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STUDY OF INDUSTRIAL LOCATION**

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INTERNATIONAL TRADE

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ABSTRACT

A U-Shaped Europe? A Simulation Study of Industrial Location*

This Paper uses a full-scale CGE-model, calibrated on 1992 data, to investigate the effects of European integration on the location of industrial production. Our results reveal large differences among individual industries. Industries with high-scale elasticities typically display a non-monotonous relationship between trade liberalisation and concentration, with maximal concentration for intermediate trade costs. Other industries, more driven by comparative advantage, become more and more concentrated as trade costs are lowered. On the aggregate European level we find an (inverse) U-shaped relation between trade costs and concentration, with Europe 1992 close to the peak of concentration. The results also show a close correlation between real income gains and growth in manufacturing production; we label this an 'externality shifting' effect: gains from pecuniary externalities in the manufacturing sectors. Finally, we note that nominal factor prices co-vary as regions specialise, while in relative terms there are traces of the Stolper-Samelson theorem.

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NON-TECHNICAL SUMMARY

A common worry among politicians of peripheral regions in the EU is that the European economic integration will lead to loss of industry and jobs in their regions. These worries are underscored by a series of recent theoretical articles (e.g. Krugman (1991) and Krugman and Venables (1995)), suggesting that economic integration may indeed lead to increased concentration of industrial production and increasing international inequalities.

The theoretical studies, however, make their argument in highly stylised models. This is necessary because of the complexity of the imperfect competition and industry-linkages framework. A question then is whether the results and intuitions from simple theoretical economic geography continue in richer models.

This Paper analyses the locational effects of economic integration in a setting closer to reality. We simulate the effects of trade liberalisation in Europe using a large-scale simulation model calibrated on actual data. The purpose of this exercise is two-fold. First, it has an obvious policy interest to try to assess the locational effects of European integration. Second, it is theoretically important to investigate if the results from small and stylised models hold in a larger model.

The main result from the theoretical literature is that industrial concentration can arise because of self-reinforcing backward and forward linkages. These stem from a combination of increasing returns to scale, trade costs and the fact that firms are linked via their input-output matrices (see Krugman and Venables, 1995). Downstream firms use an aggregate of upstream varieties as an intermediate input. When trade across borders incurs costs, a larger number of upstream firms in your region implies a lower price level for intermediate inputs. This mechanism constitutes the forward link. More downstream firms, however, also imply a larger home market for upstream firms, which increases their sales and profits. This is the backward link. Against these agglomeration forces, trade costs are a force that makes it less attractive to serve markets via exports. Higher trade costs, therefore, work in the direction of less concentration. It may be noted that low trade costs imply weak agglomeration forces as well as a weak dispersion force. Any dispersion force that is independent of trade costs will therefore tend to dominate for low trade costs. With such a dispersion force present, agglomeration will display a U-shaped pattern with agglomeration of economic activity for intermediate trade costs and dispersion for high and low trade costs. Examples of such forces are decreasing returns in some perfectly competitive sector, comparative advantage and congestion.

In this Paper we simulate the effects of economic integration in Europe using a full-scale simulation model, the EURORA model with 14 industries and 10 regions, which is calibrated on actual 1992 data. This model captures imperfect competition and scale economies, as well as backward and forward linkages through a complete input-output structure.

In our general-equilibrium simulations we gradually reduce trade costs and study the pattern of industrial concentration in individual industries as well as for manufacturing as a whole. For a number of industries we find such an (inverse) U-shaped relationship between integration and concentration: industrial concentration is low for high and low trade costs and higher for intermediate trade costs. A common feature for these industries is that there are significant increasing returns to scale and important intra-industry linkages.

For other industries there is a monotonous increase in concentration as trade costs are lowered. These industries are typically industries in which scale economies are less important, but where initial trade costs have prevented sufficient specialisation.

We also find an (inverse) U-shaped relationship between economic integration and overall concentration in manufacturing. To the extent that there is a link between industrial concentration and regional inequality, it is worth noting that, according to our simulation results, further deepening of Western European integration through declining trade costs, should not imply significant increases in overall industrial concentration.

We also investigate the effects on factor prices and welfare. We note that the distributional concerns associated with trade liberalisation, namely that skilled workers in skill-abundant regions of Europe would gain and low-skilled workers lose, are muted in our model due to the strong influence of increasing returns to scale. All nominal factor prices vary in the same direction in our simulations, even if relative changes go in favour of the abundant factor.

Finally, our results show a close correlation between real income gains and growth in manufacturing production; we label this an 'externality shifting' effect: gains from pecuniary externalities in the manufacturing sectors. The existence of such effects, which would not appear in standard perfect-competition trade models, implies that the widespread fear that increased industrial concentration could lead to more inequalities in Europe, is given some support. However, our results show that although such effects are present, there is little reason to expect further integration to change the pattern of concentration to such an extent that peripheral regions lose. On the contrary, when we are close to free trade, all regions, apart from Central Europe, gain from further integration in our simulations.

1. Introduction

A common worry among politicians of peripheral regions in the EU is that the European economic integration will lead to loss of industry and jobs in their regions. These worries are underscored by a series of recent theoretical articles (e.g. Krugman (1991) and Krugman and Venables (1995)), suggesting that economic integration may indeed lead to increased concentration of industrial production and increasing international inequalities.

The theoretical studies, however, make their argument in highly stylised models – normally a 2x2x2 framework.¹ This is necessary because of the complexity of the imperfect competition and industry-linkages framework. A question then is whether the results and intuitions from simple theoretical economic geography models go through in richer models.²

This paper analyses the locational effects of economic integration in a setting closer to reality. For this purpose we simulate the effects of trade liberalisation in Europe using a large scale CGE-model calibrated on actual data. The purpose of this exercise is twofold. First it has an obvious policy interest to try to assess the locational effects of European integration. Second, it is theoretically important to investigate if the results from small and stylised models hold in a model of more realistic dimensions.

The main result from the theoretical literature is that industrial concentration can arise because of self-reinforcing backward and forward linkages. These stem from a combination of increasing returns to scale, trade costs, and the fact that firms are linked via their input-output matrices (see Krugman and Venables, 1995). Downstream firms use an aggregate of upstream varieties as an intermediate input. When trade across borders incur costs, a larger number of upstream firms in your region implies a lower price level for intermediate inputs. This mechanism constitutes the forward link. More downstream firms, however, also imply a

¹ An exception is Puga and Venables (1996), who use a framework of multiple sectors with inter-sectoral input-output linkages.

larger home market for upstream firms, which increases their sales and profits. This is the backward link. Against these agglomeration forces, trade costs are a force that makes it less attractive to serve markets via exports. Higher trade costs, therefore, work in the direction of less concentration. It may be noted that low trade costs imply weak agglomeration forces as well as a weak dispersion force. Any dispersion force that is independent of trade costs will therefore tend to dominate for low trade costs. With such a dispersion force present, agglomeration will display a U-shaped pattern with agglomeration of economic activity for intermediate trade costs and dispersion for high and low trade costs. Examples of such forces are decreasing returns in some perfectly competitive sector (Venables, 1996), comparative advantage (Forslid and Wooton, 1999, Fujita et al, 1999), and congestion (see e.g. Helpman, 1995).

In this paper we simulate the effects of economic integration in Europe using a full-scale CGE-model - the EURORA model with 14-industries and 10-regions (Forslid et al, 1999) – which is calibrated on actual 1992 data. This model captures imperfect competition and scale economies, as well as backward and forward linkages through a complete input-output structure.

