[608] Working Paper

Globalisation and industrial location:

The impact of trade policy when geography matters

Arne Melchior

Nr. 608 December - 2000

Norwegian Institute of International Affairs
Norsk Utenrikspolitisk Institutt

Utgiver: NUPI

ISSN: 0800 - 0018

Besøksadresse: Grønlandsleiret 25
Addresse: Postboks 8159 Dep.
0033 Oslo
Internett: www.nupi.no
E-post: pub@nupi.no
Fax: [+ 47] 22 17 70 15
Tel: [+ 47] 22 05 65 00

Globalisation and industrial location:

The impact of trade policy when geography matters

Arne Melchior

Key words: Economic geography, spatial economics, economic integration, regional economics, international trade.

JEL classification numbers: R12, R13, F12, F15

Correspondence: Arne Melchior, Norwegian Institute of International Affairs, P.O.Box 8159 Dep., N-0033 Oslo, Norway, e-mail: arne.melchior@nupi.no

Abstract The paper shows how industrial location and welfare depends on "most-favoured nation" (MFN) versus distance-related trade barriers, using a monopolistic competition model with regions located along a "Hotelling" line or on a square plain. Manufacturing production will cluster close to the periphery if transport costs are relatively high, but in central areas if MFN barriers are relatively high. The peripheries will be at a disadvantage, which increases when trade barriers are reduced. When countries or trading blocs are formed, a core-periphery pattern emerges within each of them. While lower transport costs create more centralisation within countries, lower MFN barriers between countries have the opposite effect.

1. Introduction[**]

This paper attempts to bridge the gap between regional economics and international economics by examining trade and location in a framework where distance as well as trading costs unrelated to distance matter for the location of production. The paper thus seeks to analyse regional issues in a framework where international trade and trade policy matters, and to analyse international trade and trade policy in a framework where geography matters.

As noted by Krugman (1995, 1274), "the lack of a good analysis of multilateral trade in the presence of transport costs is a major gap in trade theory". This gap also applies to the analysis of trade policy: While the impact of trade liberalisation has been extensively examined in economics, little is known about how trade policy works *when geography matters*. This gap is all the more important since, during the postwar period, reduced transport costs as well as "political" trade liberalisation have contributed to increased economic integration among countries. Transport costs and other transaction costs have decreased due to technological change, and "political" trade barriers have been reduced through GATT (WTO) and within an ever increasing number of regional trading blocs.

While transport costs are generally increasing with distance, trade barriers within the WTO are not - according to the most-favoured nation (MFN) principle they should be the same for all trading partners. Within trading blocs, barriers set by governments normally apply equally to all trading partners - independent of distance. We thus face two types of trade liberalisation that differ; reductions in transport costs or *spatial trading costs* make the world smaller, and reductions in MFN trade barriers or *non-spatial trading costs* make countries more open.[1] This paper presents a theoretical analysis of how the two types of trade liberalisation work and interact. The results illustrate that the qualitative impact of "political" trade liberalisation in fact critically depends on the presence and magnitude of transport costs, and vice versa.

Spatial trading costs matter within as well as between countries, while MFN trading costs are more important between but not within countries. We therefore analyse *countries* by assuming that a group of regions eliminate MFN trade barriers between them. While countries are normally treated as dimensionless points in the analysis of trade policy, trade liberalisation may in our framework create as well as eliminate cores and peripheries inside countries.[2]

The paper builds on recent trade theory and its extension into what has been called "the new economic geography" (for surveys, see e.g., Fujita and Thisse, 1996, or Ottaviano and Puga, 1998).[3] Following this literature, we apply a two-sector general equilibrium model where one sector produces "traditional goods" with constant returns to scale, and the other sector - which we, for brevity, may call "manufacturing" - is characterised by scale economies, product differentiation and monopolistic competition à la Dixit and Stiglitz (1977). If there are trading costs for manufactured goods, a common feature of this literature is the presence of "market

[**] I thank Jens Chr. Andvig, John Black, Leo Andreas Grünfeld and Per Botolf Maurseth, as well as participants at the EEA Congress in Santiago de Compostela, Spain in September 1999, the seminar on Globalisation arranged by the Norwegian School of Economics and Business Administration/ the Norwegian Research Council in Bergen, October 1999, and at the IESG (International Economics Study Group) 25th annual conference in Sussex, September 2000, for valuable comments to an earlier draft. The responsibility for remaining errors is mine. I also thank the Norwegian Research Council for their financial support for the project.

[1] Observe that it is not unambiguously true that trade barriers set by governments are non-spatial, and that other transaction costs in trade are monotonously increasing with distance. While e.g. technical standards are politically determined, they may be more similar between neighbouring countries than between distant ones, due to e.g. culture, political systems or climate. While transport costs are generally spatial, they may have a considerable fixed cost element (e.g. in shipping). However, the empirical distinction between spatial and non-spatial trading costs is a research question that we do not consider in this paper, since the purpose is to analyse theoretically the impact of the two types of barriers.

[2] The analysis is also relevant for regional trading blocs; if we interpret the "regions" in our model as countries.

[3] Observe that in spite of its name, only a limited number of contributions in the "new economic geography" literature explicitly address spatial issues.

size effects": Producers with a favourable access to markets (home markets, regional markets, geographical markets) will have a comparative advantage for manufactured goods. Using this type of model, this paper asks the question: Given a certain pattern of trading costs (spatial and non-spatial), what will be the equilibrium location pattern of industrial activity, and the welfare levels of consumers at different locations?

Consider, for example, a "long narrow country" or a "linear city" à la Hotelling where demand is spread out evenly along the line. Other things equal, manufacturing firms at the centre of the line will have the best market access, sell more and, due to economies of scale, be more profitable. This will tend to attract new firms to the centre, and geography thus works as a centripetal force. On the other hand, centrally located manufacturing firms face higher trading costs when selling to the peripheral locations, and it may be profitable for some firms to locate close to the periphery and sell there at lower transport cost. Demand from the peripheries thus works as a centrifugal force which may prevent central agglomeration.

