Regional Integration, Scale Economies and Industry Location in the European Union

February, 1998
6,200 words

MARIUS BRÜLHART*
University of Manchester

JOHAN TORSTENSSON
Lund University and CEPR

Keywords: Regional Integration, Economic Geography, European Union, Scale Economies, Intra-Industry Trade; **JEL Classification**: F12, F15, R12

Abstract:

We analyse the effects of increasing returns and regional integration on industry location and trade. Theoretically, we show that regional integration can induce a non-monotonic locus of industry location inside the customs union, with initial dispersion to the periphery and later concentration in the core. Relationships of locational dispersion with scale economies (monotonically negative) and with regional integration (non-monotonic) also apply to equilibrium levels of intra-industry trade (IIT). Empirical evidence for the EU conforms to the theoretical predictions. Industrial specialisation among EU countries increased in the 1980s. Employment in scale-intensive industries tends to be concentrated at the centre of the EU. An IIT growth reversal is detected for the scale-intensive industries, which supports the non-monotonicity predicted by the model.

Acknowledgements: We are grateful to Karolina Ekholm, Dermot McAleese, Assar Lindbeck, Diego Puga, Geoff Reed and Tony Venables for valuable comments. This research was supported by the Stimulation Plan for Economic Sciences in the European Union (SPES-CT91-0058) and by the Swedish Council for Research in the Humanities and Social Sciences (HSFR).

* Corresponding author: School of Economic Studies, University of Manchester, Oxford Road, Manchester M13 9PL. (Marius.Brulhart@man.ac.uk)

REGIONAL INTEGRATION, SCALE ECONOMIES AND INDUSTRY LOCATION IN THE EUROPEAN UNION

I Introduction

Interest in the location of manufacturing production has recently been revived both in academic circles and among policy makers. This is due in part to *theoretical* developments, where international trade theory has been combined with insights from industrial economics and economic geography. Another reason has been the *empirical* development of trade liberalisation in Europe and elsewhere that has stimulated thinking about the locational forces unleashed by such policies.

In the context of European integration, some, mainly neo-classical, economists and policy makers subscribe to the belief that the “peripheral” countries stand to reap the greatest relative gains in terms of manufacturing production. The new theoretical models, on the other hand, tend to suggest that manufacturing production may, at least during a transitional period, become more concentrated at the “centre”. Some empirical evidence has also been invoked to demonstrate that industries may cluster geographically when trade costs are reduced. Krugman (1991b) has compared industrial concentration in the United States and in Europe and found that industries are more localised in the former. This could suggest that further integration would lead to more concentration also in Europe, hence that a “United Europe” would look much more like the United States. Under such a scenario, trade among EU countries would no longer consist mainly of a two-way exchange in similar products within the same industry, so-called *intra*-industry trade (IIT), but become increasingly *inter*-industry in nature.

However, theoretical work has mostly used two-country models. In order to examine the issue of *regional* integration, we need a model with at least three countries: two countries to analyse what happens inside the preferential trading arrangement and one outside country to examine interaction with the rest of the world. Moreover, the growing literature on the effects of trade liberalisation on location has so far been subject to remarkably little empirical testing.[1] This is a major gap in the literature, especially since the theoretical models do not always offer conclusions that are even qualitatively clear-cut, and empirical work is therefore needed to complement the theoretical enquiry.

This analysis therefore differs from earlier studies in two ways. First, we present a theoretical model with three countries, and we examine the effects of integration (a customs union) among two of them.[2] We focus on the equilibrium location of manufacturing production at various stages of economic integration, and we analyse the predictions of the model in terms of equilibrium IIT with different degrees of scale economies and trade costs.

[1] There is a growing literature on convergence of aggregate income and productivity across countries and regions (on regional convergence in the EU, see Neven and Gouyette, 1995) and a number of case studies have been conducted on the locational shifts of individual sectors. The simultaneous exploration of these processes across industries and countries has only recently begun. Notable analyses are Kim (1995), who has analysed long-term changes in industrial clustering across US regions, and Davis and Weinstein (1996) who have isolated locational determinants across manufacturing industries and OECD countries, based on an analysis of trade flows. Hanson (1997) has examined, for the case of Mexico, the relationship between increasing returns, trade and the regional structure of wages. His results seem to confirm that market access matters for industrial location. No comparable results have as yet been published for the EU.

Second, we produce empirical evidence for the European Union and discuss the relevance of the theoretical models in light of the evidence.

The paper is organised as follows. In Section II, we present the theoretical model and derive four general hypotheses. Section III reports the empirical exercise. In Section IV, we summarise the main findings and add some concluding comments.

II A Three-Country Model of Industry Location and Market Size

Related Literature and Introductory Comments

For an appraisal of our theoretical analysis it is useful to place it in the context of related theoretical work. Since the seminal contribution of Dixit and Stiglitz (1977), it has been possible to construct general-equilibrium models with imperfect competition. These models have found great resonance among trade theorists, who could finally formalise what had been known for a long time, namely that increasing returns to scale (IRS) and product differentiation can give rise to international trade (of an intra-industry nature) even in the absence of endowment differentials among countries.[3] More recently, these modelling techniques have been applied to questions of industry location and economic geography, following the lead of Krugman (1991a). Models of the "new economic

---

[2]The reason for including the third country is not that we are interested in the developments taking place in the outside country ('the rest of the world') *per se*, but that the presence of an outside country affects what is going on inside the customs union.

geography" capture the centripetal pull of large regions or countries through pecuniary forward and backward linkages between producers and consumers or among producers, which counterbalances centrifugal factor-cost considerations traditionally emphasised in neo-classical regional economics.

The principal aim of our analysis is to investigate the location of IRS industry inside the integrating area.[4] The new economic geography literature has produced a much debated hypothesis in this respect: a non-monotonic relationship between the level of trade costs and industrial agglomeration, referred to as the "u curve".[5] The non-monotonicity arises from the interaction of the centripetal agglomeration forces with the centrifugal factor-cost considerations, where the former dominate the latter only at early stages of integration. The "u curve" has been formalised in a three-country setting with regional integration by Puga and Venables (1997). Their study allows for input-output linkages and for factor price changes in response to complete specialisation in the production of IRS-goods. Countries are identical in endowments and size, but at a critical threshold of regional integration, agglomeration forces endogenously trigger a discrete formation of a core-periphery division among the participating countries.[6] Further

---

[3] For syntheses of this work, see Helpman and Krugman (1985), and Greenaway and Torstensson (1997).

[4] By focusing on the intra-CU dimension, we abstract from relocation between the rest of the world and the CU. Our model implies what Baldwin and Venables (1995) refer to as "production shifting", that is a relocation of IRS industry towards the CU. The "new" models therefore suggest that regional integration produces a locational advantage for participating countries; hence that a "Fortress Europe" effect might result endogenously from EU integration without an increase in external trade barriers.

[5] See Krugman and Venables (1991, 1995), Baldwin and Venables (1995), and Puga and Venables (1997).

[6] Note that the core-periphery distinction in this model relates only to the location of IRS industry, while production factors are internationally immobile.

integration leads to a gradual re-dispersion of IRS activity within the integrating area. The Puga and Venables (1997) analysis shows furthermore that locational changes along a “u curve” can have considerable welfare implications, since welfare gains accrue disproportionally to the core, and the periphery can suffer absolute declines in welfare in an intermediate interval of intra-union trade costs.

Our model takes up two specific points which have not been integrated in the previous formal treatments. First, we concentrate on market access as a determinant for the location of IRS industry and thereby abstract from input-output linkages, factor price changes and factor mobility. Market access considerations in the sense of Krugman (1980) have not yet received formal treatment in a three-country setting. Second, we assume that integrating countries start off with different market sizes. Such a core-periphery structure promises to be more useful empirically than the indeterminacy in the direction of symmetry breaking in Krugman-Venables-Puga models.

We find that our specific configuration reverses the “u curve”: early integration entails larger increases in IRS production for the small customs-union country, but the relative size of IRS industry in the large country increases again once integration has proceeded beyond a critical level.[7] Casual empiricism suggests that initial phases of European integration were associated with geographical dispersion rather than concentration of production. This was manifested in a continuously increasing share of IIT among EU countries, as reported by Brülhart and Elliott (1998). Hence our quest to produce a theoretical story consistent with this fact, as well a somewhat more formal empirical evaluation of its predictions.

