19.10.98

# What determines the economic geography of Europe?*

Jan I. Haaland
*Centre for International Economics and Shipping*
*Norwegian School of Economics and Business Administration*

Hans Jarle Kind
*Centre for International Economics and Shipping*
*Norwegian School of Economics and Business Administration*

Karen Helene Midelfart Knarvik
*Centre for International Economics and Shipping*
*Norwegian School of Economics and Business Administration*

Johan Torstensson**
*Department of Economics*
*Lund University*

*DISCUSSION PAPER NO. 19/98*
*DEPARTMENT OF ECONOMICS*
*NORWEGIAN SCHOOL OF ECONOMICS AND BUSINESS ADMINISTRATION*

ABSTRACT: This paper focuses on what the driving forces behind industry localisation in Europe are. Based on traditional as well as new trade theory and new economic geography our cross-sectoral empirical analysis seeks to explain the pattern of relative and absolute concentration of manufacturing activity. By comparing impact over time, we also consider whether the single market has had an influence on factors determining localisation. The results indicate that the by far most important determinant of economic geography in Europe is localisation of demand. There is also evidence of cumulative causation in the sense that absolute concentration of production and expenditure mutually influence each other.

Keywords: industrial localisation, agglomeration, comparative advantage,
economic geography
JEL classification: C21, F14, F15

---

* Thanks to Mary Amiti, Gordon Hanson, Lars Lundberg and other participants at the Arne Ryde Symposium in Lund 1998 for valuable comments and suggestions, and to Kjell G. Salvanes and Kjell Erik Lommerud for stimulating discussion. The research has been financed by the Research council of Norway.

** This work was started when Johan Torstensson visited Bergen in the fall of 1997. It was inspired by Johan's earlier work on similar issues, and - although the paper was not finished until after Johan's sudden death - it has benefited very much from his insights and experience.

## 1. Introduction

Why are some industries highly concentrated geographically, while others are dispersed? Are there underlying characteristics that can help explain the differences in specialisation and concentration between industries? How can trade theory contribute to a better understanding of the observed pattern of concentration? These are some of the key questions we address in this paper. We want to know what the driving forces in determining localisation of industries in Europe are, and we also want to see if the significance of these forces have changed over time.

To some extent we follow a line of work of a relatively small and young empirical trade literature that has been pursued by Amiti (1997), Davis and Weinstein (1996, 1997 and 1998), Brülhart and Torstensson (1997), and Brülhart (1997) a.o. But unlike previous work, our main focus is not on how economic integration has affected the geographical concentration of industrial activity in Europe. Instead, we concentrate on explaining the economic geography of Europe at certain points in time. To the extent that we consider the impact of integration this is done more indirectly: comparing what the determining factors for industrial localisation are at different points in time, changes in the relative importance of different factors over time may be attributed to the effect of economic integration.

In analysing the patterns of industrial localisation, different approaches may be useful to highlight different issues. The approach chosen here focuses on *industrial concentration* and accordingly uses summary measures (concentration indices) to elaborate on cross-sectoral variation. In order to obtain a complete picture of the economic geography of Europe, this work should be seen as a complement to analyses of trade and production patterns, e.g. Lundbäck andTorstensson (1997) and Davis andWeinstein (1996, 1997).

The paper is organised as follows: section 2 provides a theoretical framework for how to think about industry localisation, and discusses the factors that need to be taken into account in order to construct a complete empirical model. In section 3 the data sources are reviewed and descriptive analysis performed, while section 4 presents the empirical analyses. Section 5 concludes.

## 2. Theoretical Framework

Why are some industries more geographically concentrated than others? What are the determinants of industry localisation? Are these stable over time, or do they change in relative importance? When thinking about geographical concentration of industries in Europe, we should be careful in choosing how to measure concentration. In particular, we should distinguish between absolute and relative geographical concentration. An industry is relatively concentrated if it differs from the average spread of production between countries; it has a high degree of absolute concentration if it is unevenly distributed between the countries. For a group of countries with identical size, the two measures coincide. But if countries differ in size, this may no longer be the case. High relative concentration of an industry implies a high degree of country specialisation, while this is not necessarily the case when there is high absolute concentration. As an example, think of two countries were one is twice the size of the other; and two industries - one which is split 50-50 between the two countries, and one for which the small county has a market share of 1/3 and the large one 2/3. The former industry would be more concentrated than the latter in relative terms, while the opposite is true if we use an absolute measure of concentration. Depending on what we focus on, one measure or the other could be the correct one. If we study comparative advantage and specialisation, that clearly has to do with relative concentration; but if we think about scale economies and trade, then the relevant measure must be the absolute concentration of production.

We will use both measures of concentration and focus on what predictions can be made about relative and absolute concentration on the basis of traditional and new trade theory as well as new economic geography. We shall moreover look at to what extent relative and absolute indices coincide, i.e. to what extent the industries that are highly concentrated in relative terms also are so when we look at absolute concentration.

Earlier work on geographical concentration of European industries has mainly focused on relative concentration (an exception is Davies and Lyons (1996)) using measures such as the Hoover-Balassa index and Gini coefficient. We want to emphasise the importance of analysing both absolute and relative industrial concentration in order to provide a more complete picture of industry localisation in Europe. While some trade theories -- in particular comparative advantage theory -- make clear predictions about relative concentration but say little or nothing about absolute concentration, the opposite is true for other theories -- such as new economic geography models. Hence, if we want to draw on the insights from all theories, we should realise that testing different trade theories requires different empirical models.

In constructing a relative concentration index ($S_i^R$) we follow the approach of Amiti (1997), who uses a modified version of the Hoover-Balassa index

$$S_i^R = \sqrt{\frac{1}{c}\sum_j \left(s_{ij} - s_j\right)^2}$$

where $s_{ij}$ depicts the share of the production in industry *i* carried out in country *j*, $s_j$ country *j*'s share in total production[1] and *c* the number of countries in the sample. The more specialised the countries are in their production, the more concentrated will an industry appear. For absolute concentration ($S_i^A$) country size should not be adjusted for; hence, we apply the following measure:

$$S_i^A = \sqrt{\frac{1}{c}\sum_j \left(s_{ij}\right)^2} .$$

[1] Total production covers all manufacturing in the represented European countries.

The size of an industry can be measured in various ways; e.g. by production (output), value added or employment. While focusing on production, we have also constructed concentration indices based on value added and employment, to check whether the choice of measure matters for the results.

In explaining differences in the degree of geographical concentration across industries, traditional trade theory, new trade theory and new economic geography offer distinct predictions about what characterises the more concentrated ones. We aim at constructing explanatory variables that proxy for factors that according to these theories are responsible for differences in geographical concentration.

*Capturing Heckscher-Ohlin: Factor intensities*

Given that relative factor endowments differ across countries, differing factor intensities across industries may induce country specialisation and relative geographical concentration of industries. Assuming a lumpy distribution of factor endowments, the more intensive an industry is in the use of a certain factor, the more concentrated would we presume the industry to be. In order to capture how 'Heckscher-Ohlin' effects may explain sectoral variation in the degree of relative concentration, we use indices that measure 'deviation of factor intensities from mean' (see Amiti (1997)). The factors we focus on are labour and capital; with capital being divided into human capital and physical capital.[2]

Deviation of labour intensities from mean is calculated using:

[2] In order to provide a complete list of explanatory variables, natural resources such as energy, land and forest should preferably also have been included. However, the kind of data required to include these variables in our analysis have not been available. As the empirical analysis will concentrate on localisation patterns of *manufacturing* only, omitting land and forest is not considered to cause serious problems. As for energy, unlike human capital and labour this factor is highly traded internationally. Hence, no clear predictions can be made based on comparative advantage theory about specialisation and concentration of industries deviating from mean energy intensity. The pattern of production and trade will depend on market conditions and relative transaction costs of energy relative to energy intensive products (see Norman and Venables (1995)).

$$LAB_i = \left| \frac{\sum_j E_{ij}}{\sum_j VA_{ij}} - \frac{\sum_j \sum_i E_{ij}}{\sum_j \sum_i VA_{ij}} \right|$$

where $E$ depicts employment and $VA$ depicts value added. Hence, labour intensity is measured as the number of employees relative to value added. Looking at the measure for labour intensity we see that it will typically take on high values for industries that use either a lot of labour or little labour relative to the average. A high value thus signals that the industry in question differs from the average industry in terms of labour use: it may be labour intensive or non-labour intensive. In either case, we expect the industry to be relatively concentrated.