This interaction between centralising and decentralising forces is examined by Fujita and Krugman (1995)[4], who apply a model where traditional goods are produced using land and labour, while manufactures are produced by labour only. Land is evenly distributed in a "long narrow country", while labour is mobile. The authors ask the following question: When is the monocentric equilibrium, i.e. when all manufacturing production is located at the central location, an equilibrium? In general, this will be the case when demand from the peripheries is not too large, and when it is easy to serve the peripheral markets from the centre.[5] The authors did not, however, analyse other equilibrium outcomes than the monocentric one. A step in this direction was made by Fujita and Mori (1997), who examined the development of duocentric, tricentric or "multicentric" equilibria when the population of the "long narrow country" increased, using numerical simulations of a similar model. Fujita, Krugman and Mori (1999) extended the analysis to include more than one manufacturing sector with different characteristics, and showed, using numerical simulation, how a hierarchical urban system might develop. The outcome resembles the "central place theory" of urban agglomeration presented by Cristaller and Lösch more than 50 years ago (see e.g. the survey by Beckmann and Thisse, 1986), but with an explicit microeconomic foundation that was missing in the old literature.

While the contributions referred to above shed some light on the mechanisms involved in the analysis undertaken here, the focus is different and the modelling approach differs in some important respects. The model is presented in Section 2. While the demand side is similar, a simpler supply side is applied where labour is the only factor of production, and workers are assumed to be immobile. In this setting, agglomeration will not be reinforced by labour migration; it will only be caused by differences in market access. Due to the absence of labour migration, we will generally have a more even distribution of manufacturing across regions, and not outcomes where all manufacturing activity is clustered in one or a few regions.

In Section 3, we follow Fujita, Krugman and Mori by assuming a "long narrow world", and with only spatial trading costs. With our simpler supply side, explicit and new analytical results can be derived. While the peripheries will be deindustrialised, the central regions are too far away from the periphery to exploit its decline. Regions adjacent to the peripheries benefit from this, and the unique equilibrium resembles a "duocentric" outcome, with manufacturing clusters close to the periphery.

---

[4] This theme was also implicit in Fujita (1988).

[5] More specifically, the authors show that the monocentric equilibrium is stable, *ceteris paribus*, when (i) the total population of the country is not too large, (ii) when the consumption share for manufacturing is high, (iii) when manufactured goods are not too close substitutes, and (iv) when transport costs for manufacturing is not too high relative to traditional goods. If the total population is large, or income from land-based production is important (if traditional goods have a large consumption share), demand from the peripheries will be higher. If transport costs for manufacturing are high, or these costs "bite harder" due to high demand elasticities, it will be more difficult to sell from central areas to the peripheries.

In Section 4, the relationship between spatial and non-spatial trade liberalisation is examined. Another new feature is that the analysis is done with a two-dimensional space, with regions located on a square plain. [6] When non-spatial trading costs are added, the relative importance of distance is reduced, and the centrifugal force becomes weaker. If non-spatial barriers are relatively high, manufacturing is agglomerated in the central regions. While lower transport costs promote centralisation, MFN trade liberalisation promotes manufacturing belts. For the peripheries, both types of liberalisation lead to deindustrialisation, even if welfare is generally improved.

In Section 5, it is shown that when regions form countries by removing MFN barriers between them, a core-periphery pattern emerges within each country. Even regions near the centre of the landscape may be turned into peripheries. In the presence of countries, the conclusions concerning trade liberalisation are fundamentally altered. Non-spatial trade liberalisation undermines the importance of countries and weakens centralisation within them, while the opposite is the case for spatial trade liberalisation.[7]

Section 6 presents some concluding comments.

2. A stylised model

In this section, a general equilibrium model is presented which can be applied to any pattern of trading costs between regions. Later, specific assumptions concerning trade barriers are introduced.

Consider a world of N regions that are endowed with only one factor of production; labour.[8] For the purpose at hand, we neglect country size differences, and assume that all countries have L units of labour, measured in terms of the numeraire.[9] Labour is fully employed in the production of two types of goods; a homogeneous good Y produced under constant returns to scale - which we call “traditional goods”, and a sector X producing differentiated goods with economies of scale - we call this “manufacturing”. Y is costlessly traded between regions, and it is used as the numeraire. As long as all regions have production in both sectors, the nominal wage must then be equal in all locations. We shall assume that this will be the case.[10]

Production costs are the same at all locations. One unit of labour produces one unit of Y. In the X sector, each firm produces a distinct variety of the differentiated good with fixed production costs f and constant marginal costs c. In addition, firms at location i face trading costs t_{ij} when selling to market j. We express trading costs as a mark-up on marginal costs.[11] Assuming positive trading costs except in the home market, we have $t_{ij} > 1$ for $i \neq j$ and $t_{ii} = 1$ for all i = 1,..., N. Total costs for an individual manufacturing firm in region i are then

[6] This maintains the importance of core-periphery aspects. Although they are stylised, our landscapes capture the fact that within continents, some regions or countries are geographically more centrally located than others. Alternatively, it may be assumed that regions are symmetrically located, e.g. along the circumference of a circle. In this setting, Krugman (1992, 1993) analysed agglomeration driven by labour migration, and Krugman and Venables (1995) used a model where agglomeration is promoted by linkages between intermediate and final goods producers. Slight differences between regions may in these models lead to a self-enforcing process of agglomeration - typically in locations symmetrically placed around the circle. A common theme is that lower trading costs lead to fewer and larger centres of agglomeration.

[7] Since the analysis also applies to trading blocs, the results shed light on the relationship between “globalisation” and “regionalisation”. Low spatial barriers, or deeper intra-bloc integration, promotes central agglomeration within blocs.

[8] Examples of models with one production factor are Krugman (1980), Venables (1987a) or Puga and Venables (1997).

[9] See Melchior (1996) for an analysis of country size differences in the spatial model.

[10] The model is not well suited for the analysis of full specialisation; in that case a model with variable factor prices might better be applied.