What intuition underlies the “u-curve” derived in this paper? Regional integration has two relevant effects on the peripheral country. First, the periphery gains locational attractiveness *vis-à-vis the rest of the world* due to its improved access to the combined CU market; but, second, it simultaneously loses competitiveness *vis-à-vis the central country*, since lower trade costs exacerbate the locational advantage of the country with a larger home market.[8] If the rest of the world is large, and intra-CU barriers are relatively high, then the first effect is likely to dominate the second: increased competitiveness for the periphery towards the outside country outweighs the loss of competitiveness towards the partner country. As regional integration continues, relocation from the rest of the world to the CU leads to a fall in the relative size of industry in the rest of the world. Simultaneously the competitive advantage of the central CU country relative to the periphery increases. Hence, there is a critical point of regional integration where the second effect comes to dominate the first, and the size of peripheral industry shrinks relative to that of central industry.

---

[7] Strictly speaking, this result does not hold universally. There are combinations of exogenous parameters under which industrial dispersion or concentration relates monotonically to regional integration.

[8] On the second effect, see Brülhart (1995).

It should be noted, however, that the conclusions of this paper do not necessarily conflict with those in Puga and Venables (1997). In their model, the first interval of regional integration is characterised by the maintenance of symmetrical industry shares in the two equally sized CU countries. Depending on parameter values, this CU-internal symmetry can persist for large reductions of internal trade barriers, before the non-monotonic succession of agglomeration and re-dispersion sets in. Our model might thus be interpreted as an alternative approach to the "early" stages of regional integration, for which we assume exogenously different market sizes whereas Puga and Venables (1997) assume countries to be identically sized. Such an interpretation would yield a sequence of dispersion, agglomeration and dispersion, our model providing a formalisation of the first two stages, and Puga and Venables (1997) focusing on the latter two stages. With so much scope for nonlinearity, empirical work will clearly be needed in the search for general conclusions.

The other principal conclusion from our analysis is more evidently common to a larger group of models of location and trade liberalisation. Namely, we find that a high degree of scale economies in equilibrium, driven in our model by demand elasticities, produces industrial concentration in the core country. Hence, we can derive a stylised prediction that scale intensive activities will cluster near the largest markets. Furthermore, we can draw inferences from location patterns to trade flows. When export propensities across firms are similar, then industrial dispersion will produce intra-industry trade, and geographical concentration will result in inter-industry trade. Our model therefore gives us an formal basis for predictions on IIT levels given certain industry and country parameters.

The Model

Consider a world with one factor of production (labour), two industries and three countries. Two of the countries form a customs union (CU), whereas the third country represents the "rest of the world" (ROW). One industry, *Y*, produces homogeneous products under constant returns to scale (CRS). We can call this industry "agriculture". The other industry, *X*, produces horizontally differentiated manufactured goods under increasing returns to scale. For the sake of simplicity, it is assumed that zero transport costs prevail in industry *Y*.[9]

We follow Helpman and Krugman (1985) in assuming trade impediments of an "iceberg" type in the manufacturing industry *X*, where only a certain proportion of each exported unit is received by the importer. These impediments should be thought of as a composite of various man-made and physical trade barriers that can be reduced (or increased) but not totally removed by policy measures. A CU is conventionally defined as an absence of tariffs and quotas among member countries that also apply a common external tariff. In our model, there is a common external trade barrier, but positive internal trade barriers persist even after formation of the CU.

Without loss of generality, we can choose units so that there is one unit of labour in country I, “the rest of the world”. In country II, there are b units of labour, and the endowment of labour in country III equals a units. Countries II and III will form a customs union (CU). We further assume that $b > a$, so that we can call country II the “centre” and country III the “periphery” of the CU. We define $1/t$ $(t > 1)$ as the fraction of differentiated products that “arrive” at the importers in bilateral trade flows between countries I-II and I-III in industry X, whereas $1/V$, $(t > V > 1)$ is the fraction of products that arrive at the importers in trade flows between countries II and III in this industry.

We suppose that the typical household has a utility function given by the conventional Cobb-Douglas upper-tier utility function and Spence-Dixit-Stiglitz subutility functions.

$$\textbf{(1)} \qquad U = (\sum_{i=1}^{n} x_i^{\ e})^g \ Y^{1-g}, \ 0 < e < 1, e = 1-(1/s_i)$$

where x_{li} is consumption of variety l in industry X_i, and Y is consumption of the homogeneous product.[10] The substitution elasticities, s_i, are thus allowed to differ across IRS industries.[11]

[9]Allowing for transport costs in the CRS sector changes the magnitudes of the effects predicted by this model, but does not reverse the qualitative results (see Calmette and Le Poitier, 1995).

[10]In this model, the number of varieties is constant and trade liberalisation only affects the location of production.

[11]Since the demand and production functions are identical in all manufacturing industries (except, of course, for the parameter values), we can henceforth omit the industry subscripts in manufacturing.

It then follows that aggregate demand for the total of manufacturing industry *i* products produced in the three regions equals:[12]

(2)-(4)

$$\begin{aligned} D_1 = n_1 x = & \left[n_1 p_1^{-s} g / \left[n_1 p_1^{1-s} + n_2 (p_2 t)^{1-s} + n_3 (p_3 t)^{1-s} \right]\right] + \\ & \left[n_1 (p_1 t)^{-s} g b t / \left[n_1 (p_1 t)^{1-s} + n_2 p_2^{1-s} + n_3 (p_3 V)^{1-s} \right]\right] + \quad , \\ & \left[n_1 (p_1 t)^{-s} g a t / \left[n_1 (p_1 t)^{1-s} + n_2 (p_2 V)^{1-s} + n_3 p_3^{1-s} \right]\right] \end{aligned}$$

$$\begin{aligned} D_2 = n_2 x = & \left[n_2 (p_2 t)^{-s} g t / \left[n_1 p_1^{1-s} + n_2 (p_2 t)^{1-s} + n_3 (p_3 t)^{1-s} \right]\right] \\ & + \left[n_2 p_2^{-s} g b / \left[n_1 (p_1 t)^{1-s} + n_2 p_2^{1-s} + n_3 (p_3 V)^{1-s} \right]\right] + \quad , \\ & \left[n_2 (p_2 V)^{-s} g a V / \left[n_1 (p_1 t)^{1-s} + n_2 (p_2 V)^{1-s} + n_3 p_3^{1-s} \right]\right] \end{aligned}$$

$$\begin{aligned} D_3 = n_3 x = & \left[n_3 (p_3 t)^{-s} g t / \left[n_1 p_1^{1-s} + n_2 (p_2 t)^{1-s} + n_3 (p_3 t)^{1-s} \right]\right] + \\ & \left[n_3 (p_3 V)^{-s} g b V / \left[n_1 (p_1 t)^{1-s} + n_2 p_2^{1-s} + n_3 (p_3 V)^{1-s} \right]\right] + \quad , \\ & \left[n_3 p_3^{-s} g a / \left[n_1 (p_1 t)^{1-s} + n_2 (p_2 V)^{1-s} + n_3 p_3^{1-s} \right]\right] \end{aligned}$$

where p_j is the price of varieties produced in country j (equal for all varieties produced in each country, since they enter the utility function symmetrically and since they are produced with the same technology).[13]

---

[12] See Helpman and Krugman (1985, p. 206).

[13] Note that there is an indirect demand for products used up through trade impediments. That is, we have to multiply the foreign demands by V and t, respectively.

The cost functions are the same for all firms. Production of each variety of the IRS-good incurs a fixed cost and constant marginal cost. In this context output per firm (x) will be constant (see Venables, 1987). Since we assume that both countries produce the CRS-good and that technologies are identical, the wage rate and the price of the IRS-products must also be equalised.

Let us divide both sides of the three equations (2)-(4) by n_1, n_2 and n_3 respectively. Furthermore, we choose units so that w=p=1 and define $r = t^{1-s} < 1$, $d = V^{1-s}$ <1. The variables r and d, which decrease in trade impediments (since s >1) and increase in the degree of equilibrium scale economies, can be seen as the composite effect of trade costs and demand. An increase in the elasticity of demand works in the same manner as in increase in trade costs, since, in both cases, foreign demand will fall, thus creating an increase in the protection of the domestic market. Since in equilibrium, elasticity of demand relates negatively to scale economies, it is easy to understand that an increase in scale economies works in an opposite direction to an increase in trade costs.