Following Balassa (1979 and 1986), human capital intensity is measured by average labour compensation, while physical capital intensity may be defined as average non-wage value added.[3] Deviation of human capital intensity from mean is given by

$$HCAP_i = \left| \frac{\sum_j W_{ij}}{\sum_j E_{ij}} - \frac{\sum_j \sum_i W_{ij}}{\sum_j \sum_i E_{ij}} \right|.$$

It tells us to what extent an industry *i* is relatively intensive in the use of human capital, or alternatively, relatively unintensive in the use of human capital. The more the human capital intensity of an industry differs from the average, the higher degree of country specialisation do we expect, and the more geographically concentrated will the industry be in terms of relative concentration. As for physical capital, a separate measure of this is not included in the empirical model, since physical capital intensity would be reflected in the two measures we already have of factor intensity. If value added is made up of labour, human capital and of physical capital, then physical capital intensity different from the average must also imply that one or both of the two measures above -*LAB* or *HCAP* - show high values.

[3] 'Labour compensation' includes wages as well as the costs of supplements such as employer's compulsory pension or medical payments.

*Capturing Ricardo: Technological differences*

According to traditional trade theory, differences in relative technology between countries may give rise to comparative advantages and hence specialisation. Letting differences in technology be reflected by differences in labour productivity, defined as value added per employee (see Torstensson (1996)), we define the index $TECDIF_i$:

$$TECDIF_i = \sqrt{\frac{1}{c}\sum_j \left[ \frac{\frac{VA_{ij}}{E_{ij}}}{\frac{1}{c}\sum_j \frac{VA_{ij}}{E_{ij}}} - \frac{\sum_i \frac{VA_{ij}}{E_{ij}}}{\frac{1}{c}\sum_j \sum_i \frac{VA_{ij}}{E_{ij}}} \right]^2}$$

The first term within the brackets measures labour productivity in industry *i* in country *j* relative to the average labour productivity in this industry across countries, while the second term measures the average labour productivity in country *j* relative to the other countries. Hence, the more significant the cross country differences in relative productivity, the higher the value of $TECDIF_i$; absolute productivity differences between countries will on the other hand not result in high values of this measure. From comparative advantage theory we know that the more important relative productivity differences are, the higher will the degree of cross country specialisation be, and the more geographically concentrated in terms of relative concentration should the industry be.

*Capturing the new trade theory: 'Market size effects'*

According to traditional trade theory demand bias in favour of a particular good will tend to cause net import of this good, since production structures are solely determined by relative prices and supply factors. New trade theory predicts more or less the opposite: a demand bias in favour of a particular good creates a large home market for this good, and the interaction of economies of scale and trade costs typically lead to net export. Cross country differences in expenditure structure may, thus, determine production structure and industry localisation. Based on newer trade theory we typically expect industries to be more concentrated the more concentrated the demand for the goods produced by this industry.

Unlike traditional trade theories new trade theory allows us to make predictions both for relative and absolute concentration. In order to capture the impact of demand bias on industrial localisation we construct two indices: one capturing relative and one capturing absolute concentration of expenditure. The former is used as an explanatory variable in models with relative industrial concentration as regressand, while the latter appears as such in models with absolute concentration as regressand. The indices for relative and absolute concentration of expenditure are given by $EXPEN_i^R$ and $EXPEN_i^A$ respectively:

$$EXPEN_i^R = \sqrt{\frac{1}{c}\sum_j\left(\frac{e_{ij}}{\sum_j e_{ij}} - \frac{\sum_i e_{ij}}{\sum_j\sum_i e_{ij}}\right)^2}, \qquad EXPEN_i^A = \sqrt{\frac{1}{c}\sum_j\left(\frac{e_{ij}}{\sum_j e_{ij}}\right)^2}$$

where $e_{ij}$ is expenditure in country *j* on industry *i*. Expenditures are calculated as production plus imports minus exports; hence in addition to final consumption the measure includes the demand for goods as intermediates. Let us first take a closer look at the measure for *relative* concentration of expenditure, $EXPEN_i^R$. The term in the brackets tells us whether the expenditure share of country *j* on industry *i* goods deviates from the 'total expenditure' share of country *j*. If there are two countries, and one is half the size of the other in terms of total spending, $EXPEN_i^R$ will be greater than zero - indicating some degree of relative concentration of industry *i* - if expenditure in the smaller country is different from one half.

This way of capturing new trade theory effects is similar to what Lundbäck and Torstensson (1997) apply in their study of net exports, and what Davis and Weinstein (1996, 1997) use when analysing specialisation patterns, but it deviates from the approach taken in previous studies of industrial concentration where focus has been on scale economies as such.

Amiti (1997) uses average firm size (proxying for scale economies) and Brülhart and Torstensson (1996) use engineering estimates of minimum efficient scale in order to capture the content of the new trade theory. Their analyses are based on the assumption that the more important scale economies are in an industry, the higher degree of *relative concentration* will we see in that industry. We want to argue that according to theory, the degree of scale economies characterising an industry tells us something about *where* we would typically expect to see the industry to be located: in the 'centre' or in the 'periphery' - in small or large countries (see e.g. Krugman (1980), Krugman and Venables (1990), and Amiti (1998)). The knowledge of scale economies alone does, however, not allow us to draw any conclusions with respect to *how* concentrated a particular industry will tend to be *relative* to other industries. Still, even though degree of scale economies have an ambiguous impact on *relative* concentration, it does suggest that industries characterised by significant economies of scale will be *absolutely* more concentrated than others.

Regardless of whether relative or absolute concentration is considered, scale economies and trade costs imply that market size may matter for industrial localisation. In order to capture such market size effects, our expenditure index - measuring the distribution of demand across countries - appears as an appropriate variable. Brülhart and Torstensson (1997) try to capture some of the same effects through their centrality index, but while their approach focuses on the centrality of a country or a region, our measure is industry-specific, and will thus pick up differences in demand patterns between industries.

To capture the contents of the new trade, the analysis of absolute concentration requires the inclusion of the variable $EXPEN_i^A$ (which is similar to the measure for relative concentration, but does not adjust for cross country size differences) as well as a variable measuring scale economies ($SCEC_i$). $SCEC_i$ is defined as the percentage reduction in average costs for each percent increase in output. In accordance with the discussion above, we would *ceteris paribus* expect the industries characterised by the more significant scale economies to be the absolutely more concentrated ones.

Unlike the other explanatory variables the demand bias variables are possibly not exogenous – i.e. independent of the pattern of industrial concentration. The new economic geography (see for instance Krugman (1991) and Fujita, Krugman and Venables (1998)) emphasises the importance of cumulative causation, and analyses how forward and backward market linkages can cause industrial agglomeration. The market linkages may relate to the markets for final goods, for intermediates or for factors. Their existence implies that not only is industrial localisation determined by the localisation of expenditure, but also vice versa. The possible endogeneity related to the demand bias variable is important to have in mind when turning to the empirical analysis.

Finally, it may be argued that positive production effects of demand biases do not only appear within the framework of new trade theory; such effects could be in accordance with a Heckscher-Ohlin model as well, once we introduce trade costs in the model. Empirical results suggesting that demand biases are of importance for industrial localisation, can thereby not necessarily be interpreted as support of the new trade theory. Davis and Weinstein (1996) discuss the relationship between specialisation patterns and demand biases, and find that the size of the estimated coefficient allows them to distinguish between Heckscher-Ohlin models and new trade theory models; if a demand bias implies a more than proportional increase in production, it is in accordance with new trade theory but not with Heckscher-Ohlin, and vice versa. Lundbäck and Torstensson (1997) are similarly able to make clear distinctions between new trade theory and comparative advantage theory in their study of market size effects for net exports. In our model of industry concentration we are not able to distinguish unambiguously between the theories, in the sense that a certain estimated coefficient should confirm Heckscher-Ohlin, while another value would indicate some other theory. But then the purpose of our study is not really to put one theory up against the other - the purpose is to get a feeling for what the important determinants of geographical concentration of industries are.

*Capturing the new economic geography: Positive market linkages*

To some extent we have already approached the new economic geography and its implications for industrial agglomeration in the above discussion of market size effects. Still, from the new economic geography we furthermore know that input-output structures may be important determinants of industrial agglomeration.

If an industry is characterised by extensive input-output linkages, in the presence of positive trade costs a firm will be able to reduce its costs by locating together with other firms within the industry. However, proximity to other firms also means more fierce competition, which is frequently referred to as the neoclassical effect of localisation. The pro-competitive effect of proximity therefore works against industrial agglomeration. From the new economic geography (see e.g. Baldwin and Venables (1995)) we know that imperfect competition and increasing returns to scale can modify or even reverse the traditional thinking about localisation. Adding imperfect competition and increasing returns to the story, input-output linkages become sources of pecuniary externalities that encourage industrial agglomeration. Proximity to rivals does now not only imply increased competition, it also affects a firm's market size and costs.