Our results show that the locational effects of economic integration are highly region and sector specific with some sectors being driven primarily by comparative advantage and others by agglomeration forces associated with scale economies and input-output linkages. However, the results for the overall increasing returns to scale manufacturing sector reveal an (inverse) U-shaped relationship between trade liberalisation and concentration of the manufacturing industry. Dual to this we report movements in factor prices and welfare effects. We show that welfare is positively associated with the location of the increasing-returns-to-scale (IRS) manufacturing, due to an “externality-shifting” effect. Finally, all nominal factor

² For instance, Davis (1998) has challenged the robustness of the home-market effects appearing in such models. He shows that the introduction of equal trade costs for both goods in a two-sector model takes away all

prices are shown to co-vary in our simulation, which may seem contrary to the Stolper-Samuelson theorem. In a relative sense, however, Stolper-Samuelson effects are visible.

Section 2 describes the model and the data, while section 3 presents the results on industrial location. Section 4 discusses the effects on factor prices and welfare, and section 5 offers some concluding remarks.

2. Model Description and Data Sources

The model has 14 sectors and ten regions, of which four are Western European. The four Western European regions together constitute the European Economic Area (EEA) plus Switzerland; the regional split is based on geography rather than e.g. economic criteria. Table 1 describes the regions of interest to this paper.

Table 1: European Regions

<i>Regions</i>	<i>Description</i>
Europe Central (EuropeC)	Austria, Denmark, Germany, Switzerland
Europe North (EuropeN)	Finland, Iceland, Norway, Sweden
Europe South (EuropeS)	Greece, Italy, Portugal, Spain
Europe West (EuropeW)	BeNeLux, Ireland, France, UK

Sectors are linked via demand for intermediate inputs, which creates agglomeration forces *à la* Venables (1996) and Krugman and Venables (1995). In the simulation model there are both intra- and inter-industry linkages creating agglomeration forces not only within sectors but also between different kinds of economic activity. To calibrate the model we use actual input-output tables from Eurostat and GTAP, and the NBER World Trade Flows from 1992.

The model we use is related to the CGE model developed by Haaland and Norman (1992), but with significant modifications with respect to linkage structure, various types of

agglomeration tendencies.

trade costs and market structure.³ An important feature of the model is that it has a complete input-output structure, i.e. all linkages across the 14 sectors in the model are taken into account and are modelled in detail, using region-specific input-output matrices.⁴ Of the 14 sectors, two are assumed perfectly competitive, while there are 12 imperfectly competitive sectors. Two of these are non-traded services sectors while the remaining ten are traded manufacturing sectors.⁵ Three different types of trade costs are considered: transport costs, tariffs, and export taxes. The basic industrial structure of the model is shown in Table 2.

Table 2: Industries

<i>Set</i>	<i>Industry</i>	<i>Description</i>
NT	Public Services Private Services	Non-traded monopolistically competitive sector linked to all other sectors through the input-output structure
PC	Agriculture, Energy	Traded perfect competitive sectors without trade costs. Each sector has a specific factor, which creates an element of decreasing returns to scale.
ITG	Textiles, Leather and Products, Wood Products, Metals, Minerals, Chemicals, Food Products, Transport Equipment, Machinery, Other Manufacturing	Traded sectors with monopolistic competition. Transport costs of iceberg type, plus tariffs and export taxes or subsidies. Linked to all other sectors through the input-output structure.

³ Other related model-based analyses of European integration are e.g. Gasiorek, Smith and Venables (1991, 1992), Baldwin, Forslid and Haaland (1996), Allen, Gasiorek and Smith (1998), Keuschnigg and Kohler (1996), Baldwin, Francois and Portes (1997).

⁴ Baldwin, Francois and Portes (1997) also use a model with a complete input-output structure. Their model, however, treats EU 15 as one region.

⁵ It might be argued that private services should be modelled as traded goods. We do not, however, have a complete matrix of intra-European trade for this sector. Still, studies of the services sector in Europe find that trade in services is relatively limited, in the sense that trade constitutes a small share of total supply of services (see EFTA (1994)). The focus of the present paper is moreover on the manufacturing and not on the services sector.

2.1 Basic model equations

Consumers have Cobb-Douglas preferences over a set of all goods (AG), implying that they, in each market (m), will spend a fixed share of their income on each good:

$$C_{im} = \alpha_{im} \frac{Y_{im}}{P_{im}} \quad i \in \text{AG} \quad (1.)$$

For perfectly competitive goods prices are world market prices given by world market clearing conditions for the respective goods. One of these goods is chosen as numeraire. As for imperfectly competitive, differentiated goods (the set I), the price level for good i is an index of the prices of each variety of the good sold in market m. The calibrated demand parameter for each of the N_{ij} varieties of good i from country j sold in market m, is a_{ijm} .

$$P_{im} = \left(\sum_{j=1}^R N_{ij} a_{ijm} P_{ijm}^{(1-\sigma_i)} \right)^{\frac{1}{1-\sigma_i}} \quad i \in I \quad (2.)$$

For non-traded, differentiated goods $a_{ijm}=0$ for all $m \neq j$, since by assumption only domestically produced varieties are consumed. σ_i is the elasticity of substitution between various varieties of good i.

The imperfectly competitive sectors are characterised by monopolistic competition *à la* Dixit and Stiglitz. Producer prices (PPI) of individual varieties are given as a mark-up over firms' marginal costs (MC):

$$PPI_{ij} = \frac{\sigma_i}{\sigma_i - 1} MC_{ij} \quad i \in I \quad (3.)$$

while consumer prices (PI_{ijm}) for the traded goods are subject to trade costs of three types: export taxes (EXTAX), transport costs (TRANS), and tariff equivalents of import barriers (TAREQ). The transport costs are of the iceberg type, while export taxes and import tariffs are transfers (to the representative consumer).

$$PI_{ijm} = PPI_{ij} (1 + EXTAX_{ijm}) (1 + TRANS_{ijm}) (1 + TAREQ_{ijm}) \quad i \in ITG \quad (4.)$$

Demand for each variety of good i in market m may now be derived as:

$$X_{ijm} = a_{ijm} \left(\frac{P_{im}}{PI_{ijm}} \right)^{\sigma_i} C_{im} \quad i \in ITG \quad (5.)$$

Prices and demand for non-traded differentiated goods are derived in the same way as for traded goods, but with no need to distinguish between producer and consumer prices since there is only domestic consumption of these goods.

The price index for differentiated intermediate goods (Q_{hm}) is industry specific by purchasing industry (h) and region (m). The industry uses all goods as inputs, weighting the aggregate price of each good by the parameter g_{ihm} . The parameter is calibrated from the use of good i as intermediate input in the production of industry h in country m .

$$Q_{hm} = \left(\sum_{\forall i \in I} g_{ihm} P_{im}^{(1-sq)} \right)^{\frac{1}{1-sq}} \quad \forall h \in AG \quad (6.)$$

where sq is the elasticity of substitution among imperfectly competitive goods used as intermediates. Observe that we use the same price index (P_{im}) for industry i here as for consumer demand; hence, we assume that intermediate demand and final demand use different varieties of good i in the same proportions. The price indices for perfectly competitive goods (the set PC) as intermediates are constructed in the same way.

$$QPC_{hm} = \left(\sum_{\forall i \in PC} g_{ihm} PPC_i^{(1-sq)} \right)^{\frac{1}{1-sq}} \quad \forall h \in AG \quad (7.)$$

PV_{ij} is a price aggregate for all primary factors used in the production in sector i in region j .