Rewriting (2)-(4) then yields

(5)-(7)

$$x/g = \left[1/(n_1 + n_2 r + n_3 r)\ \right] + \left[(b\,r)/(n_1 r + n_2 + n_3 d)\ \right] + \left[(a\,r)/(n_1 r + n_2 d + n_3)\ \right]$$
$$x/g = \left[r/(n_1 + n_2 r + n_3 r)\ \right] + \left[b/(n_1 r + n_2 + n_3 d)\ \right] + \left[(a\,d)/(n_1 r + n_2 d + n_3)\ \right]$$
$$x/g = \left[r/(n_1 + n_2 r + n_3 r)\ \right] + \left[(b\,d)/(n_1 r + n_2 + n_3 d)\ \right] + \left[a/(n_1 r + n_2 d + n_3)\ \right]$$

In order to solve these equations, let us define three new variables:

$$\textit{(8)-(10)} \qquad \begin{aligned} 1/(n_1 + n_2 r + n_3 r) &= c \\ 1/(n_1 r + n_2 + n_3 d) &= d \\ 1/(n_1 r + n_2 d + n_3) &= e \end{aligned}$$

Then, equations (5)-(7) can be solved to yield:

$$\textit{(11)-(13)} \qquad \begin{aligned} 1/c &= g(2r^2 - d - 1)/[\ x(2r - d - 1)\ ] \\ 1/d &= gb(2r^2 - d - 1)/[x(r-1)\ ] \\ 1/e &= ga(2r^2 - d - 1)/[x(r-1)\ ] \end{aligned}$$

Substituting (11)-(13) into (8)-(10), we can construct a linear equation system with three equations that can be solved for the three unknowns, n_1, n_2, n_3. We then obtain:

(14)-(16)

$$n_1 = g[[(2r - d - 1)r(a + b)\ ] - (r-1)(d+1)]/[x(r-1)(2r - d - 1)\ ]$$
$$n_2 = g[\,a(r^2 - d)(2r - d - 1) + (1-r)(b(2r^2 + r(1-d) - d - 1) + r(1-d))\ ]/|\,x(r-1)(d-1)(2r - d - 1)\ ]$$
$$n_3 = g[\,a(2r^3 - r^2(d+1) - 2r + d + 1) + b(d - r^2)(2r - d - 1) + r(1-d)(r-1)\ ]/[\,x(1-d)(r-1)(2r - d - 1)\ .$$

We restrict our analysis to the case where all countries have positive production in all industries.[14]

Regional Integration and the Location of Manufacturing: The "U-curve"

[14] For a more elaborate presentation of this model, see Torstensson (1995).

What are the effects of a lowering of trade costs between the "centre" and "periphery" on the location of manufacturing production? By taking the partial derivatives of equations (14-(16) with respect to d, we arrive at:

(17)-(19)

$$\P n_1 / \P d = -2rg / (x(2r-d-1)^2)$$

$$\P n_2/\P d = -g(a(4r^3-4r^2d+r(d-3)(d+1))+(d+1)^2)$$
$$-b(4r^3-4r^2d+r(d-3)(d+1)+(d+1)^2)-r(d^2-2d+1))/(x(2r-d-1)^2(d-1)^2)$$

$$\P n_3/\P d = g(a(4r^3-4r^2d+r(d-3)(d+1))+(d+1)^2)-$$
$$b(4r^3-4r^2d+r(d-3)(d+1)+(d+1)^2)-r(d^2-2d+1))/(x(2r-d-1)^2(d-1)^2)$$

The results concerning the CU-members (II and III) offer some interesting insights. Internal liberalisation effectively enlarges the domestic market of CU members and therefore yields re-location of IRS industries from the outside world to the CU. The results in (17)-(19) are not easy to interpret. However, looking at the initial formation of a CU is helpful. This can be done by evaluating these expressions at the initial point where non-discrimination applies (with $r = d$):

(20)-(22)

$$\P n_1 / \P d = -2rg / [\ x(r-1)^2\ ]$$
$$\P n_2 / \P d = g[\ r+(r+1)(b-a)\ ]/[\ x(r-1)^2\ ]$$
$$\P n_3 / \P d = g[\ r+(r+1)(a-b)\ ]/[\ x(r-1)^2\ ]$$

A CU leads to an increase in the absolute size of manufacturing production in the large CU country and to an ambiguous effect on manufacturing production in the small CU country. The competitiveness of the centre increases both within the union and towards the outside country. The increased competitiveness of the "periphery", towards the rest of the world (through access to the larger joint market) may or may not be outweighed by its lower competitiveness vis-à-vis the core of the CU.

The algebraic derivation of general results is fraught with difficulties because of the non-monotonic relationships illustrated by equations (17)-(19). If we take the whole spectrum of potential trade costs between countries II and III, trade costs are always related non-monotonically to the locational attraction of the small country (II). There is an interval of intra-union trade costs where location becomes more dispersed with a fall in trade costs, but this relationship is reversed below a certain threshold of intra-CU trade costs.

The non-monotonic relationship between regional integration and industrial production in the small member country is illustrated in Figure 1, which plots the share of CU industrial production located in the central country $(n_2 / (n_2 + n_3))$ against various levels of intra-CU trade costs for one particular configuration of the remaining parameters. A "u-curve" emerges: concentration in the "centre" will initially decrease with integration. However, as intra-union trade costs are lowered beyond the position of the "hump" in the curve, dispersion of production is reversed, as production becomes again more localised at the centre.

The relationships distilled from our model can be interpreted both in an intertemporal and in a cross-sectional sense. We have tracked equilibrium industry location at gradually falling intra-EU trade costs. In a world of instantaneous and costless re-location of production, this represents the locational dynamics under regional integration. Another (looser) interpretation is to consider differences in trade costs across industries. Then, our analysis suggests a tendency for industrial concentration in industries with high trade costs, dispersion of industries with intermediate trade costs, and strongest concentration in industries with low trade costs.

We can summarise the predictions of our model in a first set of hypotheses:

H1: For a large class of parameter values on scale economies and extra-union trade costs, equilibrium location of industry relates non-monotonically to intra-union trade costs. Starting from high intra-union trade costs, a reduction of such costs leads to a higher dispersion of production within the CU. However, below a certain threshold of intra-union trade costs geographical concentration of industry increases with further reductions of these costs.

The emergence of the "u-curve" is contingent on certain parameter values. The combination of relative country sizes and scale economies can be such that the "hump" occurs not in the relevant interval of positive intra-CU trade costs that are lower than those for extra-union trade, but either at a point of negative trade costs or where trade costs are lower in extra-union trade. In these cases we observe that dispersion of production will rise or fall monotonically. For instance, when the two member countries are large compared to the rest of the world, the union market is of overriding importance and the periphery's share of IRS production will fall monotonically. [15]

We can solve for the critical threshold of intra-union trade costs at which the share of manufacturing production in the periphery will begin to fall. These results are illustrated in Figure 2, based on the assumption that the sizes of countries II and III are equal to $b = 0.2, a = 0.15.$ We choose parameter values for r between 0.0625 and 0.5. To arrive at these values we combine elasticities of demand between 2 and 5 if we assume that as much as 50 percent of export is lost in trade ($t = 2$). If only one third of total production is lost in exports ($t = 1.5$), demand elasticities lie between 2.7 and 8.6. Thus, the higher is the degree of scale economies and the lower are extra-CU trade costs, the lower is the "hump" threshold value of intra-CU trade costs, that is the lower is the degree of regional integration needed to trigger industrial concentration at the core.

Industry Location and Scale Economies

[15] Note that our "u curve" survives if we allow for general equilibrium effects such as changes in factor prices. We have, following Krugman and Venables (1990), experimented with sector-specific capital in agriculture (in this case, we allow only for one manufacturing industry) so that when labour leaves such production, its marginal product and thus the wage rate increase. This flattens the "u curve", but does not reverse it in a larger number of cases. The main effect is that the decline in peripheral production at low trade costs is less dramatic.

Instead of varying intra-CU trade costs and tracking equilibrium industry location *ceteris paribus*, we can change the degree of scale economies and hold all other variables constant. In this case, we find a strictly monotonic relationship, as concentration unambiguously increases in the degree of scale economies. Figure 3 depicts the share of production in the centre of the CU ($n_2 / (n_2 + n_3)$) as a function of trade costs and scale economies/demand elasticity (*ELDEM*). We apply the following parameter values: $b = 0.8; a = 0.5; t = 1.7$ (high trade costs), $t = 1.5$ (low trade costs).[16] Figure 3 illustrates that industries with a low degree of scale economies will, other things equal, tend to be dispersed, while scale-intensive industries tend to be highly localised.[17]

We therefore arrive at a second set of hypotheses:

H2: Industry concentration relates positively to the degree of scale economies. This concentration occurs at the "centre" of the customs union.