[11] This is qualitatively similar to the commonly used “iceberg” approach where a fraction of the goods “melt away” when they are shipped, and it allows explicitily different prices instead of consumers paying the same price for all varieties but receiving less of some of them.

$$C_i = f + \sum_j x_{ij} c t_{ij} \qquad (1)$$

where x_{ij} is the volume exported to region j. Trading costs are *real costs*; they can be thought of as transport costs or variable costs linked to marketing, distribution or adaptation to national standards. While this is realistic for most of the trading costs that we consider, it is not appropriate in the case of tariffs, where the welfare conclusions are also affected by revenue effects.

A Cobb-Douglas/CES utility function is applied:

$$U_i = Y^{1-\alpha} X_i^{\alpha} \quad \text{where} \quad X_i = \left[\sum n_j x_{ji}^{\varepsilon-1/\varepsilon}\right]^{\varepsilon/\varepsilon-1} \qquad (2)$$

n_j is the number of manufacturing firms in region j, x_{ji} is the volume of manufactured goods shipped from an individual firm in region j to region i, and ε is the elasticity of substitution between any pair of individual varieties of manufactured goods, assumed to be larger than one. With total income L in each region, this gives the demand function $Y_i = (1-\alpha)L$ for traditional goods, and for manufactured goods we have

$$X_i = \alpha L P_i^{-1} \quad \text{where} \quad P_i = \left[\sum_j n_j p_{ji}^{1-\varepsilon}\right]^{1/1-\varepsilon} \qquad (3)$$

P_i is the price index for manufactured goods in region i, dual to X_i, and p_{ji} is the price charged for x_{ji}. The demand for individual manufactured varieties will then be

$$x_{ij} = a_j p_{ij}^{-\varepsilon} P_j^{\varepsilon-1} \qquad \text{(where } a_j=\alpha L) \qquad (4)$$

Total profits for an individual manufacturing firm are

$$\pi_i = -f + \sum_j x_{ij}(p_{ij} - c t_{ij}) \qquad (5)$$

Assuming Chamberlinian monopolistic competition; firms maximise profits while neglecting the impact of their actions on the industry aggregate. The perceived elasticity of demand is therefore ε, and the first-order conditions are

$$p_{ij} = \frac{c t_{ij} \varepsilon}{\varepsilon - 1} \qquad (6)$$

This implies $(p_{ij}-ct_{ij})/p_{ij}=1/\varepsilon$, i.e. the price mark-up will be equal to the inverse of the elasticity of substitution. Using (6) and the demand functions (4), and denoting sales from an individual firm in region i to region j by v_{ij}, the ratio of market shares for individual firms from regions i and j in market j will be $v_{ij}/v_{jj} = t_{ij}^{1-\varepsilon}$, since we have assumed $t_{jj}=1$ (no trading costs in the home region). This property is useful for solving the model.

Under monopolistic competition, the number of firms will adjust so that the profits of each firm are zero. Setting (5) equal to zero and using the first-order conditions (6), we obtain

$$\sum_j v_{ij} = \sum_j x_{ij} p_{ij} = \varepsilon f \qquad (7)$$

The value of each firm's output is uniquely determined by ε and f, and all manufacturing firms in all regions are of equal size. Since firm size is constant, as well as the size of the total world market, the total number of manufacturing firms in the world will be constant (=αLN/εf). Trade liberalisation will thus not lead to any change in the number of varieties consumed - as long as trade barriers are not prohibitive. Welfare changes will therefore be linked to changes in the price levels for manufactured goods in the different regions.

Now define the matrix T as follows:

$$T = \begin{bmatrix} 1 & t^{1-e} & t^{2-2e} & \dots & \dots & t^{(N-1)(1-e)} \\ t^{1-e} & 1 & t^{1-e} & \dots & \dots & t^{(N-2)(1-e)} \\ t^{2-2e} & t^{1-e} & 1 & \dots & \dots & t^{(N-3)(1-e)} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots \\ t^{(N-1)(1-e)} & t^{(N-2)(1-e)} & t^{(N-3)(1-e)} & \dots & \dots & 1 \end{bmatrix} \quad (8)$$

The first row represents the trading costs facing firms in country 1, raised to the power 1-ε; the second row concerns country 2; and so on.

Using the property $v_{ij}/v_{jj} = t_{ij}^{1-\varepsilon}$, the sales of individual firms in all markets can be expressed as an equation system of the form

$$[T]_{N\cdot N} \cdot [v_{ii}]_{N\cdot 1} = e\ f\ [1]_{N\cdot 1} \quad (9)$$

where v_{ii} are the home market sales of individual firms in the different regions (i=1,..,N), and [1] is a unit column. The solution for v_{ii} will thus be:

$$[v_{ii}]_{N\cdot 1} = e\ f \cdot [T^{-1}]_{N\cdot N} \cdot [1]_{N\cdot 1} \quad (10)$$

The total supply of manufactured goods in every region forms an equation system of the form

$$\begin{array}{ccccccc} n_1 v_{11} & +n_2 v_{21} & +\dots & +n_N v_{N1} & = & a_1 \\ n_1 v_{12} & +n_2 v_{22} & +\dots & +n_N v_{N2} & = & a_2 \\ \dots & \dots & \dots & \dots & = & \dots \\ n_1 v_{1N} & +n_2 v_{2N} & +\dots & +n_N v_{NN} & = & a_N \end{array}$$

This can be expressed as

$$[Diag\ \ v_{ii}]_{N\cdot N} \cdot [T']_{N\cdot N} \cdot [n_i]_{N\cdot 1} = [a_i]_{N\cdot 1} \quad (11)$$

where [Diag v_{ii}] is the diagonal matrix with the home market sales of individual firms in the various regions as elements. Provided that T has full rank and can be inverted, the solution for the number of firms in each region is then

$$[n_i]_{N\cdot 1} = [T']^{-1}_{N\cdot N} \cdot [Diag\ v_{ii}]^{-1}_{N\cdot N} \cdot [a_i]_{N\cdot 1} \quad (12)$$

When $t_{ij}=t_{ji}$ for all i, j we have T=T' so the transpose superscript can be dropped.