The extent to which an industry uses its own products as intermediates can thus affect the degree to which it is absolutely concentrated. To account for the impact of intra-industry input-output linkages, we construct the $IO_i$ indices:

$$IO_i = \frac{\sum_j Input\ from\ own\ industry_{ij}}{\sum_j Output_{ij}}$$

The more of its own production an industry uses as intermediates, the more *absolutely* concentrated would we, according to the theory, expect it to be. The theory does not, however, allow us to make clear predictions with respect to the impact of intra-industry linkages on relative concentration: while new economic geography explains how the existence of such linkages can have implications for country specialisation, it does not allow for unambiguous predictions about cross sectoral variation in relative concentration. If two industries are identical except for the fact that intra-industry linkages are stronger in one than in the other, then theory says that the industry with the stronger linkages will tend to agglomerate in the larger country; hence absolute concentration is higher in that industry. Whether this implies more or less specialisation in relative terms, depends on the pattern of specialisation in absence of linkages: if the small country e.g. has a comparative advantage in the industry in question, then the agglomeration forces will tend to lower the degree of relative concentration in the industry with strong linkages.

According to the new economic geography we expect the ’agglomeration impact’ of intra-industry linkages to be stronger the higher the degree of scale economies characterising the production in an industry (see e.g. Krugman and Venables (1996)). Observing two industries with intra-industry linkages of the same magnitude, if scale economies differ across the industries, we would expect the industry with the higher returns to scale to be the most (absolutely) geographically concentrated one. Hence, the earlier included scale economies variable is also required in order to account for the interaction between market linkages and scale economies.

It may be objected that the information contained in the input-output variable is already captured through the expenditure measures introduced above. Still, looking at input-output tables for various industries (see EUROSTAT Input-Output tables, and Midelfart Knarvik and Mæstad (1997)), it is clear that with a few exceptions sales to own industry account for a minor part of an industry’s production, and may thus more or less "disappear" in the expenditure variable. So despite a small overlap, adding the intra-industry I/O variables allows for additional information to be extracted from the data. New economic geography theory predicts that input-output linkages should have two types of effects -- backward linkages affecting market size for the industry, and forward linkages through which the cost of production is affected. Even if the expenditure variable captures some of the backward linkages, we would still need the *IO* variable to pick up the agglomeration effects of forward linkages.[4]

*Trade costs*

Trade costs matter for the pattern of specialisation and concentration, and the existence of trade costs is also important for the effects of several of the variables discussed above. In particular for input-output linkages or market size to affect localisation, the existence of trade costs is essential.

As we focus on manufacturing production and concentration in EU countries, there are no tariffs. However, it is well know that there have been and are non-tariff barriers even between the EU-countries, and even if NTBs are difficult to quantify, there are clear sectoral difference. In our model we try to capture the effects of trade costs by grouping industries according to the importance of NTBs within Europe, using the classification from Buigues, Ilzkovitz andLebrun (1990).

Although it is clear that trade costs matter for industrial location and specialisation both in traditional and new theories of international trade, the predicted effects on geographical concentration differ. In traditional trade theory, the lower the trade costs are, the more will the

[4] It could be argued that in a complete model, not only input-output linkages within an industry but also such linkages between different but related industries should be included. That would require more work on the data side as well as more sophisticated econometric techniques, and will have to be the subject of future research.

countries specialise to exploit their comparative advantages, and hence, the higher will the relative concentration of industries be. In this sense there are clear predictions about the effects of liberalisation on relative concentration; however, in our cross-sectoral analysis we should be careful in interpreting differences in trade costs between industries in the same way as the effects of general liberalisation. In general equilibrium the pattern of specialisation in an industry depends not only on the trade costs in that industry, trade costs in other industries matter as well. Nevertheless, in a Heckscher-Ohlin world we should probably expect to find a negative impact of (higher) trade costs on relative concentration in an industry.

In new trade theory and new economic geography models, there is a trade-off between the advantage of being close to the larger market and being where factor costs are lower. If factor prices were the same, firms would tend to locate in a large market rather than a small one. However, that would give rise to pressure in factor markets in the larger country, and hence a cost advantage in the smaller country, causing some firms or industries to find it more attractive to locate in the smaller country. The trade-off depends on the importance of scale economies and trade costs in the industry. The lower the trade costs are, the less important will it be for the industry in question to locate close to the centre; hence the lower the trade costs, the less concentrated (in absolute terms) would the industry to be (see Amiti (1998)). So according to new trade theory, we should expect a positive relationship between trade costs and absolute concentration in our cross-sectoral analysis.

Again it is worth noting that while traditional theory allows us to make predictions about relative concentration, new theories is about absolute concentration. We cannot make clear predictions about absolute concentration from a Heckscher-Ohlin model; nor can we say what happens to relative concentration in a new economic geography model.

## 3. Data sources and descriptive analysis

### 3.1 The Data

We primarily base our analysis on data from the OECD STAN database and EUROSTAT Input-Output tables. Our data set includes thirteen out of the fifteen EU countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Portugal, Spain, Sweden, and United Kingdom. The sample includes all manufacturing activity in the countries under study, represented by 35 sectors classified according to ISIC Rev.2, four digit level.

Input-output data were only available for seven of the countries in the sample; input-output linkages are thus calculated as a mean across these countries. Previous work has shown that the differences across European countries with respect to the magnitude of such linkages are minor (see Midelfart Knarvik and Mæstad (1997)); hence, the lack of data from the remaining countries should not have any serious consequences.

As for scale economies we use the engineering estimates of minimum efficient scale (MES) calculated by Pratten (1988) and transformed into suitable measures ('percentage reduction in average costs for a one percent increase in output') by Cawley and Davenport (1988). Pratten's MES measures take into account two indicators: MES as a percentage of the output of the industries and the cost gradient below the MES. Non-tariff barriers (*NTB*) accruing to intra-European trade have been developed by Buigues, Ilzkovitz and Lebrun (1990). These were adjusted to fit the industry classification of the OECD/EUROSTAT.

### 3.2 A brief descriptive analysis of geographical concentration in Europe

Table 1 presents sample statistics of the data for 1992; the industries are ordered in decreasing values of relative concentration in production, $S_i^R$. For all columns, except *NTB*, the numbers are values relative to the average for the respective column (thus, $S_i^R$ >1.0 indicates that industry *i* is more concentrated than 'the average industry'). The table indicates a clear positive relationship between relative industry concentration and relative concentration of expenditures, while the picture is less obvious for the other variables. The corresponding table for year 1985 (available on request) does not reveal any qualitative differences in this respect.

There are significant differences across industries regarding the extent to which they are geographically concentrated. In 1992 as well as 1985 categories such as Railroad Equipment, Transport Equipment n.e.c., Aircraft, and Pottery & China etc. were among the most concentrated, while Plastic Products n.e.c., Metal Products and Iron & Steel were relatively dispersed both years. (Table 2 shows the concentration data in both relative and absolute terms in the two years.) However, for certain other industries there have been significant changes. Most notably, while Drugs & Medicines and Chemicals excluding drugs were among the ten least concentrated in 1985, they are in the upper half in 1992. On average, the relative concentration index has increased by 11.4% during this period, and only very few industries have seen a reduction in relative concentration. If we focus on the ranking of industries in terms of relative concentration (column 2 and 4 in table 2), there are substantial changes over the period from 1985 to 1992.

Table 3 shows the simple correlation matrix between the variables for 1992, and confirms the impression that there is a strong direct relationship between relative $S_i$ and *EXPEN*. This holds whether we use concentration data for production, value added, or employment. Though statistics for simple correlation have limited information value, it may be noted that both *LAB* and *HCAP* always have the expected signs. We shall relegate the discussion of the other explanatory variables until we have performed the regression analysis, but as discussed in section 2 we do not have any *a priori* beliefs for either the effects of *NTB*, *IO* or *SCEC* on relative concentration.[5]

[5] Table 4 gives the simple correlation matrix for relative concentration in 1985, while tables 5 and 6 show the corresponding tables for absolute concentration.