[16]A very large number of simulations has confirmed this result which it is difficult to attain analytically, since both d and r change with changes in the degree of scale economies.

[17]Moreover, a strictly monotonic relation also exists between location and country size. Large differences in country size strengthen the locational attraction for IRS industries to the "centre". However, in the EU context, relative "centre" and "periphery" measures do not seem to have changed significantly over time (see Section III).

Regional Integration and Intra-Industry Trade

What economic geographers refer to as the “concentration” or “localisation” of industries, is likely to be called “inter-industry specialisation” by a trade economist. The opposite scenario is termed interchangeably “locational dispersion” or “intra-industry specialisation”. If trade propensities of firms in a particular industry are similar across countries, industrial dispersion will be closely related to intra-industry trade (IIT). Numerous econometric exercises suggest that regional integration affects the share of IIT positively but some recent studies have found a tendency for IIT to stagnate or even decrease in certain countries and industries.[18]

IIT is commonly measured by the Grubel-Lloyd (GL) index. In bilateral trade between countries j and k, it is equal to:

$$\textbf{(23)} \qquad GL_{jk} = \left[\ 2\min\left(D_{jk}, D_{kj}\right)\ \right] / \left[D_{jk} + D_{kj} + T_Y\ \right]$$

where D_{jk} is demand in country j for manufacturing products in industry i produced in country k and T_Y is (net) trade in industry *Y*.[19]

[18] For a comprehensive survey of empirical IIT research see Greenaway and Milner (1986). The partial stagnation of IIT growth has been reported by Greenaway and Hine (1991) and Brülhart and Elliott (1998).

[19] From the demand equations obtained by inserting the equilibrium number of firms from (14)-(16) in (2-4), each country’s multilateral net export in the IRS-good can be determined. In turn, given the assumption of balanced multilateral trade, this determines the export of the agricultural good in bilateral trade flows.

Given the constant relationship between industrial dispersion and IIT, it should be obvious that the "u-curve" between intra-union trade costs and *industry location* also appears between intra-CU trade costs and *IIT* (although we may in certain extreme cases have either continuously increasing or decreasing shares of IIT). Figure 4 illustrates equilibrium intra-CU IIT shares, based on the initial parameter values $b = 0.2, a = 0.15, t = V = 2, s = 4$.

We can formulate a new set of hypotheses:

H3: For a large class of parameter values on scale economies and extra-union trade costs, the level of intra-industry trade between the CU countries relates non-monotonically to intra-union trade costs: equilibrium intra-industry trade rises at early stages of regional integration, but decreases when intra-union trade costs fall below a certain threshold.

Since there is a constant positive relation between industrial dispersion and IIT, the example illustrated in Figure 3 also suggests a negative relationship between scale economies and IIT. Therefore, we can formulate a fourth hypothesis:

H4: The degree of scale economies in industry relates negatively to intra-union IIT, ceteris paribus.

Our theoretical analysis has produced four (sets of) hypotheses, two relating to industry location and two concerning IIT. Their empirical relevance is explored in the next section, based on data for the European Union.

III Empirical Analysis: Industry Location and Intra-Industry Trade in the European Union

Market Size and Centrality in the European Union

Our model distinguishes between a "centre" and a "periphery" in the CU. The empirical counterpart of this theoretical concept is captured by the centrality index proposed by Keeble *et al*. (1986), who evaluated the accessibility of 166 EU regions (NUTS level II) using the following definition:[20]

$$\textbf{(24)} \qquad P_i = \sum_j \frac{Y_j}{D_{ij}} + \frac{Y_i}{D_{ii}}; \qquad i \neq j ,$$

where i is the relevant region, j stands for all other EU regions, $Y_{i,j}$ is 1983 regional gross domestic product, D_{ij} measures the shortest road distance[21] between the largest settlements in regions i and j, and D_{ii}, the "intra-regional distance cost", is defined as "one-third of the radius of a circle of the same area as region i". In order to obtain estimates of

[20]Keeble *et al*. (1986) have referred to this coefficient as the "peripherality index". Since this measure relates negatively to the peripherality of a region, we term it "centrality index" for clarity. In the case of regions on the EU borders, these indices also take account of adjacent non-EU countries, with an adjustment for tariff barriers in the case of East European and North African countries.

the centrality of EU countries, we have aggregated these indices for the 12 EU members, weighting them by 1983 regional population.[22]

Note that our model incorporates just one industry, composed of a number of perfectly symmetrical product varieties. In this context, a GDP-based measure of centrality is the appropriate proxy for market size. Our empirical exercise, however, will interpret the model in a cross-sectional sense, distinguishing several industries. In such a context, we would ideally avail of centrality indices constructed on the basis of regional expenditure in each of the industries (see Krugman, 1980). Such data are unavailable. We therefore have to make the assumption that expenditure shares of our sample industries are stable across regions. Given the similarity of incomes and preferences across EU regions, this assumption does not appear excessively restrictive. However, if we were to consider not just final consumer demand, but also demand for intermediate products, then the assumption becomes strong, since the concentration of a particular industry endogenously enlarges demand for some of its output (Krugman and Venables, 1996). Given the degree of industry concentration in the EU, reported below, this effect might be significant.

Scale Economies Across Industries

---

[21]Where regions are separated by water, weighted values of ferry costs were applied.

[22]We apply the same centrality indices to a number of years spanning a period of three decades. This approach might appear misleading, because it does not take account of shifts in relative peripherality. However, there are strong indications that the economic geography of European regions has remained remarkably stable. Begg and Mayes (1994) have re-calculated centrality indices of the EU regions for 1977, 1983, 1985, 1989 and 1990, using the Keeble methodology, and they detected only marginal changes over time. It thus seems appropriate to apply unchanged centrality indices for the different years of our data sample.

In the variable d of our model, scale economies interact with trade costs. It is difficult to capture this variable empirically, and proxies used in previous empirical analyses have often been related very loosely to theoretical concepts of scale economies. Pratten (1988, p. 2-70) compiled a ranking of manufacturing industries "in order of the importance of economies of scale for spreading development costs and for production costs". The classification is based on two criteria: engineering estimates of the minimum efficient plant scale relative to the industry's output, and estimates of the cost gradient below the minimum efficient scale.[23] This ranking is based not only on observed plant size, but also on the (unexploited) potential for scale economies. There is a clear correspondence between this empirical classification and the theoretical concept of internal scale economies.[24]

Industry Location and Scale Economies in the EU

In order to capture the degree of concentration or dispersion of EU industrial sectors, we have calculated "locational Gini indices" measuring the geographical structure of manufacturing employment, as suggested by Krugman (1991b). These indices can take values between 0 and 1. A high Gini index suggests a high degree of inter-industry specialisation. Where the Gini index is (close to) zero, a sector is not localised, but spread out in line with total manufacturing employment.

---

[23]For a discussion of other - often inappropriate - measures of scale economies, see Torstensson (1996).

[24]Note that the Pratten (1988) classification distinguishes twenty industries. These are bound to be subject to considerable intra-industry heterogeneity in terms of underlying production requirements. Our data set is thus likely to conceal considerable differences within "industries". Currently available statistics, however, do not allow a more disaggregated analysis.

Columns (2) and (4) of Table 1 report locational Gini indices for the distribution of 18 industries among 11 EU countries in 1990 and 1980. Industries are ranked in decreasing order by the level of their locational Gini index in 1990. We compare our listing by Gini indices to the ranking of industries by scale economies taken from Pratten (1988) and reported in column (1) of Table 1. There appears to be some correlation between locational concentration of an industry and the importance of increasing returns. The eight industries featuring at the top of the ranking by Pratten (1988) also feature first in our ranking by Gini index. The Spearman rank correlation between the IRS rank and the Gini rank equals 0.69, which is statistically significant at the 1% level. This finding supports the prediction of our model, formulated as part of our second hypothesis, that IRS industries will cluster geographically.[25]

Our second hypothesis predicts that IRS industries will concentrate *in the "centre"*. Pearson correlation coefficients between the centrality of a country and the employment share of a particular industry in that country are reported in columns (3) and (5) of Table 1. These coefficients are taken as indicators of locational bias towards the central countries, since the higher their value, the larger is the employment share of a particular industry in central countries relative to its share in the manufacturing employment of peripheral countries. Comparing columns (3) and (5) with the ranking by scale economies of column (1), we detect a strong correlation between an industry's potential for

[25] One might suspect the relationship between scale economies and locational Gini indices to be endogenous, since our definition of scale economies implies smaller numbers of plants for a given market size. Note, however, that the Gini indices reflect only the distribution of industries across countries, which is not *a priori* related to the number of plants per industry.

scale economies and its locational bias towards the central countries of the EU. The rank correlation between the industry ranking by scale economies (column 1) and a ranking by centre-periphery bias (column 3) equals 0.63, which is statistically significant at the 1% level. Increasing-returns industries thus appear to be located in central EU countries.[26]

Given the positive correlations between scale economies and both localisation and centre-periphery bias, it is not surprising that the two latter variables also correlate. Comparing columns (2) and (4) with columns (3) and (5), we detect a positive relationship between the degree of locational concentration, measured by the Gini index, and location in the central EU countries. Industries which are highly localised, therefore, appear to be located predominantly in central EU countries.