For welfare comparisons, we substitute the demand functions $Y_i=(1-\alpha)L_i$ and (3) into the utility function (2), and obtain the indirect utility function. When all regions are of equal size, it can then be shown (see Melchior, 1996, pp. 41ff.)) that welfare is inversely related to the home market sales of firms (10). These can therefore be used to study welfare.

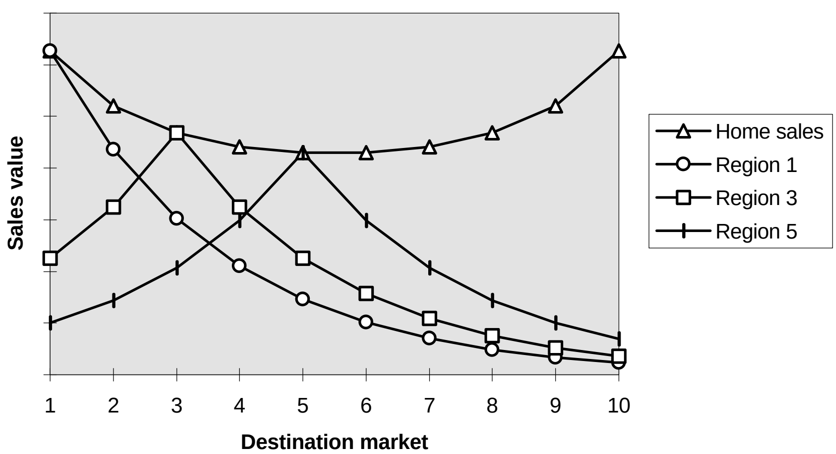
The model is stylised since regions are of equal size and production costs as well as demand are equal across regions. The focus of the analysis is the impact of trading costs, and only trade barriers may create differences between regions. In section 3, the model will be solved explicitly for the case with spatial trading costs only. In sections 4 and 5, the model will be used for numerical simulations with spatial as well as non-spatial trading costs.

3. Industrial location in a "Hotelling" world

In this section, we study the model solution for the "long narrow world", with transport costs but without MFN trading costs. Hence, trading costs are increasing with distance, and all the regions 1,...,N are located along one dimension (a line). In order to obtain analytical tractability[12], we let trading cost be equal to t between all neighbouring regions, t^2 between regions two steps away from each other, then t^3 and so on. Trading costs thus increase *exponentially* with distance. In parts 4 and 5, numerical simulations are undertaken with trading costs that increase *linearly* with distance. This provides a check on whether the results are unduly influenced by the choice of functional form. As we shall see, the location of production will be similar in the two cases, while some of the welfare results are modified in the linear case.

Before deriving the equilibrium solution, it is useful to illustrate the impact of geography by asking the following question: If there is an equal number of firms in all regions, and these firms maximise profits and behave according to equations (1)-(6) in our model, what will be the market outcome? We thus ask how trading costs affect sales and profits of individual firms, without assuming entry and exit that drive profits to zero. Diagram 1 illustrates this in an example with 10 regions, showing how much individual firms sell in different markets:

Diagram 1: Sales profile of individual firms in model with 10 regions, before entry/exit

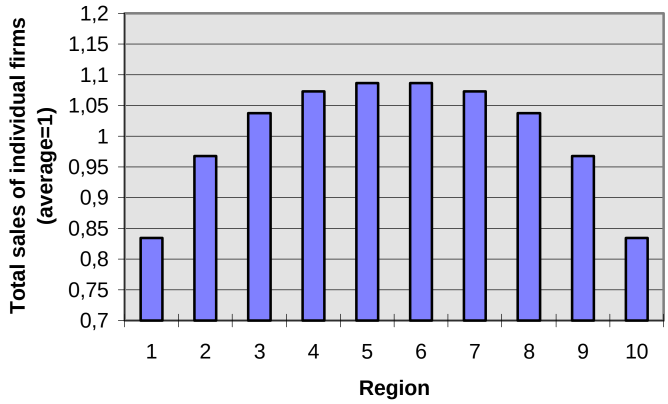


The upper line shows the home market sales of individual firms in all regions, which will be lowest for firms in the central regions. On average, these regions face lower trading costs for their imports, and thus have lower price levels. The lower lines for regions 1, 3 and 5 show how sales from firms in these selected regions to different markets are clearly falling with distance.

[12] In studies of this kind, the problem is more tractable if trading costs are increasing as a quadratic or exponential function of distance (see, for example, Tirole, 1988, p. 279)).

If we aggregate the sales of individual firms in the different regions[13], we obtain the following picture:

Diagram 2: Sales of individual firms before entry/exit in core-periphery model



In the example, firms in the central regions thus sell most. In the model, sales also measure the profits of individual firms[14], and we thus know that firms in the central regions will be larger and have higher profits. Hence, when we allow free entry and exit, there is an incentive for firms to move from the periphery towards the centre. From this, we might believe that manufacturing industry will be clustered in the central regions when entry and exit takes place. This is, however, not the case: The surprising outcome is that *manufacturing agglomeration will occur in regions 2 and 9, i.e. the regions next to the periphery*. The reason is that these regions are in a better position to take advantage of the deindustrialisation of the peripheries, compared to the central countries further away. The peripheries thus constitute a "hinterland" that provides an outlet for manufacturing production in manufacturing clusters between the centre and the periphery. The "centrifugal" force of demand from the peripheries is thus strong enough to prevent central agglomeration.

In order to show this formally, we construct the specific form of the matrix T (eq. 8), which in this case will be similar to a first-order autoregressive matrix in econometrics. The inverse will be (see e.g., Judge et. al., 1988, p. 389)):

[13] This is similar to the "market potential functions" used by e.g., Fujita and Krugman (1995).