The use of each individual factor is industry and country specific, given by the parameter β .

$$PV_{ij} = \left(\sum_{k=1}^K \beta_{ijk} W_{jk}^{1-s_i} \right)^{\frac{1}{1-s_i}} \quad i \in AG \quad (8.)$$

Finally, the marginal cost for industry i in country j is specified as a nested CES-function, with primary inputs, differentiated intermediates, and homogenous intermediates in one

second-level nest each, and with S_{top} as the elasticity of substitution between the nests at the top level. Using the price indices above, the marginal cost function may be written

$$MC_{ij} = \left[BV_{ij} (PV_{ij})^{1-S_{topi}} + BZ_{ij} (Q_{ij})^{1-S_{topi}} + BZPC_{ij} (QPC_{ij})^{1-S_{topi}} \right]^{\frac{1}{1-S_{topi}}} \quad (9.)$$

From (9), using (6) – (8) and market clearing conditions for each good, we find the demand for primary factors and intermediate goods from each sector. Together with supply conditions, these form the general equilibrium system.

The use of intermediates from own as well as other industries implies the existence of inter- and intra-industry cost linkages. The presence of these linkages, together with trade costs, means that the number of firms producing in the region affects each firm's costs, i.e. they generate pecuniary externalities. Firms located in a region with a large number of suppliers of important intermediates, will be relatively more competitive.

Agglomeration forces do not directly affect the perfectly competitive sectors. These sectors, however, expand or contract as a consequence for factors of competition with the other sectors. The decreasing returns in these sectors (due to a specific factor) act to dampen the expansion of the ITG sectors.

2.2 Data

Data sources are EUROSTAT (input-output tables for Europe), GTAP and NBER World Trade Flows (see Feenstra et al, 1997). A detailed description of the data and data sources can be found in Forslid *et al* (1999). The same paper also provides a descriptive analysis of the data material, focusing on the distribution of production across regions, trade flows and trade volume, differences in technology and factor use across industries.

2.3 Industry and region characteristics

Here we present some key elements of interest to the present study. In particular we concentrate on features that are expected to influence the location of various sectors as trade costs are lowered. Four factors affect the strength of the backward and forward linkages in this model: trade costs (transport costs, tariffs and export taxes or subsidies), scale elasticities, the input-output structure, and the size of regions (home market effects). In addition to these agglomeration forces, location is affected by standard comparative advantage - especially for low trade costs - due to differences in endowment or technology.

Total trade costs are given by the product of the three terms in equation (4). Table 3 gives a summary of the trade distortions. In the trade liberalisation experiments we lower trade costs equiproportionate over sectors, which implies that we would expect more “action” in sectors with initially high trade costs. Let us therefore note that Food products, Minerals, Chemicals and Wood Products are all sectors that are characterised by relatively significant trade distortions.

Table 3: Summary of trade distortions and scale economies

	Summary of trade distortions			Returns to scale*)
	Low	Unweighted Mean	High	
Textiles	4.3	6.2	8.8	0.06
Leather and Products	3.6	4.9	5.5	0.06
Wood Products (**)	3.8	6.2	(-)11.1	0.12
Metals	3.8	6.0	9	0.16
Minerals	2.4	9.3	14.9	0.10
Chemicals	4.7	8.7	16	0.24
Food Products	14.4	20.1	31.1	0.08
Transport Equipment	2.3	3.1	4.2	0.26
Machinery	2.6	3.5	3.9	0.20
Other Manufacturing	3	4.1	4.8	0.08

*) Percent reduction in average cost (AC) with a one-percent increase in output.

***) The negative sign represents export subsidies for wood products in Europe North.

The next factor affecting agglomeration forces is scale elasticity.⁶ The last column in table 3 shows that scale economies are most important for Transport equipment, Chemicals,

⁶ Pratten (1988) offers a ranking of industries according to economies of scale; this has been transformed into scale elasticities by Cawley and Davenport (1988). We use an adjusted version of the Cawley-Davenport elasticities, where all scale elasticities have been increased, but in such a way that the relative differences

Machinery and Metals, which all have a scale elasticity above average. According to theory (see Krugman, 1980; Krugman and Venables, 1995; Amiti, 1998) we would, *ceteris paribus*, expect these to agglomerate the most.

The use of intermediates is also a factor determining the location of production and the degree of concentration. Industries purchase intermediates from own sector as well as from other sectors. Table 4 gives a summary of key characteristics regarding the average European intermediate use. Column (a) gives use of input from own sector as share of output value; column (b) gives total use of intermediates from all sectors as share of value of output. In column (c) the dependence on own relative to other sectors' inputs is shown (column (a) relative to column (b)): a number higher than 0.5 indicates that inputs from own industry are more important than inputs from all other industries together. Finally, column (d) gives use of public and private services – which by assumption are non-traded goods – as share of output.

While purchases from own sector create a positive feedback and make agglomeration self-reinforcing, the use of intermediates from other sectors may work both for and against agglomeration depending on the location of the supplying sectors. A strong dependence on sectors that are rather dispersed across regions or alternatively concentrated in another region than the purchasing sector, discourages agglomeration. In general, we would *ceteris paribus* expect industries with a strong bias towards use of inputs from own industries (high (a)), and with intra-industry linkages that are stronger than inter-industry linkages (high (c)), to be relatively more concentrated geographically.⁷ From Table 4 we can see that Textiles, Wood Products, Metals and Chemicals are industries with an above average use of inputs from own sector and which also have stronger within than between industry linkages.

between industries are preserved. In a model with large-group monopolistic competition and free entry/exit, there is a one-to-one (inverse) relationship between scale elasticity and demand elasticity; and using the original Cawley-Davenport estimates would result in unrealistically high elasticities of demand in almost all industries.

⁷ See Fujita et al (1999) for a discussion of the impact of inter- versus intra-industry linkages on agglomeration.

Table 4: Use of intermediates (average for the Western European regions)

	(a) Own input share	(b) Intermediate share	(c) Own share of intermediates	(d) Services input share
Textiles	0.294	0.561	0.524	0.131
Leather and Products	0.187	0.543	0.344	0.117
Wood Products	0.268	0.555	0.483	0.156
Metals	0.366	0.634	0.577	0.169
Minerals	0.130	0.486	0.267	0.205
Chemicals	0.297	0.603	0.493	0.163
Food Products	0.158	0.655	0.241	0.116
Transport Equipment	0.145	0.570	0.254	0.138
Machinery	0.169	0.489	0.346	0.145
Other Manufacturing	0.026	0.335	0.078	0.095
MEAN	0.204	0.543	0.376	0.143

For low trade costs, agglomeration forces become weak. Instead comparative advantage forces will tend to dominate. Industries have different factor intensities, which opens up for location of production based on comparative advantage. This does, however, not necessarily imply a greater geographical dispersion of production in an industry; depending on the interaction among the total set of forces determining location, comparative advantage may reinforce or discourage geographical concentration of industries.

Table 5: Value added shares and factor intensity ratios (European averages).

	Unskilled labour	Skilled labour	Capital	Unskilled/skilled ratio	Labour/capital ratio
Textiles	0.595	0.175	0.235	3.40	3.28
Leather and Products	0.603	0.175	0.225	3.44	3.46
Wood Products	0.530	0.245	0.228	2.16	3.41
Metals	0.565	0.233	0.203	2.43	3.94
Minerals	0.455	0.195	0.353	2.33	1.84
Chemicals	0.438	0.278	0.285	1.58	2.51
Food Products	0.450	0.185	0.365	2.43	1.74
Transport Equipment	0.540	0.268	0.198	2.02	4.09
Machinery	0.478	0.313	0.210	1.53	3.76
Other Manufacturing	0.553	0.240	0.205	2.30	3.87
MEAN	0.521	0.231	0.251	2.36	3.19

Value added shares and factor intensities ratios are shown in Table 5. Since the rankings of different sectors in terms of factor intensities are similar across the European regions, we shall only focus on European averages. Chemicals, Transport equipment and Machinery are skill-

intensive sectors. Textiles and Leather use unskilled labour intensively (and will hence be labelled labour intensive), while Food products and Minerals are capital intensive.