Entire countries, however, could be ill-suited locational units on which to base our analysis. We therefore supplement our investigation by the analysis of a regional data set, drawing on published statistics for nine EU countries and seven of the 18 sectors covered in Table 1. The results are reported in Table 2. They confirm our findings obtained from country data. The greater the importance of scale economies, the more strongly industries were concentrated in central EU regions both in 1976 and in 1985.

---

[26] An alternative explanation for the correlation between centrality and the concentration of IRS industry could lie in the importance of skilled labour. If central countries were shown to be relatively skill abundant, and IRS industries were generally skill intensive, then our correlation might be driven by neo-Heckscher-Ohlin determinants. The formal exploration of this issue would be an interesting topic for future empirical research.

Industry Location and Integration in the EU

Hypothesis 1 suggests that, after a certain interval, the attraction of large countries is enhanced by the dismantling of trade barriers. This effect is difficult to measure empirically, due to the impossibility of isolating integration-induced changes. Inspection of the last row in Table 1 shows that industry has become more localised during the 1980s (rising Gini coefficients). However, it should be noted this appears not to have been biased in favour of central countries (falling correlations with centrality). The degree of concentration in central EU countries of industries subject to high scale economies does not seem to have increased during the 1980s.

There are two plausible scenarios in which these results are compatible with the model outlined above. First, it is conceivable that the main steps of economic integration in the EU (corresponding to a fall in V) have occurred previous to the period covered by our data. CU formation and the first EU enlargement might have removed the principal obstacles to intra-EU trade in industrial goods, and induced the current concentrated locational structure of IRS sectors. Under such a scenario, the forces described by our model would have been unleashed in the 1950s to 1970s, the EU has reached the end point of the "u curve", and relatively little further concentration of IRS industry should be anticipated. Alternatively, it could be hypothesised that remaining non-tariff barriers continued to segment EU markets in the 1980s (yielding a significant V) and were only dismantled gradually by the Single Market programme.[27] Under that scenario, the EU was at the mid-point of our "u curve" in the 1980s, and the locational forces emphasised in our model might be an important determinant of industrial adjustment and concentration following the full implementation of the Single Market.

Intra-Industry Trade and Scale Economies in the EU

Our model suggests a close correspondence between the level of IIT and the dispersion of industries. This section therefore draws on a set of highly disaggregated IIT measures for 12 EU countries. The indices are calculated from SITC 4 and 5-digit statistics, where the underlying number of manufacturing "industries" ranges between 365 (1961) and 2169 (1990).[28]

According to our fourth hypothesis, the proportion of IIT will decrease in an industry's degree of scale economies. Based on the classification by Pratten (1988), we find in Table 3 that industries with high and intermediate economies of scale exhibit consistently lower IIT than industries with low scale economies. The "scale intensive" industries identified by the OECD (1987) also display consistently and significantly lower IIT than the average.[29] These results are is in line with a number of previous studies which

[27] It is well known that, following the two oil crises in the 1970s, non-tariff barriers among EU countries tended to increase (see e.g. Greenaway, 1983). This development contributed to the impetus behind the Single Market initiative.

[28] For details on data sources and transformations see the Appendix.

[29] Unfortunately, the OECD (1987) report does not make the selection criteria for "scale-intensive" industries explicit. Hence, the Pratten (1988) classification appears more reliable.

have found a negative relationship between scale economies and IIT, and it supports the prediction of our model .[30]

The results of Table 3 furthermore suggest that post-war growth in intra-EU IIT has been reversed in the scale-sensitive industries in the 1980s. The detected rise and subsequent fall of IIT in those industries is suggestive of a "hump-shaped" development of these industries in peripheral EU regions as predicted by the third hypothesis derived from our theoretical model. Relative expansion of IRS sectors in peripheral EU countries during the early periods of European integration appears to have been followed by a relative contraction in the 1980s. Moreover, IIT in the whole sample has shown some tendency to stagnate offering support for out third hypothesis of a hump-shaped relationship between IIT and intra-union trade costs. [31]

Intra-Industry Trade and Economic Integration

Our empirical results are suggestive of a negative relationship between IIT and scale economies. Strictly speaking, our theoretical model shows that trade costs interact with scale economies in determining the share of IIT. We can get a qualitative handle on intra-union trade costs through the work of Buigues *et al*. (1990). Based on that

[30] Econometric studies which found a negative association between scale economies and IIT include Loertscher and Wolter (1980), Greenaway and Milner (1984), Balassa and Bauwens (1987), Ray (1991) and Somma (1994). For a sensitivity analysis of the relationship, see Torstensson (1996).

[31] The non-monotonic development of intra-EU IIT in IRS industries might be attributed to the revision of the SITC code of 1988, which significantly increased the number of separate 5-digit industries, and hence be discarded as a statistical artefact. We calculated ratios of pre-revision to post-revision industry numbers for each of the three categories, and found that it was largest in the "intermediate" category, but that it was lower in the "high" category than in the "low" category.

classification, we have categorised our IIT into one group of industries subject to significant non-tariff barriers (NTBs) and one group of industries with low NTBs. These two categories were further divided into two subcategories by the importance of scale economies, according to Pratten (1988), and IIT averages were calculated for each of the four industry groups.[32] The results are reported in Figure 5.

The first result to note is that the split of the total sample into high NTB and low NTB industries (not represented in Figure 5) produces no statistically significant differences of IIT means for any of the six sample years. In Figure 5, we see that this also applies to the industry category subject to low scale economies, where the split by NTBs has no statistically significant impact on observed IIT averages.[33]

As expected from the theory, NTBs appear to matter for the IRS industries. In the 1960s, IRS industries subject to low NTBs displayed significantly lower intra-EU IIT than IRS industries with high NTBs, and the low-NTB industries also displayed the most pronounced "hump-shaped" evolution of IIT.[34] It is plausible that the abolition of intra-EU tariff barriers had a stronger effect on the low-NTB sectors than on those industries where high NTBs persisted until the 1990s. Hence, we can interpret differences in trends between

---

Hence, at least the relative fall of average IIT in the "high" category cannot be explained by statistical re-classification.

[32] For details of our classification procedure, see the Appendix.

[33] One implication of this result is that the relatively low levels of IIT found to prevail in IRS industries do not stem from the possibility that IRS industries could be subject to above-average trade impediments, and that the latter reduce IIT. NTBs do not appear to affect IIT levels systematically, hence the categorisation by scale economies seems to be an independent source of differences in IIT patterns.

low and high NTB industries as effects of CU formation. The locational evolution of European IRS and tariff-sensitive industry was dominated by centripetal dispersion initially, but forces towards renewed concentration re-emerged in the 1980s. This corresponds with the shape of the "u curve" identified in our model.

IV Concluding Remarks

Our theoretical model, which is derived from the widely used monopolistic-competition framework underlying the "new" trade theory, has produced a number of topical hypotheses. The empirical study, conducted on employment and trade data for the European Union, largely conforms with the predictions of the model. In particular, we find that industrial specialisation among EU countries has increased in the 1980s. These results are confirmed by and analysis of trade data, which are more disaggregated and for which we have observations covering the period 1960-1990. We find that increasing-returns industries tend to be highly localised, concentrated in central EU countries and subject to relatively low IIT. These industries have also been subject to a reversal of intra-EU IIT growth in the 1980s.

The results of this paper point to important policy conclusions. Given that our model predicts integration ultimately to favour concentration of industry in central countries,

[34] These differences are statistically significant at the 0.01 level in 1961 and at the 0.05 level for 1967 (ANOVA).

one might infer that further reductions of trade costs in Europe will lead to considerable centripetal shifts in European industry. Under this scenario, we would expect increased concentration of scale-intensive production at the core of the EU, whereas the periphery would specialise in manufacturing activities not characterised by scale economies and in non-manufacturing activities. This would imply a stagnation or even decrease in the share of IIT in total trade among EU countries. Such a development might pose considerable structural adjustment problems.

