. See Krugman (1991).

5. All the way through the report we shall use some sort of moving average to try to remove spurious fluctuations due to the differential timing of country and sector business cycles.

6. Despite the overall rise in specialization in thirteen out of fourteen countries from 1980/83 to 1994/97, four countries – France, Great Britain, Portugal and the Netherlands – actually became marginally less specialized during the second half of this period (1988/91-1994/97) . However, for France, Great Britain and Portugal these slight decreases in specialization are not enough to undo the large increases that they saw during the 1980s. The overall picture is one of a general increase in specialization over the last two decades.

7. EC1 comprises Belgium, France, Germany, Italy and the Netherlands. EC2 comprises Denmark, Ireland and the UK. EC3 comprises Greece, Spain and Portugal. Finally EC4 comprises Austria, Finland and Sweden.

8. The Gini coefficient of specialization summarises the distribution of relative production shares, $r_i^k(t)$, across industries in a given country. The Lorenz curve associated with the measure gives cumulated values of $v_i^k(t)$ on the vertical axis, against cumulated values of $\overline{v}_i^k(t)$ on the horizontal, and observations are ranked in descending order by the gradient, $r_i^k(t)$.

9. Note that the relative shares employed here differ from the type of relative shares based on Balassa (1965)'s concept of revealed comparative advantage, that are frequently used in the literature.

10. We measure these at a single point in time, and assume that they are unchanging. This is because our focus on industrial structure means that we seek to capture, eg. whether France has acquired more capital intensive sectors, not whether sectors in France have become more capital intensive.

11. The decline in the average technology level characterising the industrial composition of Greece and Portugal, partly relates to the slight decrease in Industrial Chemicals (Greece and Portugal) and Office & Computing (Portugal) experienced by these countries between the early eighties and mid-nineties, and partly to stronger specialization in low tech industries like Wearing apparel (Portugal), and Food and Beverages (Greece).

12. The Gini coefficient of concentration measures the dispersion of a distribution of absolute production shares, $s_i^k(t)$, across countries for a given industry. The Lorenz curve associated with the coefficient has cumulated s_i^k on the vertical (as before), cumulated number of locations on the horizontal (each interval with the same width, 1/N). Locations are ranked by s_i^k (the gradient of the Lorenz curve).

13. Traditionally researchers have tended to consider relative instead of absolute shares of industries when constructing summary measures of concentration, see e.g. Brülhart and Torstensson (1996). Summary indices of concentration based on relative shares are less informative as they are beset with problems related to the different sizes of the units of observations (countries). An industry will be absolutely concentrated if particular countries -- independent of the size of the countries -- have very large shares of that particular industry. However, if we look at relative indices of concentration, the degree of concentration of an industry will depend on the size of the countries that have the largest shares of the industries. See Haaland et al (1999) for further discussion of absolute versus relative indices.

14.Particularly since the smaller EU countries have grown more rapidly than the larger EU countries, and that the industries that have declined in concentration typically are industries where larger countries have tended to have the highest shares.

15.See, for example, Brülhart and Torstensson (1996), Amiti (1999) and Brülhart (1998), who regress these summary statistics on a number of industry characteristics.

16. In a simple Heckscher-Ohlin model this is the Rybczynski effect.

17. The standard references on testing trade theory are Leamer and Levinsohn (1995) and Helpman (1999). Davis and Weinstein (1999) test one hypothesis from economic geography, but fall short of developing a general specification.

18. Earlier versions of this report did not use heteroscedastic consistent standard errors. Because OLS provides consistent estimators, even in the presence of heteroscedasticity, our point estimates have not changed. However, OLS *is* inefficient in the presence of general forms of heteroscedasticity. Our new estimates generally increase the standard errors of the coefficients. For the interaction terms, this only changes the results of significant tests for one of the interactions in 1997. Thus, the market potential / sales to industry interaction is now significant at the 10% rather than the 5% level. There are also minor changes to the significance of several of the levels variables. But, these variables are only of secondary interest, and we do not comment on them in the text.

19. This is actually a simplification. There are somewhat complicated restrictions on the parameter values. For example, the market potential variable captures the cut-off for all three intensities that are interacted with market potential. Because our interest is in the sensitivity estimates, rather than the cut-offs, we have presented the raw results for the intensity and country characteristic coefficients. In addition, all variables have been normalised by their standard deviation to make comparisons across variables more appropriate - this makes it even harder to calculate the cut-offs from information on the parameter estimates.

20.Imagine including a dummy variable for Ireland for one of the high tech sectors. A positive value of the dummy variable will occur if the residual for Ireland in that sector is positive. Even if there is no effect, a positive residual should occur 50% of the time - precisely because residuals should be randomly distributed

21. Gross production value is, to our knowledge, not available for the services sectors and time span employed in the present report; we therefore have to use another measure of activity in services industries - namely employment.

22. The OECD (1999) studies national and regional specialisation in Europe based on a sectoral output classification that covers both manufacturing and services (8 economic sectors), they report increased national specialization over the period 1980 to 1996. However, moving to a more aggregated sectoral classification (3 sectors: agriculture, manufacturing, and services) while analysing regional (NUTS 1) instead of national specialization, we see a fall in the average regional specialization.

23. Note that, data on all services apart from Financial services, Insurance, Real Estate and Business Services are missing for Ireland and Greece.

24. We use the average of the 1990 input-output value tables of Denmark, France, Germany and the UK.

25. Note that due to the fact that the EU sectors are aggregated up to the 21 US sectors before the indices are calculated, the indices reported in table 6.1 are not identical to those in table 2.3.

26. See Kim (1995) and Ellison and Glaeser (1999).