In order to say something about the importance of comparative advantage for the location of production, we need information about relative factor endowments across regions. These are displayed in Table 6, columns 1 and 2.⁸

Table 6: *Relative Factor Endowments and relative size*

	Unskilled/Skilled labour force	Labour/Capital stock	Share of European GDP *)
Europe Central	4.02	0.019	34.5 %
Europe North	1.69	0.017	5.8 %
Europe South	7.41	0.038	24.3 %
Europe West	2.77	0.037	35.5 %
MEAN	2.99	0.028	

*) Base case (1992) model data.

It should come as no surprise that Europe South is relatively abundantly endowed with unskilled labour, while Europe North is relatively abundant in skilled labour. As for capital endowment, Europe Central and Europe North are relatively more capital abundant than Europe South and Europe West.

The last key factor we want to focus on is the size of regions, since we know that home market effects may have a strong impact on the location of production. The last column of table 6 gives the base-case GDP shares for the Western European regions. While Europe West and Central are about the same size, South is considerably smaller, and Europe North is around 1/7 of the size of the large core regions of Europe.

⁸ We cannot separate factor prices and factor stocks in our benchmark data. For this purpose, we therefore use the factor endowments provided by Maskus and Penubarti (1995).

3. Economic integration and the location of production

We now turn to the question of how the pattern of industrial production in Europe will change as trade impediments are dismantled within the European Economic Area (EEA). We first discuss the relocation of individual manufacturing sectors in Europe resulting from trade liberalisation. In a simple two-regions model it is obvious what increased industrial concentration means, while in our case with four integrating regions it is less clear. We therefore go on by analysing changes in locational patterns using concentration indices. These indices provide us with an overall picture of the degree of industrial concentration. We first study such a concentration measure for each manufacturing industry individually, and then we look at concentration for all traded manufacturing production together. This latter measure indicates whether industries tend to agglomerate in the same or in different regions.

Our model experiments consist of successive lowering of all three types of trade costs (transport costs, tariffs and export taxes) with 10% per step, starting from the benchmark 1992-data. We do, however, also show the result for a few steps of increase in trade costs. We focus on the imperfectly competitive, traded goods (ITG) sectors, as services are non-traded and therefore not directly affected by changes in trade costs. Agriculture and energy are modelled with perfect competition and free trade, which implies that agglomeration forces are absent. Agriculture and energy can in effect be viewed as residuals to the other sectors.

3.1 Changing patterns of production

We shall here describe the simulated production patterns, while leaving further analysis of geographical concentration to the next section. Figure 1 shows how production in different sectors changes as trade costs are lowered. The horizontal axis depicts trade costs relative to the base case. (e.g. 0.5 means half of base case trade costs).

{Figure 1 about here}

Four sectors – Textiles, Leather, Wood Products, and Food Products – show the most dramatic patterns in terms of changing locations. Textiles move out of Europe Central and into Europe West and Europe South. Leather expands in Europe South, while contracting in all other regions. Wood Products leave Europe North and increase in Europe Central and West. Food production leaves South and Central, moves into North but particularly into Europe West.

Consider first textiles. This sector displays a locational pattern that looks very much like a bifurcation, where for very low trade costs production abruptly disappears from central Europe and agglomerates in Europe West and Europe South. The possibility of abrupt changes in location as trade costs are lowered is well known from theory (e.g. Krugman 1991). Table 5 shows that within-industry linkages are relatively strong in textile production, which implies that self-reinforcing forces of agglomeration are likely to be important for the location of production of textiles; thus, the sector is a candidate for strong locational effects. It should also be noted that textiles are a relatively small industry, which implies that large swings in this sector can occur without causing much pressure in the factor markets.

The reason why textiles expand so substantially in Europe South seems rather clear: textile production is one of the most (unskilled) labour-intensive industries, and Europe South has a comparative advantage in the production of labour-intensive goods. But why is it that production moves out of Europe Central and into Europe West and not *vice versa*? Factor endowments cannot explain this change in production patterns. Still, for a true bifurcation an infinitesimal, initial difference will suffice to tip the balance in favour of one location. In our case Europe West does have a slightly larger production than Europe Central initially.

Another small industry is the leather industry, which exhibits a locational pattern similar to textiles - with low trade costs leading to a core-periphery outcome. The difference is that the relocation of production is more continuous and that agglomeration only takes

place in one region: Europe South. The characteristics of the leather sector are similar to textiles. However, in the base case the leather production of Europe South is more than twice as large as in any other European region, which together with South's comparative advantage in labour-intensive production is certainly the main explanation for the resulting agglomeration in this region. The more continuous relocation of this sector is consistent with a relatively low own input share, and thus less significant intra-industry linkages encouraging geographical concentration.

The Wood Products industry is a particular case. The big action here is the loss of production in Europe North and a corresponding gain in the other regions. The driving force behind this result is most certainly a 15% export subsidy in Europe North, which is dismantled as all trade distortions are lowered.

The large swings in production of Food products are linked to this industry's initially high trade costs (c.f. Table 3). One surprise, perhaps, is that this industry starts to agglomerate in Europe North for low trade costs, even though this region initially has production that is only one third or less of the other regions' production volume. The explanation seems to be that Food Products are a relatively capital-intensive industry, which gives Europe North a comparative advantage. Food Products are also characterised by rather low (increasing) returns to scale and a low own input share, which *ceteris paribus* make proximity to a large market less important for its location, and further justify the movement into the Northern periphery of Europe.

What about the remaining ITG industries? These industries exhibit relatively stable patterns of localisation. It should, however, be noted that they generally display a non-monotone relationship between trade liberalisation and location. Among these industries are the four sectors with the most significant increasing-returns-to-scale technology: Metals, Chemicals, Transport equipment and Machinery. In the base case they are all rather

concentrated in the two largest regions: Europe Central and Europe West. Substantial increasing returns to scale and the presence of intra-industry linkages suggest that proximity to markets and self-reinforcing agglomeration forces are important determinants of the location of production in these industries. This is probably why the sectors remain concentrated in the core of Europe when trade costs are reduced.

Taking a more aggregated perspective, Figure 2 displays the share of ITG-industry in each of the regions. Europe North, being by far the smallest region, shows a distinct U-shaped pattern with a loss of ITG-industry for intermediate trade costs for which agglomerative forces reach a maximum. The large region Europe Central exhibits an inverse relationship between ITG share and trade costs. The region's dominant position in the ITG sectors is reinforced for intermediate trade costs, while it may decline as trade costs are further reduced. Europe West shows a monotonous increase in ITG-share as trade costs are lowered, while the ITG share of Europe South actually follows a bell-shaped pattern, although it is not very distinct.

{Figure 2 about here}

To conclude this section, comparative advantages as well as economies of scale and intra-industry linkages all appear as important determinants of the location of industry. There are, however, large differences across industries as to which factors are relatively more important.