However, our calculations indicate that much of the scale-driven concentration process in European manufacturing has already taken place. There appears to remain greater scope for inter-industry specialisation in industries which are mainly sensitive to factor costs. It is in traditional, relatively small-scale industries that Krugman (1991b) has detected the most pronounced locational clustering in the United States. Our results show that these sectors are still relatively dispersed in the EU, and locational shift of these activities seem more likely to benefit peripheral countries. This scenario would gain particular relevance in the event of an eastward enlargement of the EU.

The fact that predictions derived from our model correspond with empirical observation should not be interpreted as proof that we have found the true or at least more realistic theoretical representation of the world. The specific and restrictive construction of our model strongly militates against such an conclusion. Most importantly, our model is constrained to a one-factor world and, by assuming incomplete specialisation, implies equalised factor prices throughout. In reality, some of the adjustment to lower trade barriers may come through higher factor costs in the central location. This will tend to counteract the centripetal forces of increasing returns and the minimisation of transport cost and favour a sustained IRS activity at the periphery (and hence IIT) even at very low intra-union trade costs. Under such a configuration, the “u curve” might bend in the opposite direction to that predicted by our model, and integration ultimately leads to industrial dispersion.[35]

Which scenario is right? An inductive approach from empirical evidence appears to favour our model, while deductive reasoning suggests that no location model can come close to reality without considering factor-cost effects. The real world might accommodate both models: locational determinants are likely to vary strongly across industries, and different models are will capture more or less adequately the main aspects of different industries. Our model appears most relevant for those industries where fixed costs and market access are the main determinants. Given the complexity of economic geography, it seems impossible for one model to capture the common and essential determinants of location, hence different models are complements rather than substitutes.[36] Our analysis of EU trade patterns provides evidence that the locational predictions of our model bear empirical relevance.

---

[35] See Krugman and Venables (1990), and Puga and Venables (1997).

[36] A promising avenue for future research, therefore, is to assess the relative explanatory power of different location models. One study of this question has been conducted by Davis and

We should also note certain specific features of the empirics in this paper. In spite of their remarkable consistency, our findings should be considered as suggestive rather than conclusive, since they are subject to several statistical constraints. The level of industry disaggregation of our employment data is relatively low, so that these "industries" are likely to group together quite heterogeneous activities. While the degree of statistical disaggregation of our trade data is much more satisfactory, the explanatory variables do not match that level of precision. In particular, we only avail of qualitative measures of our explanatory variables, hence a parametric exercise was not feasible. Our exercise implicitly assumes that the relative degrees of increasing returns across industries do not change over time, since no data are available on changes in minimum efficient plant scales. Furthermore, we could capture the effect of trade costs only in an approximate and qualitative fashion. With time-variant, location- and sector-specific measures of trade costs, it would be possible to test explicitly the existence and shapes of locational "u-curves". This obviously leaves considerable scope for further research.

Weinstein (1996), who suggest that factor endowments strongly dominate market-size effects in determining industry location among OECD countries.

Table 1

Locational Concentration and Centre-Periphery Structure of Industrial Employment in EU Countries[1]

			1990		1980		1980-90
		(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
NACE	Industry description	Rank by scale economies[2]	Locational Gini coefficient	Locational bias towards centre[3]	Locational Gini coefficient	Locational bias towards centre[3]	Change in Gini coefficient (%)
37	Instrument engineering	9	0.392	-0.01	0.402	0.17	-3
32	Mechan. engineering	7	0.370	0.55*	0.320	0.59*	15
35	Motor vehicles	1	0.344	0.63**	0.270	0.60*	28
33	Office, data processing	6	0.328	-0.05	0.312	0.15	5
34	Electrical engineering	8	0.316	0.72**	0.254	0.87***	25
36	Other transp. equipm.	2	0.288	0.21	0.238	-0.04	21
22	Metals	5	0.242	0.30	0.188	-0.24	29
25/6	Chemicals	3/4	0.230	0.75***	0.178	0.77***	29
31	Misc. metal articles	12	0.228	0.40	0.192	0.29	19
48	Rubber and plastics	13	0.226	0.57*	0.174	0.62**	29
44	Leather goods	20	0.212	-0.42	0.150	-0.63**	42
46	Timber and furniture	18	0.202	-0.47	0.206	-0.45	-2
49	Misc. manufactures	16	0.198	0.12	0.194	0.16	2
47	Paper and printing	10	0.192	0.22	0.208	0.20	-7
43	Textiles	17	0.170	-0.60**	0.106	-0.64**	60
41/2	Food, drink, tobacco	14/5	0.162	-0.58*	0.176	-0.54*	-8
45	Clothing and footwear	19	0.148	-0.74***	0.096	-0.79***	54
24	Non-metallic minerals	11	0.122	-0.82***	0.100	-0.78***	20
	ALL		0.188	0.60*	0.156	0.62*	21

[1]EU12, excluding Luxembourg.

[2]Ranking by decreasing "importance of economies of scale for spreading development costs and for production costs", by Pratten (1988, p. 2.70).

[3]Pearson correlation coefficients between $(E_i / \Sigma E_i)_j$ and C_j, where E_i denotes employment in the manufacturing sector i, j is the country subscript, C stands for the centrality index. Statistical significance (t tests, N=11): 0.01: ***, 0.05: **, 0.1: *.

Table 2

Centre-Periphery Structure of Industrial Employment in EU Regions

NACE	Industry Description	Rank by scale economies	Number of observations	Locational bias towards central regions, 1985	Locational bias towards central regions, 1976
35	Motor vehicles	1	72	0.39***	0.40***
25/6	Chemicals	3	80	0.23*	0.31**
33	Office, data proc.	6	34	0.09	0.16
37	Instrument engin.	9	70	0.13	0.09
43	Textiles	17	88	-0.09	0.14
45	Clothing, footwear	19	76	-0.42***	-0.19*
44	Leather goods	20	65	-0.28**	-0.32**

Data source: Eurostat regional statistics. For further explanation see footnotes to *Table 1*.

Table 3

Trends in Intra-Industry Trade Among EU Countries in Different Industry Categories[1]

	Whole Sample	High scale economies (Pratten)	Intermed. scale ec. (Pratten)	Scale intensive (OECD)
Industries	*98*	*20*	*33*	*26*
IIT, 1961	0.35	0.32 (2.4)	0.29 (16.7)***	0.29 (7.0)***
IIT, 1967	0.41	0.38 (2.7)	0.36 (12.4)***	0.35 (8.8)***
IIT, 1972	0.43	0.40 (3.0)*	0.39 (7.4)***	0.38 (7.6)***
IIT, 1977	0.47	0.44 (1.8)	0.44 (2.7)*	0.42 (6.4)**
IIT, 1985	0.47	0.45 (1.8)	0.46 (1.4)	0.43 (6.4)**
IIT, 1990	0.46	0.42 (4.7)**	0.44 (2.8)*	0.41 (8.4)***

[1] IIT are unadjusted Grubel-Lloyd indices for manufactures trade (SITC 5-8) among the EU12, calculated from SITC 4-digit (1961, 67) and 5-digit data, aggregated to the SITC Rev. 1 3-digit level (98 industries), unweighted averages across countries. Figures in brackets are *F*-ratios of analysis of variance on null hypothesis that category mean is equal to sample mean (statistical significance: 0.01: ***, 0.05: **, 0.1: *).