[14] This is easily seen by using (6) to derive $ct_{ij}=p_{ij}(\varepsilon-1)/\varepsilon$, and then substituting this into (5).

$$T^{-1} = d \cdot \begin{bmatrix} t^{2e} & -t^{1+e} & 0 & 0 & \dots & 0 & 0 & 0 \\ -t^{1+e} & t^{2e}+t^{2} & -t^{1+e} & 0 & \dots & 0 & 0 & 0 \\ 0 & -t^{1+e} & t^{2e}+t^{2} & -t^{1+e} & \dots & 0 & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & 0 & \dots & -t^{1+e} & t^{2e}+t^{2} & -t^{1+e} \\ 0 & 0 & 0 & 0 & \dots & 0 & -t^{1+e} & t^{2e} \end{bmatrix}_{N \cdot N} \qquad (13)$$

$$\text{where } d = \frac{1}{t^{2e} - t^{2}}$$

Using (13) and (10), the home market sales of individual manufacturing firms in all regions will be:

$$v_{11} = v_{NN} = e\ f\ \frac{t^{e}}{t^{e}+t} \qquad (14a)$$

$$v_{ii} = e\ f\ \frac{t^{e}-t}{t^{e}+t} \quad for\ \ i \neq 1,N \qquad (14b)$$

Manufacturing firms in the peripheral regions (1 and N) will sell a larger proportion of their goods to the home market. Since welfare is inversely related to home market sales, we have

Proposition 1: *Welfare levels will be lower in the peripheral regions, and equal but higher in all the other regions.*

The are two reasons for the higher price level in the peripheral regions: The first is that they, *ceteris paribus*, pay more transport costs for their imports. The second is that they will have a lower share of manufacturing production, and import a larger share of their consumption. In order to see this, we derive the number of firms in each region. Using (14) we can form the diagonal matrix [Diag v_{ii}], in equation (12). The inverse of this matrix will simply be the diagonal matrix with the inverses of each v_{ii} as elements. The solution for the number of manufacturing firms in the regions is then:

$$n_1 = n_N = \frac{W}{e\ f\ N} \left\{ 1 - \frac{t^{2}}{(t^{e}-t)^{2}} \right\} \qquad (15a)$$

$$n_2 = n_{N-1} = \frac{W}{e\ f\ N} \left\{ 1 + \frac{t^{2}}{(t^{e}-t)^{2}} \right\} \qquad (15b)$$

$$n_i = \frac{\alpha L}{\varepsilon f} \qquad \textit{for } i=1,...., (N-2) \qquad (15c)$$

When interpreting these expressions, it may be recalled from equation (7) that εf is the size of all individual firms, and αL is the market for manufactures in each region. The expression (15c) is thus equal to the average share. We have:

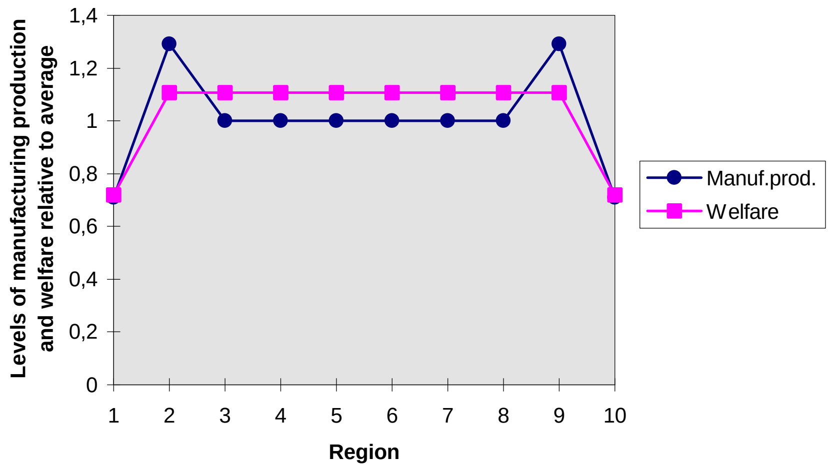
Proposition 2: *The central regions (regions 3,..., (N-2)) will have a share of world manufacturing production equal to 1/N. The peripheral regions (1 and N) will have a lower than average share, while the regions next to the peripheral regions (2 and (N-1)) will have the largest manufacturing production.*

Manufacturing production will thus not be clustered in the central regions, but in regions next to the periphery. These regions will benefit from privileged access to the market for manufactured goods in the peripheral regions, while the peripheral regions will be weaker competitors due to their disadvantage regarding trading costs.[15] The model thus generates a "duocentric" pattern of production.

In spite of these manufacturing clusters in regions 2 and N, these regions will - according to Proposition 1 - have the same welfare levels as the central regions. The regions next to the periphery have, compared to the central regions, a disadvantage concerning trading costs, but this will be compensated for by their larger manufacturing production. The stylised outcome where welfare is exactly equal in regions 2,..,N-1 is due to the particular form of trading costs applied in the model, and section 4 will demonstrate that the result may be modified when trading costs increase linearly with distance.

Diagram 3 illustrates the model outcome in our example with 10 regions:

Diagram 3: Equilibrium in core-periphery model with 10 regions



The model is thus a story about manufacturing agglomeration due to "hinterlands" where some regions benefit from the demand from peripheral areas. According to this, Denmark should e.g. be in a better position than Norway with respect to manufacturing production. In the U.S., regions close to the national borders could be better placed than the central regions. The analysis thus provides hypotheses for the empirical study of industrial location within nations and continents.

[15] The number of firms in regions 1 and N is weakly positive if $t^{\varepsilon} \geq 2t$. Our assumption on non-specialisation imply that we do not examine the outcome outside this range.

The duocentric outcome is the unique equilibrium in our model, and this is not changed when trading costs are reduced. It is easily established that

$$\frac{\partial n_1}{\partial t} = \frac{\partial n_N}{\partial t} > 0 \qquad \frac{\partial n_2}{\partial t} = \frac{\partial n_{N-1}}{\partial t} < 0 \qquad \frac{\partial n_i}{\partial t} = 0 \quad \text{for i=3,...,N-2} \qquad (16)$$

and

$$\frac{\partial v_{ii}}{\partial t} > 0 \qquad \text{for all i}$$

(17)

We thus have:

Proposition 3: *Spatial trade liberalisation will raise welfare in all regions, leave manufacturing production in regions 3,...,N-2 unaffected, and relocate more manufacturing production from regions 1 and N to regions 2 and N-1.*

While trading costs are the reason why peripheral regions are left behind, their disadvantage in terms of manufacturing production becomes - paradoxically - greater when trading costs are reduced. The *relative* improvement in market access is in fact largest for the peripheral regions[16], and a reduction in t will thus - before entry and exit occurs - lead to a relatively higher increase in export sales from firms in the peripheral regions. Since the peripheral regions import a larger share of their consumption, however, the losses in their home markets will more than offset the export increase; with a resulting loss of manufacturing production. When the periphery builds bridges to overcome its locational disadvantage, it becomes even more peripheral, since more goods will pass in than out. Although the peripheries' welfare will increase due to lower trading costs, it is easily shown that the welfare gap between the peripheries and the rest will be enlarged.