3.2. Industrial Concentration

So far we have investigated the location of different industry sectors as Europe integrates. Although the discussion above suggests some conclusions, it is, however, not clear whether industrial production becomes more or less concentrated in Europe as a consequence of integration. To take only a few examples, it is not obvious from figure 1 whether the

production of wood products gets more or less concentrated as integration takes place; it is also difficult to see what happens to the concentration of e.g. production of transport equipment. In this and the next section we shall focus on industrial concentration using summary indices of concentration. We will start by analysing the concentration tendencies of individual industries.

We use a measure for absolute industrial concentration of the following form⁹,

$$C_i = \sqrt{\sum_j (s_{ij} - \bar{s}_{ij})^2 / N}$$

with $s_{ij} = X_{ij} / \sum_j X_{ij}$ being the share of production in industry i taking place in region j, and with N depicting the number of regions (4) in Europe. The index of absolute concentration C_i is the standard deviation of the distribution of s_{ij} . A high value of this statistic indicates a highly concentrated industry. Figure 3 illustrates how increased integration affects the degree of concentration of the ITG industries in the model.

{Figure 3 about here}

There appear to be two groups of industries. Consider first Metals, Chemicals, Transport Equipment and Machinery - a group of industries where concentration displays an (inverse) U-shaped curve as the regions are integrated. These industries all have high scale elasticities (c.f. Table 3), indicating strong agglomeration forces. When trade costs are reduced from a high level, concentration initially increases¹⁰. However, lower trade costs also decrease the agglomeration forces so that, when a critical level of trade costs is reached, the process is reversed as other forces – e.g. comparative advantages – start to dominate. Whether this will

⁹ The differing sizes of the units (the regions) make relative indices a less attractive choice as a measure of *industrial* concentration. See Haaland et al, 1999 and Midelfart Knarvik et al, 1999 for discussion of the use of relative and absolute measures of concentration.

¹⁰ In the figures, t=1 represents the initial level of trade costs, and we study increases of up to 30 percent in these costs as well as a gradual removal of all trade costs, including transportation costs. The actual, initial trade costs vary significantly between the sectors (see Table 3).

make individual industries concentrate more or less is *a priori* not clear, but on the aggregate level factor market pressures will tend to dampen the tendencies of agglomeration.

We would expect industries with high economies of scale to concentrate in large markets. Hence, it comes as no surprise that initially they are all rather concentrated in the large, core regions in Europe Central and West, with Europe Central having the dominant position in all four industries. Metals and Chemicals moreover exhibit relatively strong intra-industry linkages. Even though the changes in concentration that we observe are modest, there is a clear pattern: when trade costs are reduced, agglomeration is first reinforced, confirming that the forces of agglomeration are strongest for “intermediate” levels of trade costs. This development is then proceeded by declining concentration. Metals experience the most significant decline in geographical concentration (around 19%): Europe Central’s dominant position is reduced, while especially Europe West increases its share of the industry.

The second group of industries becomes increasingly concentrated when integration proceeds and allows for reduced trade costs. The industries where lower trade costs imply agglomeration, are exactly the same industries as the ones that exhibit the most dramatic changes in location patterns: Textiles, Leather, Wood Products and Food Products. As argued in the previous section, comparative advantage is a dominating factor for Textiles and Leather, amplified by strong intra-industry linkages and the initial pattern of production. Significant initial impediments to trade are an important explanation for the large movements of the other two sectors in this group.

The possibility of a non-monotone relationship between economic integration and industrial concentration is borne out in several theoretical models. An issue of great political interest in Europe in this context is where we are on the curve. That is: will further integration increase or decrease concentration? These simulations give a tentative answer. It seems that for the manufacturing industries with high degrees of economies of scale, we are close to the

peak in terms of concentration, while other industries – where location is more determined by comparative advantage – may continue to concentrate as integration proceeds.

3.3 Overall Concentration

Having studied concentration effects for individual industries, a natural question is whether industries – to the extent that they become more concentrated - tend to concentrate in the same or in different regions. In other words, will all manufacturing activities tend to concentrate in the core, with de-industrialisation of the periphery?¹¹

We will measure the degree of overall industrial concentration by the following index:

$$H = \sqrt{\sum_j (h_j - \bar{h}_j)^2 / N}$$

with $h_j = \sum_i X_{ij} / \sum_j \sum_i X_{ij}$ being the share of overall manufacturing production taking place in region j, and with N depicting the number of regions (4) in Europe.

{Figure 4 about here}

Figure 4 shows the overall concentration of ITG industries in Europe. Again, agglomeration forces tend to dominate for intermediate trade costs, while other forces – such as comparative advantage - will dominate for low trade costs. However, even if this pattern is well known from simple theoretical two-sector models, it is not obvious from theory that we should get such a pattern in a multi-sector model. Even if agglomeration forces in each sector work like this, it could well be the case that the sectors would agglomerate in different regions. Whether they actually end up in the same or different regions, must depend on the trade-off between on the one hand agglomeration forces through inter-industry linkages, and on the other hand general equilibrium factor price effects. Figure 4 indicates that – at least for

¹¹ See Krugman and Venables (1995) for a theoretical analysis of such issues.

intermediate trade costs – agglomeration forces are strong enough to yield increased overall concentration of manufacturing activities in Europe.

The question of whether further economic integration will foster more or less industrial concentration in Europe can now be addressed. Figure 4 indicates that at the initial 1992-level of trade costs ($t=1$), Europe is fairly close to the peak of overall concentration, but that significant liberalisation is necessary before any signs of increased dispersion will show up. Hence, according to simulations, further integration can cause significant relocation and increased concentration at the individual industry level – in particular in industries that are intensive in the use of unskilled labour. However, at the overall manufacturing level, there is less reason to expect continued movements towards more concentration.

4. Factor prices and Welfare

Whereas the patterns of industrial concentration and regional specialisation are interesting phenomena in their own right, the main reason for the political interest is probably the theoretically based presumption about a relationship between the pattern of production and specialisation and real national income. Moreover, from neoclassical trade theory there are strong reasons to expect changes in national income to be unevenly distributed among different factors of production. Next, we therefore investigate the effects of European economic integration on factor prices.

4.1 Factor Prices

In a Heckscher-Ohlin framework, regional specialisation will have very different impact on the factors of production in a region. The relatively abundant factor will gain whereas the scarce factor will lose according to the Stolper-Samuelson theorem. Indeed, it has been put forward as a serious problem of economic integration that in regions well endowed with

skilled labour – in our case Europe North and West – integration tends to benefit skilled labour at the expense of unskilled. Figure 5 shows nominal factor returns in our four regions.

{Figure 5 about here}

The first thing to note about Figure 5 is that nominal factor prices of different factors within a region co-vary as trade costs are lowered. This may seem to contradict the Stolper-Samuelson theorem. Stolper-Samuelson type effects are nevertheless present, in the sense that relative factor prices move according to the theorem. For instance, when we get down to low trade costs, skilled labour is a winner in a relative sense in both Europe North and West as skill-intensive industries agglomerate in these regions, while low-skilled workers are the relative winners in Europe South.

4.2 Welfare

Traditional trade models would predict gains from specialisation according to comparative advantages, but the theory would not predict that some industries are “more worth” than other industries. New trade theory models add a “profit shifting” effect – saying that there are potential gains from getting a larger share of industries in which there are pure profits.

In our model, free entry and exit of firms in all industries eliminate pure profits; hence, the standard profit shifting argument does not apply. Yet, imperfect competition and linkages matter; there are rents associated with the pecuniary externalities generated in the model, and these rents must show up in the returns to factors of production. Since the magnitude of such externalities differs between industries, the location of manufacturing activities may have important welfare (or real income) implications. *Ceteris paribus* a region gains from getting more of the industries with strong externalities relative to other industries – there is thus an “externality shifting” effect. Whether this is strong enough to outweigh other effects of

relocation of industry, is an empirical question; in this section we present some indicative “evidence” of the importance of externalities for real income.