Figure 1

The "U-curve": Industry Concentration and Regional Integration

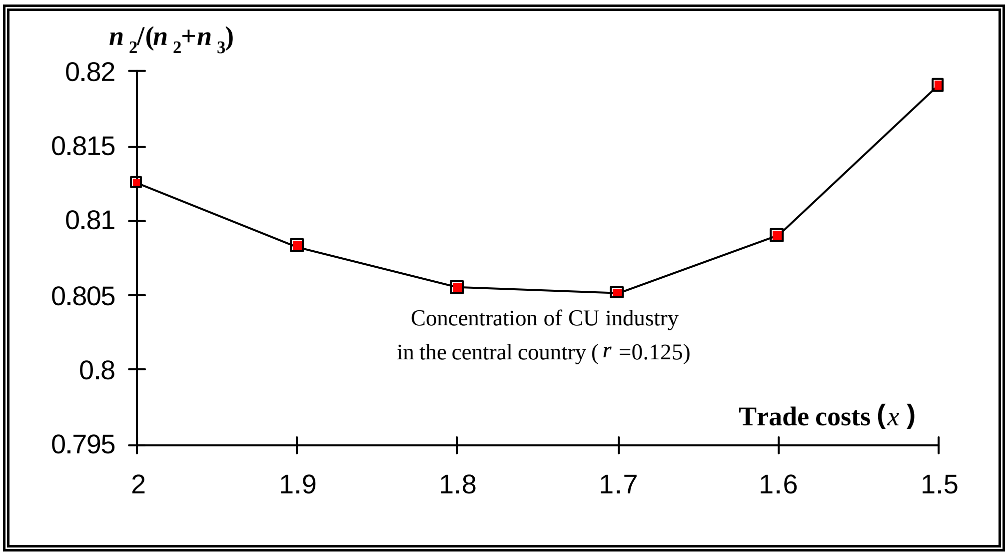


Figure 2

Critical Values of the "Hump"

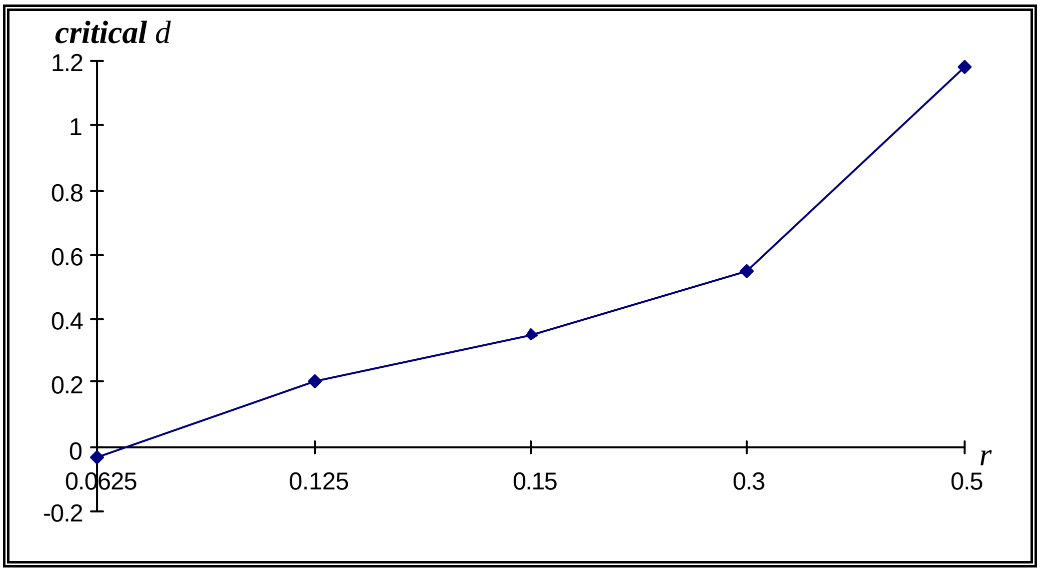


Figure 3
Concentration, Scale Economies and Trade Costs

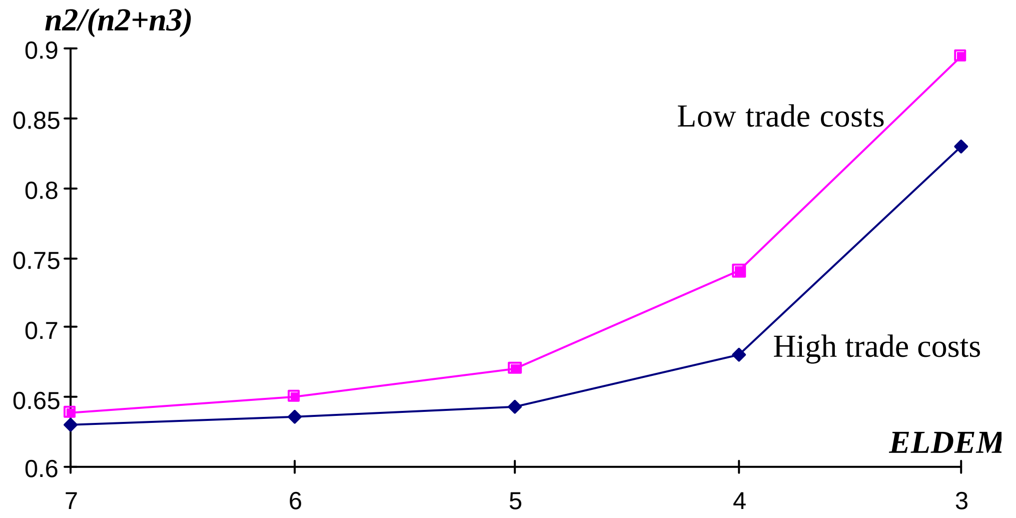


Figure 4
Intra-Industry Trade and Economic Integration

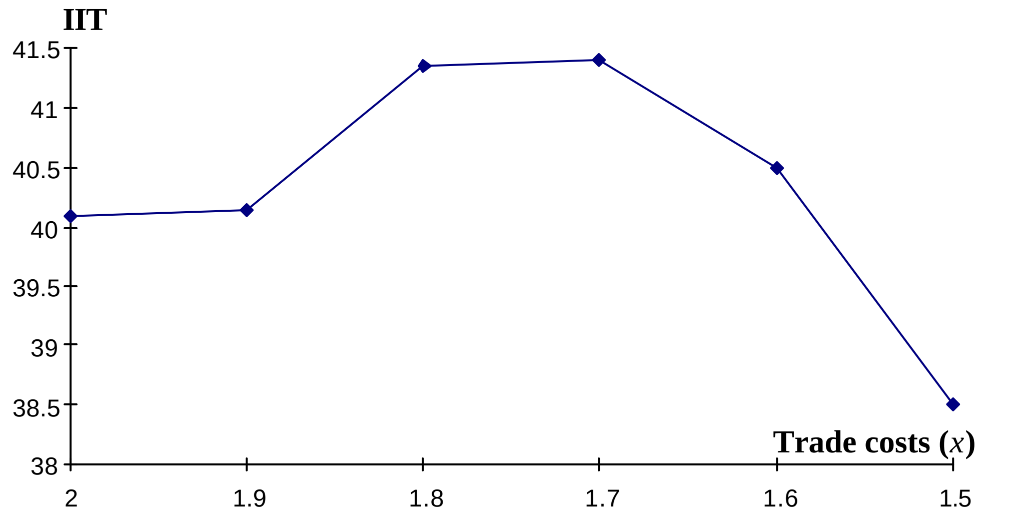
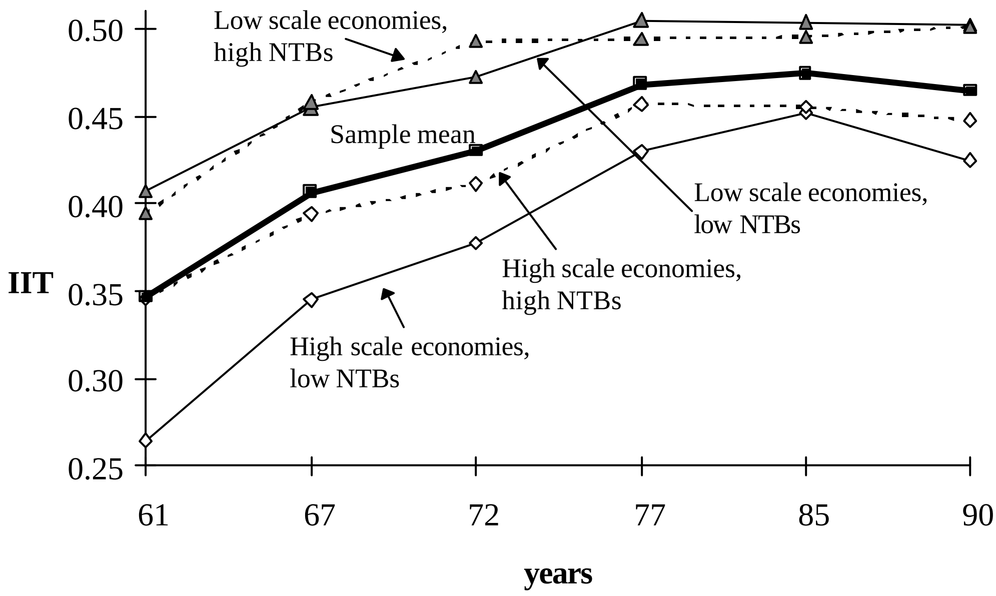


Figure 5

Intra-Industry Trade, Scale Economies and Non-Tariff Barriers Among EU Countries



For information on data sources and transformation see the Appendix.