If we compare ranking of industries according to relative and absolute concentration (see table 2), it is interesting to note that industries like Motor Vehicles, Electrical Apparatus n.e.c., Machinery and Equipment n.e.c., Radio, TV & Communication Equipment and Office and Computing Machinery are all among the most concentrated ones in terms of absolute concentration, whereas these are not particularly concentrated in relative terms. That implies that these industries are typically localised in large countries. It is worth noting that these are all industries where scale economies and imperfect competition play an important role. Railroad Equipment, Wearing Apparel and Shipbuilding and Repairing are examples of industries that are fairly concentrated in relative terms, but not in absolute terms. The reason must be that some relatively small countries are specialised in these industries.

## 4. Empirical analysis

We formulate two empirical models: one to explain cross sectoral variation in the degree of relative geographical concentration and one to explain cross sectoral variation in the degree of absolute geographical concentration. From the theoretical considerations above, it follows that traditional trade theory only makes unambiguous predictions with respect to relative concentration, new trade theory makes predictions for both relative and absolute concentration, while new economic geography only allows for clear predictions to be drawn with respect to absolute concentration.

Our data observations are for the years 1985 and 1992. Hence, we have information on concentration patterns both before and after the completion of the ’Single Market’. This enables us to elaborate on whether the relative importance of the forces driving agglomeration of industrial activity have remained stable through the integration process or changed over time. Exactly because there is a possibility of agglomeration forces losing or gaining importance over time, the data from the two periods are not pooled, since pooling might entail loss of valuable information. Instead, the models explaining relative and absolute concentration respectively are estimated twice, with 1992 as well as 1985 data.

### 4.1 Explaining cross-sectoral variation in relative concentration

The equation employed to explain relative concentration of industry *i* takes the following form:

$$S_i^R = a + b_1 LAB_i + b_2 HCAP_i + b_3 TECDIF_i + b_4 EXPEN_i^R + b_5 SCEC + b_6 IO_i + b_7 NTB_i \qquad (1)$$

When estimating (1) concentration patterns were evaluated individually for the years 1992 and 1985; the results from linear OLS regressions are reported in the first and third column of Table 7a for 1992 and 1985, respectively. Both in 1992 and 1985 the impact of $EXPEN^R$ and $IO$ (intra-industry linkages) are positive and significant, while the impact of other variables differ across the two years. However, before discussing the results further, we shall consider econometric issues that may require modified estimation techniques, and thereby may influence the original results.

*Econometric considerations*

First, since we work with cross section data, heteroscedasticity is a likely problem. As suggested by e.g. Thomas (1997), we therefore use log transformations of equation (1). The results are reported in Table 7b. Based on the assumption that the log-log model is superior to the linear model in terms of statistical properties, we shall in the following concentrate on the former model when performing test and discussing results.

The phenomenon 'cumulative causation' implying that expenditure localisation may not only be decisive for industry localisation, but also vice versa, suggests that reversed causality and endogeneity might also be a problem. Endogeneity implies contemporaneous correlation between the error term and the explanatory variable $EXPEN^R$, and as a consequence, the OLS estimators are inconsistent. To test for endogeneity, a Hausman specification test (see Hausman (1978)) can be used, while a potential endogeneity problem may be dealt with by performing 2SLS estimation.

Both the Hausman specification test and the 2SLS procedure require the use of instrument variables (IV). Instruments should preferably not be affected by the endogeneity, but still be highly correlated with the variables they are instruments for. Such variables are not easy to find, but one common approach - which we shall adopt here - is to use lagged measures. Thus, we calculate the variable $EXPEN^R$ for 1991 and 1984 and use these as instrument for the $EXPEN^R$ in 1992 and 1985 model respectively. The results from the 2SLS estimation are presented in the second and fourth columns of table 7a and 7b, while the Hausman specification test statistics are reported in the same tables. It appears that the null hypothesis of no contemporaneous correlation between $EXPEN^R$ and the error term cannot be rejected, suggesting that endogeneity might be a less severe problem. We shall therefore not discuss the results from the 2SLS regressions any further.

Third, a potential econometric problem is non-normality of the error terms, in which case the OLS estimates may be less efficient than other estimates. Considering the sample which includes 35 different industries, 'outliers 'may be anticipated, since the localisation patterns of certain industries may be determined by factors omitted in the econometric model, such as natural resources. But performing a chi-square goodness of fit test for normality of residuals, at a 5% level of significance the null hypothesis of normality cannot be rejected.

*Results*

Regardless of year, model or estimation technique, in accordance with a priori expectations, $EXPEN^R$ has a significant positive impact on relative concentration. Looking at the standardised coefficients, frequently referred to as Beta coefficients, (table 8) it is moreover obvious that the localisation of expenditure is indeed the most important determinant of industrial localisation.[6] What the empirical analysis does not tell us, is whether the reported impact of demand bias should be interpreted as support for new trade theory or for Heckscher-Ohlin theory in a world with positive trade costs. However, using similar OECD data, Lundbäck and Torstensson (1997) find a tendency for demand bias in favour of a good to affect net export positively, which may allow us to interpret our results as to provide support for the relevance of new trade theory.

While clearly of less importance than expenditure, human capital intensity (*HCAP*) has a – statistically as well as economically – significant influence on relative concentration in 1992 as well as in 1985: the more the human capital intensity of an industry differs from the average, the more concentrated it appears. As for labour intensity (*LAB*), this did not seem to have a significant impact on concentration patterns in 1985. Whether an industry deviated from the average with respect to labour intensity, did in other words not seem to affect the degree of relative concentration of the industry in question. But in 1992, with closer integration between European markets, the degree of labour intensity appears to matter for relative concentration - although not as much as expenditure localisation and capital intensity. The evidence suggests that the completing of the internal market has allowed for increased specialisation in accordance with comparative advantage in labour intensive products. This is also consistent with what Brülhart (1997) finds.

[6] The standardised coefficients tell us something about the magnitude of the impact that an explanatory variable have on the dependent variable. The standardised coefficients thus allow us to describe the relative importance of the different independent variables. The coefficient tells us how many standard deviations the dependent variable on average moves when the explanatory variable moves one standard deviation.

The evidence with respect to degree of technogical differences across countries (*TECDIF*) is a bit mixed, and appears to be rather sensitive to model and techniques. According to the reported results, *TECDIF* does not have any significant impact on relative concentration. But in addition to the reported results we also experimented with a Heckscher-Ohlin-Ricardo version of the model, where only H-O variables and *TECDIF* were included. In this case a significant positive impact of *TECDIF* was reported, which is in accordance with a priori beliefs. Apparently this effect vanishes in the full model, possibly due to some degree of multicollinearity. The mixed evidence may however also be due to the measure we employ. One may argue (see Torstensson (1996)) that for the employed measure to capture technological differences correctly, wages must be approximately the same across the countries in the sample, which is clearly not the case here.

Regarding scale economies (*SCEC*), in the light of the results that can be found in earlier work that uses the same measures for scale economies (see e.g. Brülhart and Torstensson (1997), Brülhart (1997)), the significant negative impact of scale economies (in 1992) seems a bit surprising. The seemingly contrasting evidence presented in previous work is primarily based on correlation estimates, not on regression analysis. Considering the correlation matrices that were presented in section 3.2, we also find a positive correlation between relative concentration and degree of scale economies, but is not found to be statistically significant. One should moreover have in mind what was emphasised in section 2, that trade theory does not allow for unambiguous predictions related to the impact of scale economies on *relative* concentration. Like the *IO* variable it is included in the empirical model in order to ensure that most of the factors that might possibly affect localisation patterns are included. We have also experimented with a model where *SCEC* and *IO* were excluded; this did, however, reduce the fit of the model measured in terms of adjusted $R^2$.

Neither intra-industry linkages (*IO*) nor non-tariff barriers (*NTB*) are not found to have any significant impact on relative concentration (see table 7b).

## 4.2 Explaining cross-sectoral variation in absolute concentration

Turning to absolute concentration, traditional trade theory does not allow for any predictions. We therefore choose to modify the empirical model, by eliminating the variables *LAB*, *HCAP*, and *TECDIF*, at the same time as $EXPEN^A$ is used to replace $EXPEN^R$. The equation employed to explain absolute concentration of industry *i* then takes the form:

$$S_i^A = a + b_1 EXPEN_i^A + b_2 SCEC_i + b_3 IO_i + b_4 NTB \quad (2)$$

The results from the estimation of equation (2) appear in the Tables 9a and 9b.