{Figure 6 about here}

In figure 6 real GDP effects of integration are shown, starting from the benchmark situation 1992 at $t=1$, where GDP is normalised to one in all regions. Together with figure 2, this reveals a close link between a region’s specialisation in imperfectly competitive, traded goods (ITG) industries and real income; hence, externalities seem to matter for value added. Figure 2 shows the aggregate share of total value of production taking place in the ITG industries. In reality, the ITG-share is only a crude measure of the importance of externalities, as there is significant variation with regard to externalities across the ITG industries. Nevertheless, the results in figure 6 are quite illustrative – they indicate that the dispersion of ITG industries across Europe is of a particular importance when it comes to reducing regional and national inequalities.

5. Conclusions

This paper simulates the locational effects on European industry as Europe continues to integrate economically. For this purpose we use a full-scale CGE-model - the EURORA model (Forslid et al, 1999) – which has a complete input-output structure in the sense that all linkages across the 14 sectors in the model are taken into account and are modelled in detail.

From stylised theoretical models we know that in such a setting with scale economies, trade costs and intra- and inter-industry linkages, there will be a trade-off between agglomeration forces tending to give industrial concentration and general-equilibrium forces working in the opposite direction. The outcome is often a bell-shaped (inverse U-shape) relationship between trade costs and concentration, where agglomeration forces dominate for intermediate trade costs. It is not obvious, however, that localisation of individual industries

should follow such an (inverse) U-shaped pattern in a multi-sector model, even if we would expect this pattern to hold in an aggregate sense.

In our general-equilibrium simulations we gradually reduce trade costs, and study the pattern of industrial concentration in individual industries as well as for manufacturing as a whole. For a number of industries we find an (inverse) U-shaped relationship between integration and concentration – industrial concentration is low for high and low trade costs, and higher for intermediate trade costs. A common feature for these industries is that there are significant increasing returns to scale and important intra-industry linkages.

For other industries there is a monotonous increase in concentration as trade costs are lowered. These industries are typically industries in which scale economies are less important, but where initial trade costs have prevented sufficient specialisation.

We also find an (inverse) U-shaped relationship between economic integration and overall concentration in manufacturing. To the extent that there is a link between industrial concentration and regional inequality, it is worth noting that – according to our simulation results – further deepening of Western European integration through declining trade costs, should not imply significant increases in overall industrial concentration.

We also investigate the effects on factor prices and welfare. We note that the distributional concerns associated with trade liberalisation in a traditional trade model (the Stolper-Samuelson theorem) are muted in our model due to the strong influence of increasing returns to scale. All nominal factor prices co-vary in our simulations, even if the relative changes go in the Stolper-Samuelson direction.

Finally, our results show a close correlation between real income gains and growth in manufacturing production; we label this an “externality shifting” effect – gains from pecuniary externalities in the manufacturing sectors. The existence of such effects – which would not appear in neo-classical trade models – implies that the wide-spread fear that

increased industrial concentration could lead to more inequalities in Europe, is given some support. However, our results show that although such effects are present, there is little reason to expect further integration to change the pattern of concentration to such an extent that peripheral regions would lose. On the contrary, when we are close to free trade, all regions, apart from Europe Central, gain from further integration in our simulations.

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Figure 1: Production

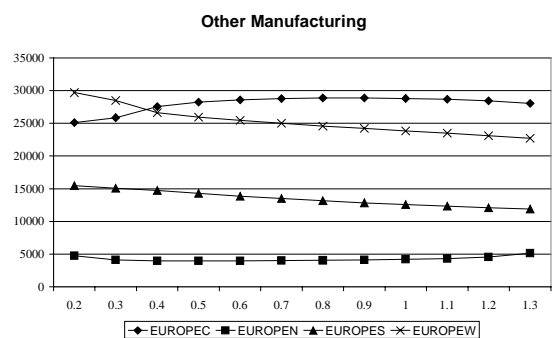
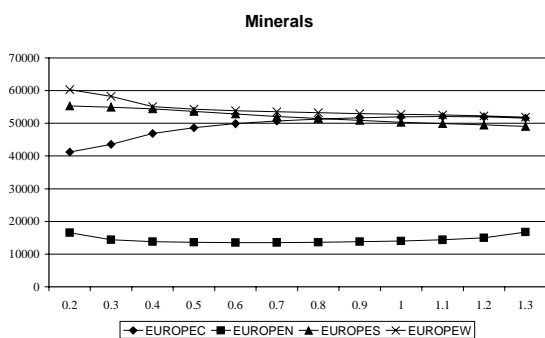
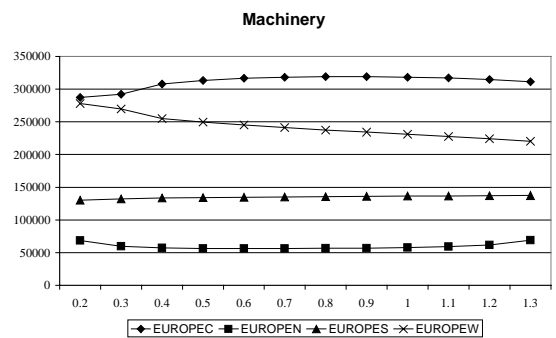
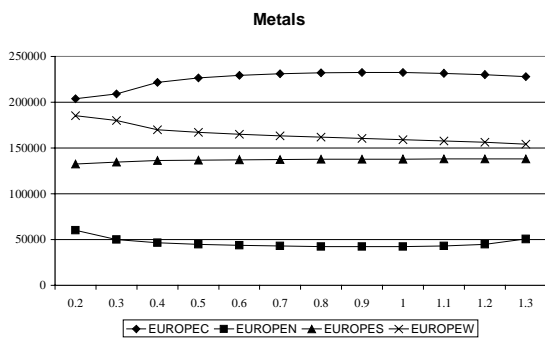
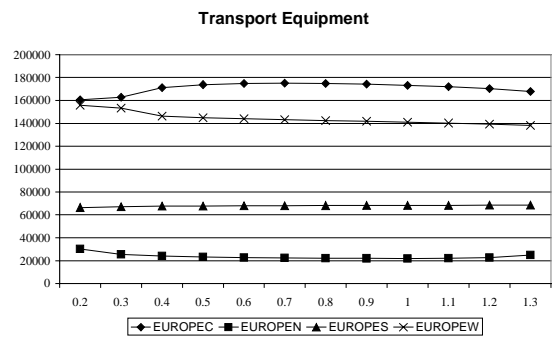
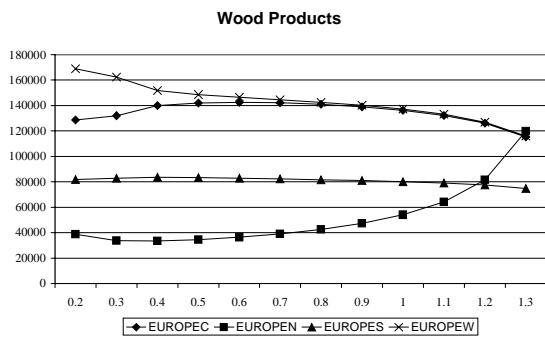
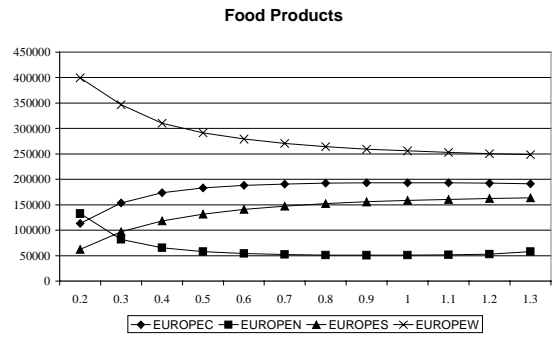
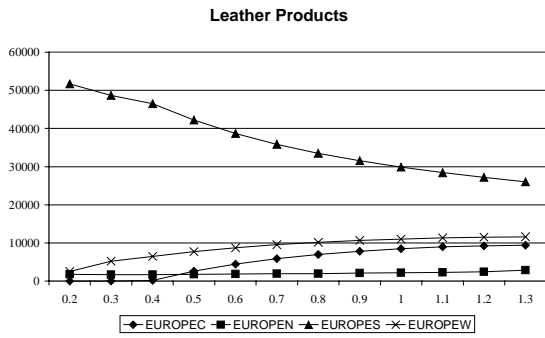
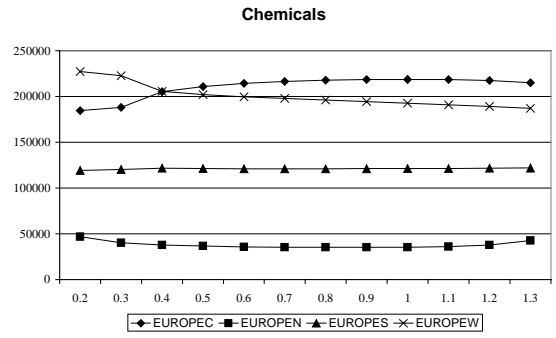
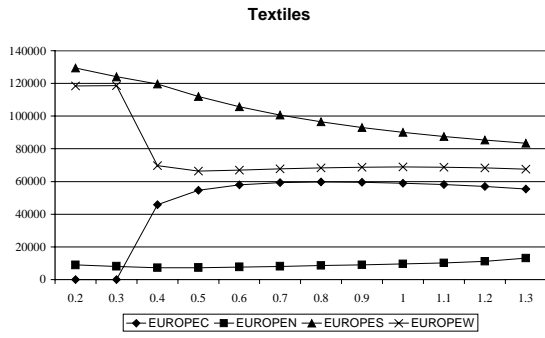