Appendix

The centrality indices underlying Table 1 are calculated from the regional indices reported by Keeble *et al*. (1986, p. 29ff.). We chose the indices adjusted by the authors for purchasing-power parity exchange rates and aggregated them for each country, weighting the indices by 1983 regional population taken from Eurostat regional statistics. The employment figures for the 18 NACE sectors underlying the results of Table 1 were taken from Eurostat's annual industrial structure statistics. Gaps in these data were filled with estimates based on industry statistics published by the OECD.

Our IIT data are taken from a database created by the participants of the SPES research network on "Trade, Specialisation and Market Structure in the EC" between 1992 and 1995. In the SPES database, the IIT indices are aggregated to and reported at the SITC 3-digit level. Since the SITC product classification was revised twice over the period covered in our study, we re-arranged all the SPES indices into SITC Revision 1 product groups, based on United Nations (1961, 1986), so that changes in the IIT indices over time could be tracked industry by industry.

In order to calculate the results reported in data columns 2 to 4 of Table 3, four of the 98 industries of our data set had to be eliminated, because they could not be allocated to any of the three categories of scale economies. The categories are based on the "Ranking of Manufacturing Industry Groups by Economies of Scale" in Pratten (1988, p. 2-70). Our "high" category contains the first four of the 20 industries in Pratten's table (Motor Vehicles, Other Vehicles, Chemicals and Man-Made Fibres). Our "intermediate" category consists of the sectors ranked 5 to 9 in Pratten (1988) (Metals, Office Machinery, Mechanical Engineering, Electrical Engineering and Instrument Engineering). Since the industries in Pratten's table are based on the NACE classification, they had to be identified among our SITC sectors using a NACE-SITC concordance table. 20 SITC industries were attributed to the "high" category, 33 to the "intermediate" category and 41 to the "low" category. Underlying the results reported on the right-hand side of Table 5 is the classification in ISIC 2-digit and 3-digit product groups compiled by the OECD (1987, p. 29ff.).

The "high scale economies" industries of Figure 5 comprise the "high" and "intermediate" categories based on the Pratten (1988) classification. The sectors subject to intra-EU NTBs were identified on the basis of Buigues *et al*. (1990, p. 24) and a NACE-SITC concordance table. The category with high scale economies and high NTBs comprises 25 industries, the category with high scale economies and low NTBs comprises 28 industries, the category with low scale economies an high NTBs comprises 12 industries, and the category with low scale economies and low NTBs comprises 29 industries.

References

Balassa, Bela and Bauwens, Luc (1987) "Intra-Industry Specialisation in a Multi-Country and Multi-Industry Framework". *Economic Journal*, vol. 97, pp. 923-939.

Baldwin, Richard E. and Venables, Anthony J. (1995) "Regional Economic Integration". In: Grossman, Gene M. and Rogoff, Kenneth, *Handbook of International Economics*, Elsevier, Amsterdam.

Begg, Iain and Mayes, David (1994) "The Implications of Peripherality for Northern Ireland". Northern Ireland Economic Council, Report 111, Belfast.

Brülhart, Marius (1995) "Scale Economies, Intra-Industry Trade and Industry Location in the New Trade Theory". *Trinity Economic Papers*, Technical Paper No. 4.

Brülhart, Marius and Elliott, Robert (1998) "Adjustment to the European Single Market: Inferences from Intra-Industry Trade Patterns". *Journal of Economic Studies*, forthcoming.

Buigues, P.; Ilzkovitz, F. and Lebrun, J.-F. (1990) "The Impact of the Internal Market by Industrial Sector: The Challenge for the Member States". In: *The European Economy - Social Europe* (Special Edition), Commission of European Communities, Brussels.

Calmette, Marie-Françoise and Le Pottier, Jacques (1995) "Localisation des activités: Un modèle bisectoriel avec coûts de transport". *Revue Économique*, vol. 46, pp. 901-909.

Davis, Donald R. and Weinstein, David E. (1996) "Does Economic Geography Matter for International Specialisation?". *NBER Working Paper*, No. 5706.

Dixit, Avinash K. and Stiglitz, Joseph E. (1977) "Monopolistic Competition and Optimum Product Diversity". *The American Economic Review*, vol. 67, pp. 297-308.

Greenaway, David (1983) *International Trade Policy: From Tariffs to the New Protectionism*. Macmillan, London.

Greenaway, David and Hine, Robert C. (1991) "Intra-Industry Specialization, Trade Expansion and Adjustment in the European Economic Space". *Journal of Common Market Studies*, vol. 24, pp. 603-622.

Greenaway, David and Milner, Chris (1984) "A Cross-Section Analysis of Intra-Industry Trade in the UK". *European Economic Review*, vol. 25, pp. 319-344.

Greenaway, David and Milner, Chris (1986) *The Economics of Intra-Industry Trade*. Basil Blackwell, Oxford.

Greenaway, David and Torstensson, Johan (1997), "Back to the Future: Taking Stock on Intra-Industry Trade", *Weltwirtschaftliches Archiv*, vol. 133, pp. 249-269..

Hanson, Gordon (1997), "Increasing Returns, Trade and the Regional Structure of Wages, *Economic Journal*, vol. 107, pp. 113-133.

Helpman, Elhanan and Krugman, Paul (1985) *Market Structure and Foreign Trade*. MIT Press, Cambridge (Mass.).

Keeble, David; Offord, John and Walker, Sheila (1986) Peripheral Regions in a Community of Twelve Member States. Commission of the European Communities, Luxembourg.

Kim, Sukkoo (1995) “Expansion of Markets and the Geographic Distribution of Economic Activities: The Trends in U.S. Regional Manufacturing Structure, 1860-1987”. *Quarterly Journal of Economics*, vol. 110, pp. 881-908.

Krugman, Paul (1980) “Scale Economies, Product Differentiation, and the Pattern of Trade”. *American Economic Review*, vol. 70, pp. 950-959.

Krugman, Paul (1991a) “Increasing Returns and Economic Geography”. *Journal of Political Economy*, vol. 99, pp. 483-499.

Krugman, Paul (1991b) *Geography and Trade*, MIT Press, Cambridge (Mass.).

Krugman, Paul and Venables, Anthony J. (1990) “Integration and the Competitiveness of Peripheral Industry”. In: Bliss, C. and de Macedo, J. (ed.) *Unity with Diversity in the European Community*, Cambridge University Press, pp. 56-75.

Krugman, Paul and Venables, Anthony J. (1995) “Globalization and the Inequality of Nations”. *Quarterly Journal of Economics*, vol. 110, pp. 857-880.

Krugman, Paul and Venables, Anthony J. (1996) “Integration, Specialization and Adjustment”. *European Economic Review*, vol. 40, pp. 959-967.

Loertscher, Rudolf and Wolter, Frank (1980) “Determinants of Intra-Industry Trade”: Among Countries and Across Industries. *Weltwirtschaftliches Archiv*, vol. 116, pp. 280-293.

Neven, Damien and Gouyette, Claudine (1995) “Regional Convergence in the European Community”. Journal of Common Market Studies, vol. 33, pp. 47-65.

Organisation for Economic Co-operation and Development (1987) Structural Adjustment and Economic Performance. OECD, Paris.

Pratten, Cliff (1988) “A Survey of the Economies of Scale. In: Commission of the European Communities”. Research on the “Cost of Non-Europe”, Volume 2: Studies on the Economics of Integration, Luxembourg.

Puga, D. and A. Venables (1997) “Preferential Trading Arrangements and Industrial Location”, *Journal of International Economics*, vol. 43, pp. 347-368.

Ray, Edward John (1991) “U.S. Protection and Intra-Industry Trade: The Message to Developing Countries”. *Economic Development and Cultural Change*, vol. 40, pp. 169-187.

Somma, Ernesto (1994) “Intra-Industry Trade in the European Computers Industry”. *Weltwirtschaftliches Archiv*, vol. 130, pp. 784-799.

Torstensson, Johan (1995), ”Economic Integration, Market Size and the Location of Industries”, CREDIT Research Paper, 2/95, University of Nottingham.

Torstensson, Johan (1996), “Determinants of Intra-Industry Trade: A Sensitivity Analysis”, *Oxford Bulletin of Economics and Statistics*, vol. 58, pp. 507-22.

United Nations (1961) “Standard International Trade Classification, Revised”. Statistical Papers, Series M, No. 34, New York.

United Nations (1986) “Standard International Trade Classification, Revision 3”. Statistical Papers, Series M, No. 34/Rev. 3, New York.