*Econometric considerations*

Based on the same reasoning as in the case of the model of relative concentration, we shall focus on the log-log models (Table 9b), in order to remedy or reduce potential heterogeneity problems. The chi-square goodness of fit tests for the normality of residuals also suggest that log-log models are superior to the linear models in terms of statistical properties. In the linear models the null hypothesis of normality of residuals can be rejected at at least a 5% level of significance, while in the log-log models it cannot be rejected. Looking at the Hausman specification test statistics, the null hypothesis of no contemporaneous correlation between $EXPEN^A$ and the error term may be rejected at a 5% level of significance. The discussion of the impact of the various explanatory variables will consequently rely on the 2SLS estimates (also reported in Tables 9a and 9b).

*Results*

Regardless of year of observation, localisation of expenditure is crucial for the localisation of production. Not only is the variable $EXPEN^A$ significant even at a 1% level of significance, but looking at the standardised variables (see table 10) it is clear that the relative influence of expenditure concentration on industrial concentration is more important than that of any other of the variables included.

We also see that intra-industry linkages (*IO*) have a significant positive impact on absolute concentration, in accordance with what the new economic geography predicts. It is also worth noting that the magnitude of the impact of intra-industry linkages has risen between 1985 and 1992.

What may seem as the most unexpected result is the significant negative impact of the degree of scale economies on absolute concentration in the 1992 data. Normally one would expect that the more important scale economies are, the more concentrated would the industry be. However, there is not necessarily a puzzle here, so even if we cannot claim that we know the "correct" reason for this results, let us give some possible explanations. First, the measures we use for scale economies may not be relevant any more; the measures were calculated in the 1980s and significant changes in technology and production techniques may have taken place since then. Among other things, there has been a change towards less large scale production in many industries. Another possibility is that the positive impact of scale economies on absolute concentration is ’washed out’ by other variables due to some degree of multicollinearity. Secondly, even if we disregard measurement errors, as indicated above, we should think carefully about what our variable measures. The variable is defined as the elasticity of average costs with regard to output. But such an elasticity depends both on the shape of the average cost curve and on where the industry is on the curve. If two industries are estimated to have different scale elasticities, that may then be due to differences in underlying cost functions and scale properties; the industries may, however, also have identical underlying cost curves, but for some reason be on different parts of the curve. If an industry shows large output per firm, then scale economies are to a large extent exploited, and an estimation of potential average cost reductions if output increases further would give low scale elasticity. Another industry could be characterised by less output per firm, but if the underlying cost function is the same, then the estimated scale elasticity would be higher in this industry than in the first one. Hence, the measure we apply is possibly more about unexploited scale properties than about the actual production or cost function for the firms. If this is correct, then our empirical result says that the more unexploited scale economies there are in an industry, the less concentrated will it be.

We should then, however, think about why firms with the identical cost functions could end up producing in different scale. Obviously, the demand side must play a role here. In simple large-group monopolistic competition models there is actually a one-to-one relationship between demand elasticity and scale elasticity. This follows from the tangency between demand curves and average costs curves for each firm in the free-entry equilibrium in such models. The more elastic the demand for individual varieties is, the lower must the estimated scale economies be in equilibrium, and vice versa. But then we could also use insights from the demand side to study the expected differences in localisation and concentration between industries that differ in their scale economies and demand elasticity. Amiti (1998) compares industries with different degrees of product differentiation and hence demand elasticities, and shows that depending on the level of trade costs (assumed to be the same in both industries in her theoretical experiments) the industry with higher demand elasticity (and hence lower scale elasticity) may be either localised in the big or the small country. The ambiguity appears because there are two opposing forces; the trade costs tend to draw the industry with the most elastic demand to the larger market, while the factor price and hence production cost differences may draw it in the opposite direction. Thus, in such a world, our result - showing that industries with low degree of scale economies are more concentrated in absolute terms - would not be inconsistent with the theory.

Finally, in more complex models the link between product differentiation and scale properties is not as straightforward as in the simple, large-group monopolistic competition models (see Ottaviano and Thisse (1998)), and a complete empirical model should probably include independent measures of the degree of scale economies and the importance of product differentiation and hence demand elasticities for individual varieties.

As for non tariff barriers (*NTB*), they were not found to have a significant impact on absolute concentration in 1985, but in 1992 the picture had changed, and a significant positive impact is reported. In other words, it appears that industries subject to high NTBs are absolutely more concentrated than those that faces less significant NTB. Apparently, the industries facing high trade costs agglomerate their production close to the large market(s), while those confronted with low trade costs prefer moving out to more peripheral location. This is in accordance with the theoretical predictions from new trade theory.

## 5. Concluding remarks

Reviewing the results, the most important determinant of the economic geography of Europe is localisation of expenditure. It always has a significant impact on industrial concentration and is by far the most important one in terms of economic significance among the factors presumed to affect localisation. Comparing the two years 1985 and 1992, expenditure localisation also seems to have gained in importance during the integration process, although there are only minor differences.

Experimenting with models where relative concentration is explained by Heckscher-Ohlin and Ricardo variables only, around 50 percent of the cross-sectoral variation in concentration could be explained. Adding expenditure localisation to the model, R-square increased substantially, and the new model was able to explain 80-90 percent of the cross-sectoral variation. So while the importance of Heckscher-Ohlin and Ricardo theory should not be ignored when explaining the economic geography of Europe, expenditure localisation clearly dominates the picture. It should, however, be remembered that for a complete test of Heckscher-Ohlin one should also have included measures of the distribution of factor endowments across countries.

As for absolute concentration of industries, intra-industry linkages also play a major role in determining localisation. Turning to relative concentration -- where we do not have any clear a priori assumptions about their impact -- according to the evidence a positive influence cannot be precluded.

Not surprisingly, industry localisation and expenditure localisation are found to exhibit mutual influence on each other: absolute industry concentration affects absolute expenditure concentration and vice versa. The occurrence of endogeneity provides support for the new economic geography that predicts cumulative causation in localisation.

The results on scale economies indicate the need for work on the theory as well as the empirical side, and should be the scope of future research.

## References


Amiti, Mary (1997): 'Specialisation patterns in Europe', CEP Discussion Paper no. 363

Amiti, Mary (1998): 'Inter-industry trade in manufactures: Does country size matter? ', *Journal of International Economics* 44: 231-255

Balassa, B. (1979): 'The changing pattern of comparative advantage in manufactured goods', *Review of Economics and Statistics* 61: 259-266

Balassa, B. (1986): 'Comparative advantage in maufactured goods: A reappraisal', *Review of Economics and Statistics* 61: 315-319

Brülhart, Marius and Johan Torstensson (1997): 'Regional integration, scale economies and industry location in the European Union', revised version of CEPR Discussion Paper no. 1435

Brülhart, Marius (1997): 'Trading places: industrial specialisation in the European Union', forthcoming in the *Journal of Common Market Studies*

Buigues, P., Ilzkovitz, F. and J.-F. Lebrun (1990): 'The impact of the internal market by industrial sector: The Challenge for the member states', in Commission of the European Communities: *The European Economy – Social Europe*, Special edition

Cawley, Richard and Michael Davenport (1988): 'Partial equilibrium calculations of the impact of internal market barriers in the European Community', in Commission of the European Communities: Research on the 'cost of non-Europe', Vol. 2: Studies on the economics of integration

Davies, Stephen and Bruce Lyons (eds.) (1996): *Industrial organization in the European Union: Structure, strategy, and the competitive mechanism*, Oxford University Press, Oxford, 1996

Davis, Donald R. and David E. Weinstein (1996): 'Does economic geography matter for international specialization', Harvard Institute of Economic Research Discussion Paper no. 1773

Davis, Donald R. and David E. Weinstein (1997): 'Economic geography and regional production structure: An empirical investigation', Harvard Institute of Economic Research Discussion Paper no. 1802

Davis, Donald R. and David E. Weinstein (1998): 'Market Access, economic geography and comparative advantage: An empirical assessment', mimeo

EUROSTAT: Input-Output tables

Fujita, Masahisa, Paul R. Krugman and Anthony J. Venables (1998): *The spatial economy: cities, regions and international trade*, manuscript

Harrigan, James (1994): 'Scale economies and the volume of trade', *Review of Economics and Statistics* 76: 321-328

Hausman, J. (1978): 'Specification tests in econometrics', *Econometrica* 46: 1251-1271

Judge, G. G., R. Carter Hill, William E. Griffiths, Helmut Lütkepohl and Tsoung-Chao Lee (1988): *Introduction to the theory and practice of econometrics*, Wiley, New York, 1988

Krugman, Paul R. (1980): 'Scale economies, product differentiation, and the pattern of trade', *American Economic Review* 70: 950-959