Figure 2: ITG Shares across European Regions

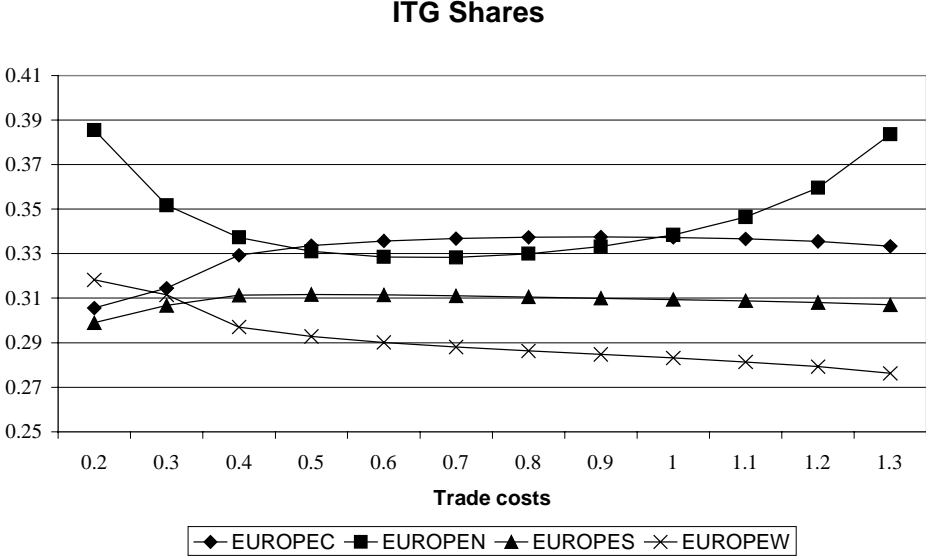


Figure 3: Industrial Concentration

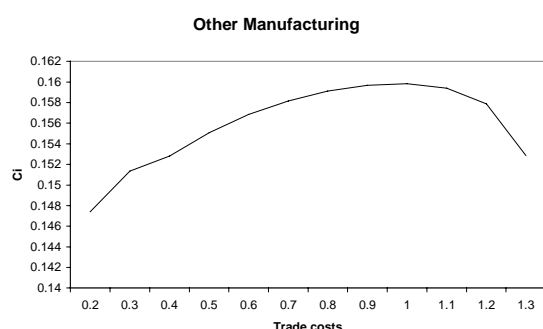
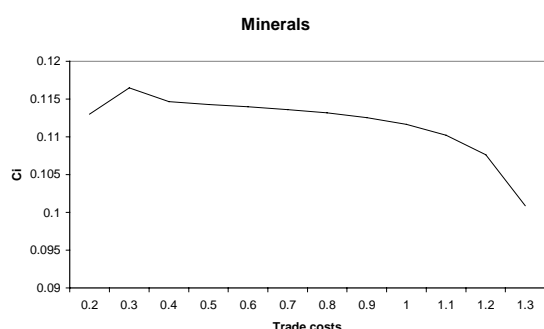
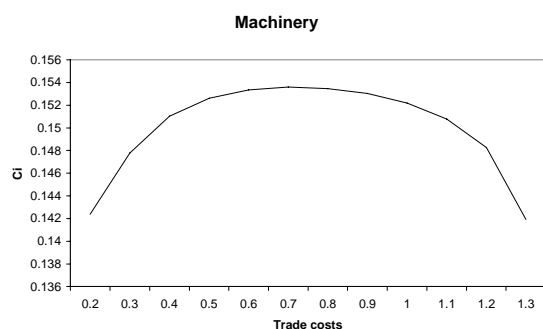
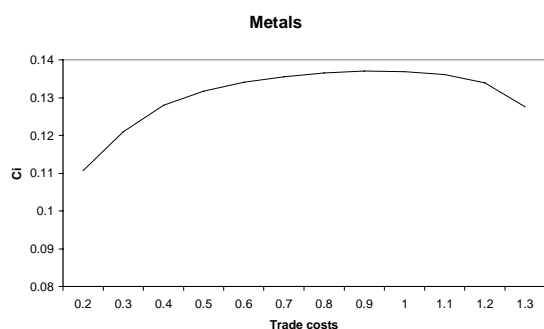
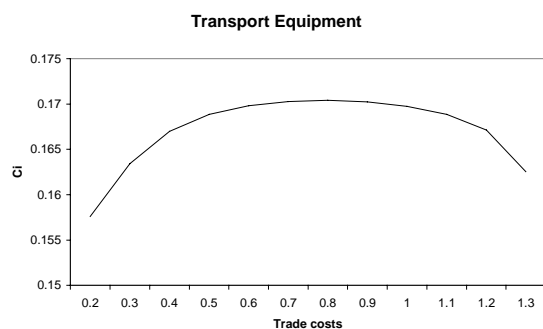
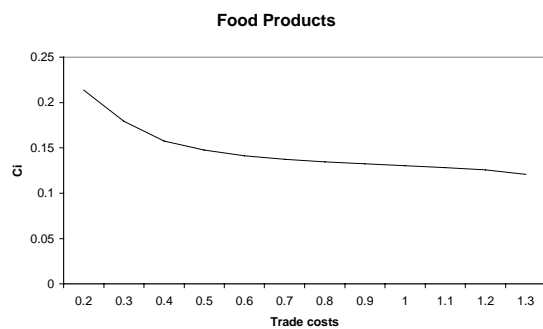
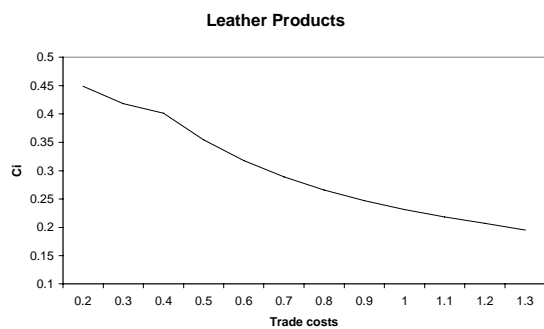
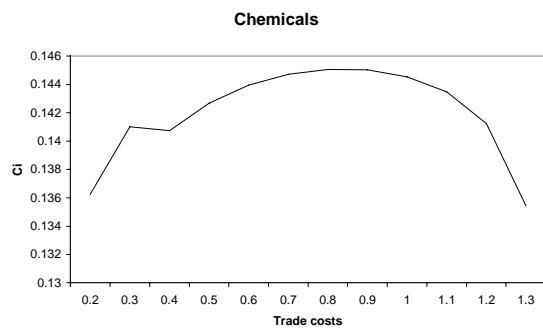
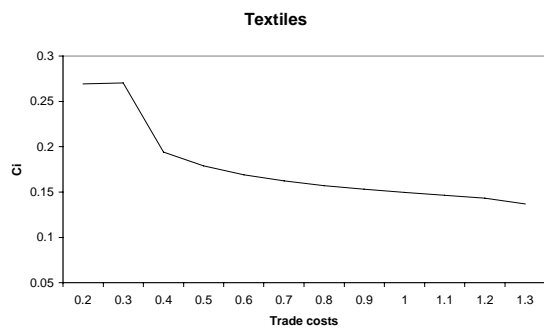