The results demonstrate in a compact manner the interplay between centralising and decentralising forces in a centre-periphery landscape. The "duocentric" outcome is, however, hardly general, since it depends on the stylised assumptions made. When MFN trading costs between regions are added in later sections, equilibria with centralisation may occur. As shown by Fujita and Krugman (1995) in their model with labour migration, centralisation or "monocentric" equilibria are more likely when transport costs are low.[17]

4. Spatial versus non-spatial trade liberalisation

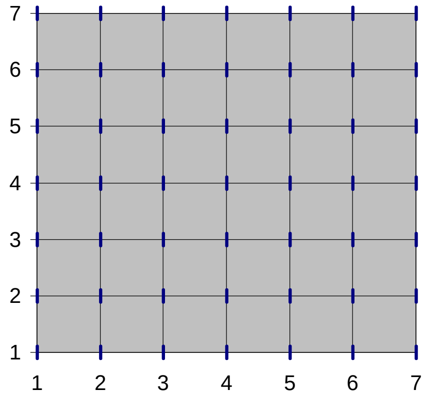
When MFN trading costs are added to transport costs, it is no longer possible to derive explicit analytical solutions, and we revert to numerical simulations of the model. Since analytical tractability is no longer a concern, we use a two-dimensional model where 49 regions are spread out symmetrically in a *square* landscape, as illustrated by diagram 4. While the world is certainly not square, there is economic activity in only a small part of its surface, and the surface is split by oceans, mountains and deserts in a way which creates parts with a distinct core-periphery dimension. Although stylised, the square landscape is indended to capture some of these aspects.

---

[16] The elasticity of t^{γ} (where γ is a constant) with respect to t is equal to γ, and countries with high γ's will thus have a stronger reduction in trading costs.

[17] Even without labour migration, centralisation may occur when factor prices are allowed to differ. Venables (1996) examine industrial location in a model with regions located on a circular plain, and with two factors of production and different factor prices across regions. Although the pattern of industrial location is not explicitly addressed in the two-sector case, real wage comparisons show a picture similar to our welfare results when trading costs are high, but with higher real wages in central regions when trading costs are lower.

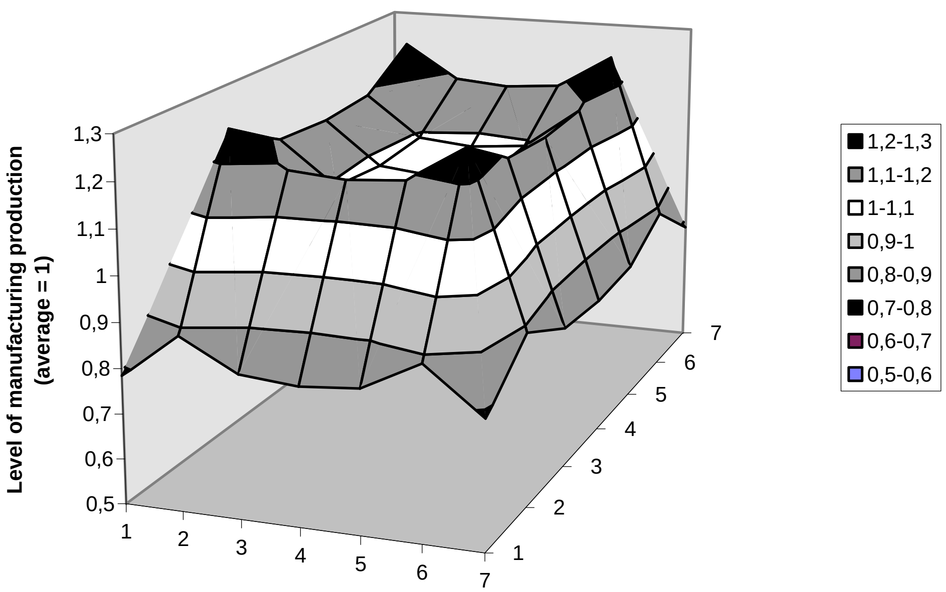
Diagram 4: A 7x7 quadratic surface with 49 regions



Trading costs are expressed as a linear function of the geometrical distance *g* between the regions (the dots). The minimum distance is 1 (between two adjacent countries along a line), and the maximum distance (between opposite corners) is 8,49 units. When simulating the model, we use a parameter *d* that is multiplied by the number of distance units, and which may be adjusted upwards or downwards. Trading costs are thus expressed as $t_{ij}=1+dg_{ij}$. By assuming that trading costs increase *linearly* with distance, we also obtain a check on the generality of our results from Section 3, where trading costs were assumed to increase *exponentially* with distance.

Diagram 5 shows the distribution of manufacturing production in this case when only spatial trading costs are present (using d=0.6 and ε=5). Table A1 in the Appendix shows the numbers as well as the welfare results. We expect a similar outcome as in Section 3.