Krugman, Paul R. and Anthony J. Venables (1990): 'Integration and the competitiveness of the peripheral industry', in C. Bliss and J. Braga de Macedo (eds.): *Unity with diversity in the European Economy: the Community's Southern frontier*, Cambridge University Press, Cambridge

Krugman, Paul R. (1991): *Geography and trade*, MIT Press, Cambridge, Mass., 1991

Krugman, Paul R. and Anthony J. Venables (1996): 'Integration, specialization and adjustment', *European Economic Review* 40: 959-968

Lundbäck, Jerker and Johan Torstensson (1997): 'Demand, comparative advantage and economic geography in international trade: evidence from the OECD', forthcoming in *Weltwirtschaftliches Archiv*

Midelfart Knarvik, Karen Helene and Ottar Mæstad (1997): 'A data set for European regional analysis', SNF Working paper No. 16/97

Norman, Victor D. and Anthony J. Venables (1995): 'International trade, factor mobility and trade costs', *Economic Journal* (105):1488-1504

OECD: Stan database, version 1997

Ottaviano, Gianmarco I. P. and Jacques-Francois Thisse (1998): 'Agglomeration and trade revisited', paper presented at ERWIT 1998

Pratten, Cliff (1988): 'A survey of the economies of scale', in Commission of the European Communities: Research on the 'cost of non-Europe', Vol. 2: Studies on the economics of integration

Thomas, R. Leighton (1997): *Modern Econometrics*, Addison Wesley Longman, Essex, 1997

Torstensson, Johan (1996): 'Technical differences and inter-industry trade in the Nordic countries', *Scandinavian Journal of Economics* 98: 507-524

## Appendix

**Table 1:** Relative production indexes, 1992.

| | $s_i^R$ | *EXPEN* | *LAB* | *HCAP* | *TECDIF* | *NTB** | *IO* | *SCEC*** |
|---|---|---|---|---|---|---|---|---|
| Pottery, China etc | 2.480 | 2.875 | 1.276 | 1.105 | 0.729 | 2 | 0.143 | 0.684 |
| Aircraft | 2.165 | 2.022 | 0.599 | 1.048 | 3.152 | 2 | 0.907 | 1.641 |
| Footwear | 2.128 | 1.037 | 3.246 | 2.388 | 0.422 | 2 | 1.335 | 0.410 |
| Leather & Products | 1.995 | 1.612 | 1.342 | 1.556 | 1.063 | 2 | 1.335 | 0.410 |
| Transport Equipment, nec | 1.901 | 2.406 | 0.563 | 0.837 | 0.874 | 1 | 0.907 | 1.641 |
| Railroad Equipment | 1.396 | 2.430 | 1.854 | 2.079 | 0.943 | 3 | 0.907 | 1.641 |
| Wearing Apparel | 1.310 | 0.696 | 2.783 | 2.229 | 0.652 | 2 | 2.042 | 0.410 |
| Shipbuilding & Repairing | 1.300 | 1.663 | 1.529 | 0.336 | 1.300 | 3 | 0.907 | 1.641 |
| Motorcycles & Bicycles | 1.300 | 1.565 | 3.201 | 0.497 | 2.834 | 2 | 0.907 | 1.641 |
| Textiles | 1.250 | 0.986 | 1.407 | 1.541 | 0.589 | 2 | 2.042 | 0.410 |
| Petroleum Refineries & products | 1.142 | 1.314 | 2.494 | 3.445 | 1.228 | 1 | 0.494 | 1.641 |
| Drugs & Medicines | 1.115 | 1.164 | 1.227 | 1.686 | 0.443 | 2 | 1.967 | 1.641 |
| Tobacco | 1.112 | 1.079 | 2.264 | 0.236 | 1.918 | 1 | 0.370 | 0.410 |
| Printing & Publishing | 1.036 | 1.180 | 0.013 | 0.523 | 0.567 | 1 | 1.053 | 0.957 |
| Motor Vehicles | 1.023 | 0.834 | 0.252 | 1.100 | 0.260 | 2 | 1.024 | 1.914 |
| Chemicals excluding drugs | 1.012 | 0.868 | 1.093 | 2.293 | 0.242 | 3 | 1.967 | 1.641 |
| Office & Computing Machinery | 0.959 | 0.685 | 1.089 | 2.454 | 2.737 | 3 | 0.695 | 1.504 |
| Other Manufacturing | 0.952 | 0.958 | 0.944 | 1.121 | 2.855 | 1 | 0.268 | 0.547 |
| Electrical Apparatus, nec | 0.820 | 0.823 | 0.357 | 0.584 | 0.429 | 3 | 0.938 | 1.094 |
| Radio, TV & Comm. Equipment | 0.779 | 0.753 | 0.428 | 0.930 | 0.719 | 3 | 0.938 | 1.094 |
| Machinery & Equipment, nec | 0.734 | 0.546 | 0.625 | 0.229 | 2.812 | 2 | 0.917 | 1.367 |
| Furnitures & Fixtures | 0.730 | 0.567 | 1.361 | 1.497 | 0.644 | 1 | 1.445 | 0.547 |
| Professional Goods | 0.706 | 1.019 | 0.451 | 0.003 | 0.918 | 2 | 0.268 | 0.547 |
| Wood Products | 0.644 | 0.472 | 1.127 | 1.436 | 0.503 | 1 | 1.445 | 0.547 |
| Food | 0.631 | 0.561 | 0.106 | 0.840 | 0.943 | 3 | 0.762 | 0.547 |
| Paper & Products | 0.614 | 0.387 | 0.414 | 0.544 | 0.670 | 1 | 1.817 | 0.957 |
| Beverages | 0.591 | 0.872 | 1.331 | 0.356 | 1.297 | 3 | 0.463 | 0.547 |
| Non-Ferrous Metals | 0.487 | 0.517 | 0.236 | 0.831 | 0.735 | 1 | 2.232 | 1.504 |
| Glass & Products | 0.472 | 0.519 | 0.025 | 0.070 | 0.230 | 2 | 0.493 | 0.684 |
| Iron & Steel | 0.454 | 0.691 | 0.107 | 0.441 | 0.730 | 1 | 1.669 | 1.504 |
| Metal Products | 0.446 | 0.616 | 0.362 | 0.168 | 0.359 | 2 | 0.608 | 0.820 |
| Cement, lime, pl. | 0.427 | 0.381 | 0.433 | 0.079 | 0.229 | 1 | 0.080 | 0.684 |
| Other min & der. | 0.427 | 0.381 | 0.433 | 0.079 | 0.229 | 1 | 0.666 | 0.684 |
| Rubber Products | 0.254 | 0.219 | 0.015 | 0.395 | 0.424 | 2 | 0.495 | 0.547 |
| Plastic Products, nec | 0.206 | 0.302 | 0.013 | 0.045 | 0.318 | 1 | 0.495 | 0.547 |

* *NTB*s are classified as low (1), medium (2), and high (3). ** The degree of scale economies is increasing in *SCEC*.
*Note:* The numbers in columns 2-6 and 8-9 are values relative to the average for the respective column.