Figure 4: Overall industrial concentration

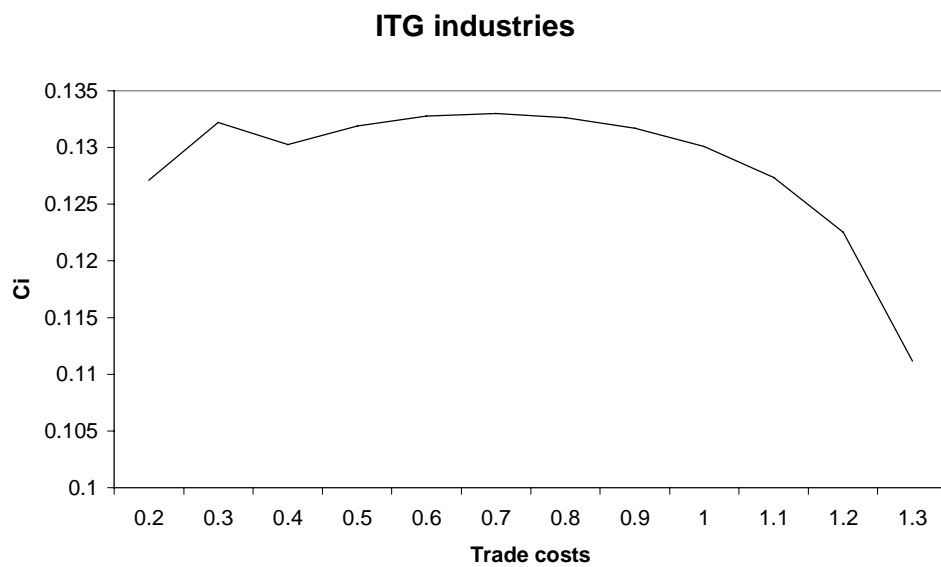


Figure 5: Nominal Factor Prices

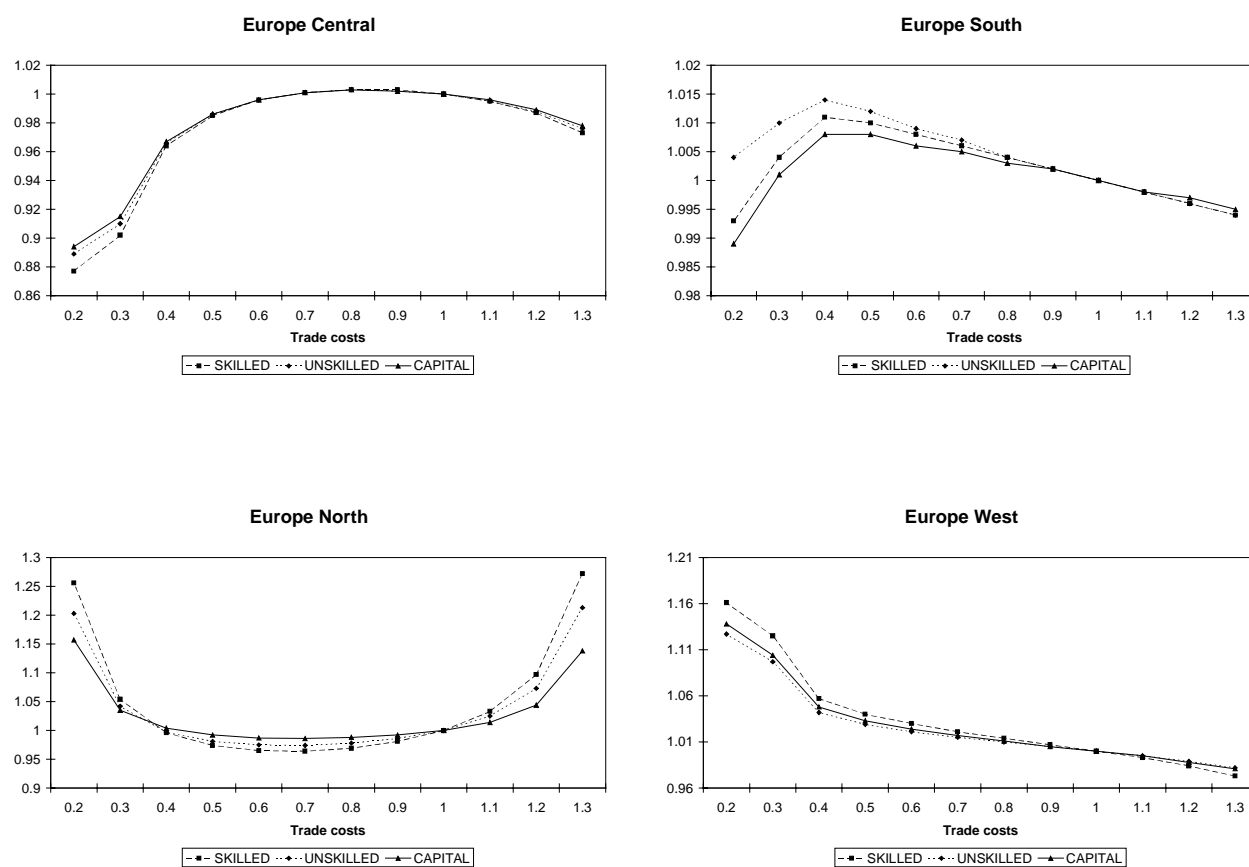


Figure 6: Real GDP