Diagram 5: The impact of spatial trading costs on manufacturing agglomeration (with d=0.6)



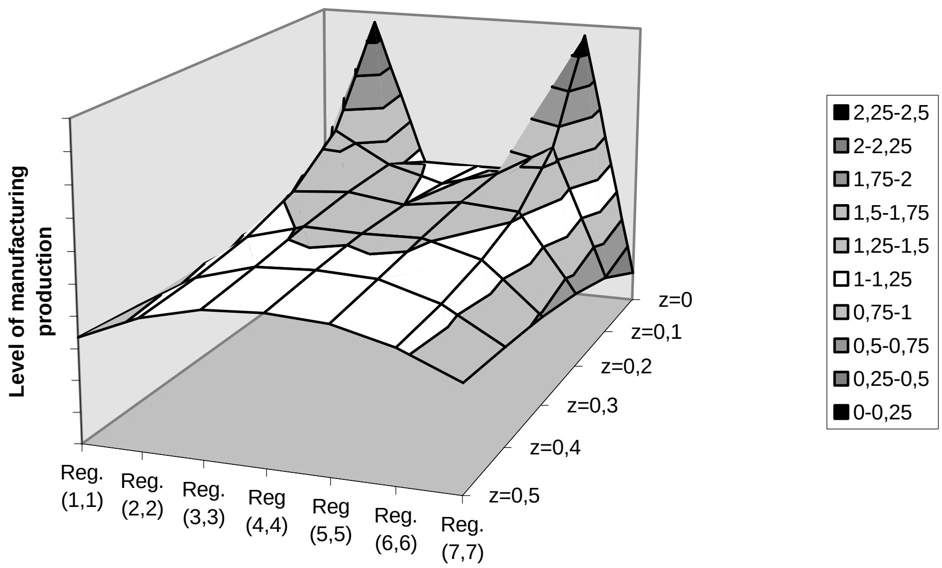
The outcome broadly resembles the analytical results from the linear landscape analysed in Section 3. The peripheral regions have lower manufacturing production than the rest; a "manufacturing belt" is located in regions one step away from the periphery; and the central regions have an intermediate level of manufacturing production - slightly declining as we approach the centre. Concerning industrial location, the outcome is thus broadly similar to the case with exponentially increasing trade barriers. The welfare results are slightly altered, however, since the central regions now have the highest welfare levels (see Table A2).

Due to the asymmetries of the square landscape, the peaks of agglomeration occur along the diagonals of the surface. Regions (2,2) etc. can exploit their better access to the "hinterlands" in the corners of the landscape, and thus obtain the highest levels of manufacturing production. Observe also the asymmetries among the regions located at the edge of the plain; with regions (1,2), (2,1) etc. better off than the others in terms of manufacturing agglomeration. Slight differences in location, as between e.g. Norway and Sweden, or Portugal and Spain, may - according to this - have a considerable impact on production.

Further simulations show that a lowering of trading costs will amplify this pattern of industrial agglomeration, while higher trading costs will modify the differences. While the changes are modest for the central regions, lower spatial trading costs leads to a relocation of manufacturing production from the peripheral regions to the "manufacturing belt". The impact of trade liberalisation is thus similar to the analytical results in Section 3. With this pattern of trade barriers, spatial trade liberalisation thus promotes the development of a manufacturing belt.[18]

We now add non-spatial trading costs on top of the spatial trade barriers. In this section, it is assumed that non-spatial trading costs are the same between all pairs of regions, and equal to z. Total trading costs between regions i and j are thus $t_{ij} = 1 + z + d\, g_{ij}$. It is evident that for regions that are close to each other, z constitutes a larger share of total trading costs than for regions that are far away from each other. If we reduce z, total trading costs will this increase more steeply with distance, and vice versa. *A reduction in z thus makes distance relatively more important*, while *a reduction in d (spatial trade liberalisation) makes geography relatively less important*. In order to show how this works out, we use a value of d=0.4, and simulate the outcome with different values of z. Diagram 6 shows the levels of manufacturing production for regions along one of the diagonals of the surface. Table A2 in the Appendix shows the numerical values.

Diagram 6: Spatial versus non-spatial trading costs



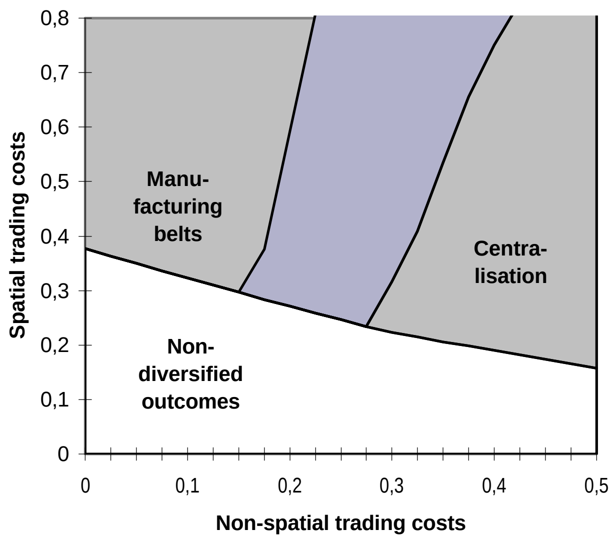
[18] The simulations also show that the higher is the elasticity of substitution, the more equal is the distribution of production. More elastic demand thus makes trading costs bite harder and protects the peripheries from being deindustrialised.

When z=0 we have a pattern with pronounced manufacturing belts; the “twin peaks” in the diagram. When z increases, the manufacturing belts gradually disappear. With z=0.2 or z=0.3, regions (3,3) and (5,5) have the highest levels of manufacturing production. With z=0.4 or higher, the central region (4,4) has the highest level. Observe that as z rises, the distribution of production across regions becomes more equitable. For the peripheries, non-spatial trade liberalisation may lead to the “duocentric” scenario with a more inequitable distribution of production. Protectionism with high non-spatial trading costs is thus more equitable in terms of production structures. For the industrial development of the peripheries, modest centralisation is better than pronounced manufacturing belts.

In spite of the strong changes in the pattern of industrial agglomeration, all countries gain from non-spatial liberalisation in terms of welfare (see Table A2 in the Appendix). Observe, however, that as liberalisation proceeds, the welfare gap between the peripheries and the more central countries increase. Also in terms of welfare, spatial liberalisation thus leads to a less equitable outcome.

In order to obtain a more general understanding of how spatial and non-spatial liberalisation interact, we undertake a number of simulations with different combinations of spatial and non-spatial trading costs. Diagram 7 summarises the results.