**Table 2:** Relative and absolute concentration indexes (production), 1985 and 1992.

| Industry name (number)* | Relative concentration | | | | Absolute concentration | | | |
|---|---|---|---|---|---|---|---|---|
| | 1992 | | 1985 | | 1992 | | 1985 | |
| | $S_i^R$ | *Rank* | $S_i^R$ | *Rank* | $S_i^A$ | *Rank* | $S_i^A$ | *Rank* |
| Pottery, China etc (3610) | 0.121 | *1* | 0.114 | *1* | 0.162 | *1* | 0.156 | *1* |
| Aircraft (3845) | 0.106 | *2* | 0.080 | *5* | 0.153 | *2* | 0.140 | *3* |
| Footwear (3240) | 0.104 | *3* | 0.089 | *3* | 0.143 | *4* | 0.135 | *5* |
| Leather & Products (3230) | 0.097 | *4* | 0.082 | *4* | 0.140 | *5* | 0.130 | *9* |
| Transport Equipment, nec (3849) | 0.093 | *5* | 0.065 | *7* | 0.132 | *10* | 0.111 | *27* |
| Railroad Equipment (3842) | 0.068 | *6* | 0.070 | *6* | 0.122 | *19* | 0.122 | *13* |
| Wearing Apparel (3220) | 0.064 | *7* | 0.048 | *11* | 0.122 | *19* | 0.116 | *19* |
| Shipbuilding & Repairing (3841) | 0.063 | *8* | 0.042 | *16* | 0.105 | *31* | 0.098 | *35* |
| Motorcycles & Bicycles (3844) | 0.063 | *8* | 0.109 | *2* | 0.129 | *13* | 0.154 | *2* |
| Textiles (3210) | 0.061 | *10* | 0.056 | *8* | 0.12 | *21* | 0.115 | *22* |
| Petroleum Ref. & products (3534A) | 0.056 | *11* | 0.056 | *8* | 0.135 | *8* | 0.122 | *13* |
| Drugs & Medicines (3522) | 0.054 | *12* | 0.018 | *31* | 0.118 | *25* | 0.112 | *26* |
| Tobacco (3140) | 0.054 | *12* | 0.056 | *8* | 0.130 | *12* | 0.130 | *9* |
| Printing & Publishing (3420) | 0.051 | *14* | 0.047 | *12* | 0.105 | *31* | 0.106 | *31* |
| Motor Vehicles (3843) | 0.050 | *15* | 0.047 | *12* | 0.146 | *3* | 0.140 | *3* |
| Chemicals excluding drugs (3512X) | 0.049 | *16* | 0.021 | *27* | 0.127 | *14* | 0.116 | *19* |
| Office & Computing Machinery (3825) | 0.047 | *17* | 0.047 | *12* | 0.132 | *10* | 0.131 | *6* |
| Other Manufacturing (3900) | 0.047 | *17* | 0.044 | *15* | 0.111 | *30* | 0.110 | *28* |
| Electrical Apparatus, nec (383X) | 0.040 | *19* | 0.036 | *18* | 0.139 | *6* | 0.131 | *6* |
| Radio, TV & Comm. Equip.(3832) | 0.038 | *20* | 0.033 | *22* | 0.133 | *9* | 0.126 | *11* |
| Machinery & Equipment, nec (382X) | 0.036 | *21* | 0.034 | *21* | 0.138 | *7* | 0.131 | *6* |
| Furnitures & Fixtures (3320) | 0.036 | *21* | 0.038 | *17* | 0.119 | *24* | 0.115 | *22* |
| Professional Goods (3850) | 0.034 | *23* | 0.028 | *24* | 0.126 | *16* | 0.125 | *12* |
| Wood Products (3310) | 0.031 | *24* | 0.036 | *18* | 0.104 | *33* | 0.100 | *32* |
| Food (3112) | 0.031 | *24* | 0.026 | *25* | 0.101 | *35* | 0.100 | *32* |
| Paper & Products (3410) | 0.030 | *26* | 0.035 | *20* | 0.103 | *34* | 0.099 | *34* |
| Beverages (3130) | 0.029 | *27* | 0.032 | *23* | 0.113 | *27* | 0.114 | *24* |
| Non-Ferrous Metals (3720) | 0.024 | *28* | 0.023 | *26* | 0.127 | *14* | 0.119 | *15* |
| Glass & Products (3620) | 0.023 | *29* | 0.021 | *27* | 0.120 | *21* | 0.118 | *17* |
| Iron & Steel (3710) | 0.022 | *30* | 0.018 | *31* | 0.124 | *17* | 0.116 | *19* |
| Metal Products (3810) | 0.022 | *30* | 0.009 | *35* | 0.123 | *18* | 0.113 | *25* |
| Cement, lime, pl (3691) | 0.021 | *32* | 0.019 | *29* | 0.112 | *28* | 0.109 | *29* |
| Other min & der (3692) | 0.021 | *32* | 0.019 | *29* | 0.112 | *28* | 0.109 | *29* |
| Rubber Products (3550) | 0.012 | *34* | 0.014 | *33* | 0.120 | *21* | 0.119 | *15* |
| Plastic Products, nec (3560) | 0.010 | *35* | 0.014 | *33* | 0.118 | *25* | 0.117 | *18* |

* Industry categorisation according to ISIC Revision 2.
Source: OECD STAN Database.

**Table 3:** Correlation matrix for relative concentration ($S_i^R$), 1992.

| | *(Prod)* | *(VA)* | *(Empl)* | *EXPEN* | *LAB* | *HCAP* | *TECD.* | *NTB* | *IO* | *SCEC* |
|---|---|---|---|---|---|---|---|---|---|---|
| *(Prod)* | 1.00 | | | | | | | | | |
| *(VA)* | 0.94 | 1.00 | | | | | | | | |
| *(Empl)* | 0.81 | 0.85 | 1.00 | | | | | | | |
| *EXPEN* | 0.84 | 0.84 | 0.61 | 1.00 | | | | | | |
| *LAB* | 0.53 | 0.53 | 0.54 | 0.35 | 1.00 | | | | | |
| *HCAP* | 0.45 | 0.51 | 0.42 | 0.25 | 0.57 | 1.00 | | | | |
| *TECDIF* | 0.28 | 0.16 | 0.23 | 0.27 | 0.27 | 0.05 | 1.00 | | | |
| *NTB* | 0.16 | 0.07 | 0.07 | 0.18 | 0.10 | 0.17 | 0.09 | 1.00 | | |
| *IO* | 0.06 | 0.07 | 0.20 | -0.14 | 0.14 | 0.37 | -0.24 | -0.02 | 1.00 | |
| *SCEC* | 0.15 | 0.18 | 0.16 | 0.33 | -0.03 | 0.21 | 0.25 | 0.19 | 0.20 | 1.00 |

**Table 4:** Correlation matrix for relative concentration ($S_i^R$), 1985.

| | *(Prod)* | *(VA)* | *(Empl)* | *EXPEN* | *LAB* | *HCAP* | *TECD.* | *NTB* | *IO* | *SCEC* |
|---|---|---|---|---|---|---|---|---|---|---|
| *(Prod)* | 1.00 | | | | | | | | | |
| *(VA)* | 0.94 | 1.00 | | | | | | | | |
| *(Empl)* | 0.73 | 0.81 | 1.00 | | | | | | | |
| *EXPEN* | 0.85 | 0.79 | 0.57 | 1.00 | | | | | | |
| *LAB* | 0.46 | 0.51 | 0.35 | 0.24 | 1.00 | | | | | |
| *HCAP* | 0.38 | 0.43 | 0.32 | 0.21 | 0.65 | 1.00 | | | | |
| *TECDIF* | 0.40 | 0.35 | 0.28 | 0.40 | 0.13 | 0.22 | 1.00 | | | |
| *NTB* | 0.08 | -0.01 | -0.01 | 0.08 | -0.01 | 0.17 | -0.01 | 1.00 | | |
| *IO* | -0.07 | -0.06 | 0.03 | -0.30 | 0.21 | 0.35 | -0.29 | -0.02 | 1.00 | |
| *SCEC* | 0.09 | 0.13 | 0.17 | 0.15 | -0.21 | 0.20 | 0.18 | 0.19 | 0.20 | 1.00 |

**Table 5:** Correlation matrix for absolute concentration ($S_i^A$), 1992.

| | *(Prod)* | *(VA)* | *(Empl)* | *EXPEN* | *NTB* | *IO* | *SCEC* |
|---|---|---|---|---|---|---|---|
| *(Prod)* | 1.00 | | | | | | |
| *(VA)* | 0.89 | 1.00 | | | | | |
| *(Empl)* | 0.62 | 0.67 | 1.00 | | | | |
| *EXPEN* | 0.89 | 0.84 | 0.49 | 1.00 | | | |
| *NTB* | 0.16 | 0.01 | 0.23 | 0.02 | 1.00 | | |
| *IO* | -0.10 | -0.08 | 0.19 | -0.22 | -0.02 | 1.00 | |
| *SCEC* | 0.26 | 0.31 | 0.43 | 0.34 | 0.19 | 0.20 | 1.00 |

**Table 6:** Correlation matrix for absolute concentration ($S_i^A$), 1985.

| | *(Prod)* | *(VA)* | *(Empl)* | *EXPEN* | *NTB* | *IO* | *SCEC* |
|---|---|---|---|---|---|---|---|
| *(Prod)* | 1.00 | | | | | | |
| *(VA)* | 0.86 | 1.00 | | | | | |
| *(Empl)* | 0.52 | 0.54 | 1.00 | | | | |
| *EXPEN* | 0.87 | 0.76 | 0.34 | 1.00 | | | |
| *NTB* | 0.21 | -0.05 | 0.16 | 0.12 | 1.00 | | |
| *IO* | -0.21 | -0.19 | 0.04 | -0.31 | 0.19 | 1.00 | |
| *SCEC* | 0.20 | 0.24 | 0.47 | 0.17 | 0.19 | 0.20 | 1.00 |

**Table 7a:** OLS and 2SLS estimation of equation (1)

| | 1992 | | 1985 | |
|---|---|---|---|---|
| | OLS | 2SLS | OLS | 2SLS |
| Independent variable: | $S_i^R$ | $S_i^R$ | $S_i^R$ | $S_i^R$ |
| LAB | 264.33<br>(519.4) | -361.25<br>(667.3) | 433.08<br>(274.2) | 251.22<br>(311.6) |
| HCAP | 7.83E-07*** <br>(4.44E-07) | 6.91E-07<br>(5.53E-07) | -7.02E-08<br>(1.38E-06) | -1.80E-07<br>(1.55E-06) |
| TECDIF | 6.40E-03<br>(4.58E-03) | 6.40E-03<br>(5.69E-03) | 4.63E-03<br>(3.84E-03) | 2.59E-03<br>(4.35E-03) |
| EXPEN(R) | 0.86097*<br>(9.49E-02) | 1.2255*<br>(0.1533) | 0.87947*<br>(0.1059) | 1.1623*<br>(0.1387) |
| SCEC | -0.18032*<br>(7.08E-02) | -0.28185*<br>(9.22E-02) | -3.69E-02<br>(7.19E-02) | -8.24E-02<br>(8.16E-02) |
| IO | 5.30E-02***<br>(2.68E-02) | 8.26E-02**<br>(3.42E-02 | 4.91E-02<br>(2.89E-02) | 7.54E-02**<br>(3.31E-02) |
| NTB | 2.68E-04<br>(2.89E-03) | -4.33E-04<br>(3.60E-03) | 1.13E-03<br>(2.93E-03) | 9.35E-04<br>(3.30E-03) |
| Constant | 4.37E-03<br>(7.87E-03) | -2.61E-03<br>(9.96E-03) | -4.12E-03<br>(8.73E-03) | -1.10E-02<br>(9.96E-03) |
| $R^2$ | .84 | .75 | .82 | .77 |
| $\bar{R}^2$ | .80 | .69 | .77 | .71 |
| Hausman Specification Test statistics: $c^2_{(7)}$ | 9.17 | | 9.97 | |

*significance level 1%, **significance level 5%, ***significance level 10%
Note: Numbers in parentheses are standard errors.

**Table 7b:** OLS and 2SLS estimation of the log transformation of equation (1)

| | 1992 | | 1985 | |
|---|---|---|---|---|
| | OLS | 2SLS | OLS | 2SLS |
| Independent variable: | Log$S_i^R$ | Log$S_i^R$ | Log$S_i^R$ | Log$S_i^R$ |
| LAB | 6.18E-02***<br>(3.25E-02) | 1.35E-02<br>(4.34E-02) | -1.04E-02<br>(3.90E-02) | -2.20E-02<br>(4.90E-02) |
| HCAP | 8.86E-02*<br>(3.52E-02) | 6.59E-02<br>(4.52E-02) | 0.14008***<br>(7.50E-02) | 6.04E-02<br>(9.65E-02) |
| TECDIF | -2.59E-03<br>(5.69E-02) | -5.83E-02<br>(7.40E-02) | 7.85E-03<br>(7.54E-02) | -0.12223<br>(0.1008) |
| EXPEN(R) | 0.74537*<br>(8.35E-02) | 1.0884*<br>(0.1404) | 0.76977*<br>(0.1261) | 1.2668*<br>(0.2059) |
| SCEC | -0.16183***<br>(7.93E-02) | -0.25929*<br>(0.1044) | -0.12927<br>(0.1224) | -0.19363<br>(0.1546) |
| IO | 5.21E-02<br>(5.98E-02) | 9.94E-02<br>(7.73E-02) | 6.70E-02<br>(9.88E-02) | 0.18125<br>(0.1276) |
| NTB | 1.90E-02<br>(9.06E-02) | -3.94E-02<br>(0.1165) | -6.84E-03<br>(0.1366) | -4.22E-02<br>(0.1718) |
| Constant | -1.0063<br>(0.677) | -0.46615<br>(0.875) | -2.0061<br>(1.187) | 0.14778<br>(1.596) |
| $R^2$ | .89 | .82 | .76 | .61 |
| $\bar{R}^2$ | .86 | .77 | .69 | .52 |
| Hausman Specification Test statistics: $c^2_{(7)}$ | 9.23 | | 9.31 | |

*significance level 1%, **significance level 5%, ***significance level 10%

Note: Numbers in parentheses are standard errors.

**Table 8:** Relative geographical concentration; Standardised coefficients from OLS estimations

| Independent variable: | 1992<br>Log $S_i^R$ | 1985<br>Log $S_i^R$ |
|---|---|---|
| LAB | .160*** | -.029 |
| HCAP | .214* | .252*** |
| TECDIF | -.003 | .013 |
| EXPEN(R) | .768* | .763* |
| SCEC | -.147*** | -.114 |
| IO | .068 | .085 |
| NTB | .014 | -.005 |

*significance level 1%, **significance level 5%, ***significance level 10%

**Table 9a:** OLS and 2SLS estimation of equation (2)

| | 1992 | | 1985 | |
|---|---|---|---|---|
| | OLS | 2SLS | OLS | 2SLS |
| Independent variable: | $S_i^A$ | $S_i^A$ | $S_i^A$ | $S_i^A$ |
| EXPEN(A) | 1.1363*<br>(0.1006) | 1.4085*<br>(0.1282) | 1.1406*<br>(0.1243) | 1.4828*<br>(0.1603) |
| SCEC | -4.93E-02<br>(3.32E-02) | -8.65E-02**<br>(3.80E-02) | 5.20E-03<br>(3.54E-02) | -1.81E-02<br>(4.00E-02) |
| IO | 2.05E-02***<br>(1.21E-02) | 3.11E-02**<br>(1.37E-02) | 9.49E-03<br>(1.40E-02) | 2.33E-02<br>(1.60E-02) |
| NTB | 3.13E-03**<br>(1.44E-03) | 3.40E-03**<br>(1.60E-03) | 1.80E-03<br>(1.63E-03) | 1.46E-03<br>(1.83E-03) |
| Constant | -2.00E-02<br>(1.27E-02) | -5.28E-02*<br>(1.60E-02) | -1.99E-02<br>(1.52E-02) | -6.02E-02*<br>(1.95E-02) |
| $R^2$ | .83 | .79 | .77 | .71 |
| $\bar{R}^2$ | .81 | .76 | .74 | .68 |
| Hausman Specification Test statistics: $\chi^2_{(4)}$ | 11.72 | | 11.43 | |

*significance level 1%, **significance level 5%, ***significance level 10%
Note: Numbers in parentheses are standard errors.

**Table 9b:** OLS and 2SLS estimation of the log transformation of equation (2)

| Independent variable: | 1992 OLS $\text{Log} S_i^A$ | 1992 2SLS $\text{Log} S_i^A$ | 1985 OLS $\text{Log} S_i^A$ | 1985 2SLS $\text{Log} S_i^A$ |
|---|---|---|---|---|
| EXPEN(A) | 1.1464* (9.45E-02) | 1.3966* (0.1194) | 1.1863* (0.124) | 1.5431* (0.1622) |
| SCEC | -3.42E-02*** (1.70E-02) | -5.21E-02** (1.93E-02) | -1.06E-02 (1.92E-02) | -2.45E-02 (2.19E-02) |
| IO | 1.97E-02*** (1.13E-02) | 2.85E-02** (1.27E-02) | 1.54E-02 (1.39E-02) | 3.03E-02*** (1.60E-02) |
| NTB | 4.57E-02** (1.86E-02) | 4.37E-02** (2.07E-02) | 3.24E-02 (2.26E-02) | 2.03E-02 (2.56E-02) |
| Constant | 0.24636 (0.1933) | 0.74283* (0.2426) | 0.39764 (0.2707) | 1.1596* (0.3523) |
| $R^2$ | .85 | .81 | .79 | .73 |
| $\bar{R}^2$ | .83 | .79 | .76 | .69 |
| Hausman Specification Test statistics: $\chi^2_{(4)}$ | 11.74 | | 11.62 | |

*significance level 1%, **significance level 5%, ***significance level 10%
Note: Numbers in parentheses are standard errors.

**Table 10:** Absolute geographical Concentration;
Standardised coefficients from 2SLS estimations

| Independent variable: | 1992 $\text{Log} S_i^A$ | 1985 $\text{Log } S_i^A$ |
|---|---|---|
| EXPEN(A) | 1.168* | 1.159* |
| SCEC | -.246** | -.115 |
| IO | .379** | .204*** |
| NTB | .169** | .078 |

*significance level 1%, **significance level 5%, ***significance level 10%