Diagram 7: Agglomeration patterns for different combinations of spatial and non-spatial trading costs



At the upper left of the diagram, when transport costs are high while MFN trade barriers are low, the outcome is “manufacturing belts” where regions (2,2) etc. have the highest levels of manufacturing production. To the right, when MFN barriers are high, the outcome is centralisation, with the highest level of manufacturing production in region (4,4). Between these two areas, intermediate outcomes occur with more manufacturing production in regions (3,3) etc.. The white area at the bottom of the diagram, where trading costs are low, illustrates outcomes where some region is completely deindustrialised.[19]

Diagram 7 shows that it is generally the case that for a given level of spatial trading costs, non-spatial trade liberalisation (moving from right to left in Diagram 7) promotes the development of manufacturing belts. If spatial trading costs are high, even a reduction of z from high levels may cause a development of manufacturing belts. With lower d, however, centralisation is maintained until z is rather low.

[19] As noted in section 2, we do not examine the outcomes with full specialisation since the model is not well suited for this purpose. The “problem” could be solved by allowing wage differences, but a two-factor model would be better suited for this purpose. In spite of this shortcoming of the model used here, it provides useful information about the qualitative impact of trading costs in a spatial framework.

If spatial trading costs are reduced while non-spatial barriers stay constant (i.e. moving vertically from top to bottom in Diagram 7), there will be a modest trend towards more centralisation. Frequently, however, the main impact will be to maintain the existing pattern of agglomeration, but with more inequality. As trading costs are lowered, the peripheral regions lose more and more of their manufacturing production. Spatial as well as non-spatial trade liberalisation generally tends to create a less equitable allocation of production. When we move downwards or left in the diagram, the most peripheral regions always obtain a lower share of manufacturing production.

These results are obtained in an extremely stylised model which focuses solely on market access, and neglects other aspects of importance. Secondly, the conclusions are relevant only in contexts where a geographical core-peripery pattern is present. With these reservations, the model nevertheless sheds light on some important mechanisms. When spatial trading costs are relatively high, the central countries are - due to distance - unable to benefit from the decline in the peripheries, and manufacturing belts are developed closer to the periphery. When distance matters less, centralisation may occur since central areas can now exploit the backwardness of the periphery. Accordingly, the results suggest that *MFN trade liberalisation (making distance relatively more important) tends to promote decentralisation of production and the development of manufacturing belts, while reductions in transport costs (making distance relatively less important) tends to promote centralisation or reinforce the existing pattern of agglomeration. If spatial and non-spatial liberalisation occur in parallel, the outcome will be ambiguous with respect to centralisation or manufacturing belts, but the most peripheral countries will generally lose manufacturing production.*

For comparisons over time, the model suggests that *in periods with protectionism* in trade policy (moving to the right in Diagram 7), like the interwar period, we should expect *more centralisation* of “manufacturing”, for example within Europe. Furthermore, since international trade liberalisation in the GATT/WTO has led to a low level of MFN trade barriers, *it is more likely now than in past history that manufacturing belts will develop*. An important thing to observe is that spatial and non-spatial trading costs interact and create qualitatively new implications that can not be derived when we consider one of the two types of trading costs alone.

5. The formation of countries or trading blocs

Transport costs matter within as well as between countries. MFN trade barriers are, on the other hand, generally absent withing countries. An interesting extension of the analysis is thus to see what happens when a group of regions form countries by reducing or eliminating MFN trading costs between them.

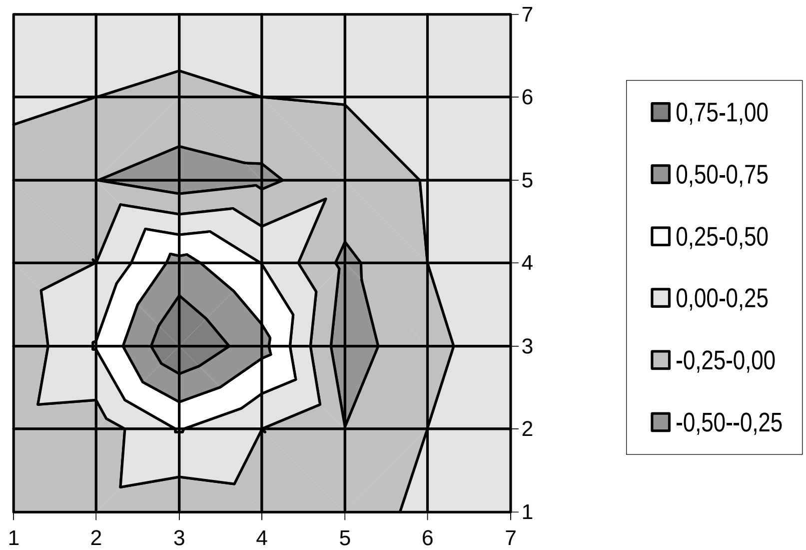
A similar pattern of trading costs may occur for regional trading blocs. MFN trading costs are generally lower within trading blocs than for trade with non-members, while transport costs remain important inside the bloc as well. The analysis is thus relevant also in this context, if we rename “regions” into “countries”, and “countries” into “trading blocs”. In the following, we speak of countries/ trading blocs when only one such integrated area is formed, and regions/ countries when all the regions integrate into such market areas.

In a “market size model” without a spatial dimension, regional trade integration will create a favourable access to the regional market for manufacturing firms in the integrating region. This type of market size effect was first analysed by Venables (1987b) in a model with oligopoly, and under monopolistic competition by Baldwin and Venables (1995), Torstensson (1995), Melchior (1996, Chapters 4 and 5) and Puga and Venables (1997). The impact of such a regional market size effect is to relocate manufacturing production from outside countries to the integrating region. In addition to such “production-shifting” (to use the term of Baldwin and Venables), welfare levels will increase in the integrating region and decrease outside. The gains from integration are thus partly at the expense of others.

How will regional integration work when distance matters? It seems likely that distance will dampen the effects predicted by the non-spatial model; European integration will not affect Australia and Turkey to the same extent. A special feature of spatial models is that local "shocks" may have effects only in the neighbourhood of where they occur.[20] According to this, we may expect that a regional trading bloc will not take over manufacturing production from all outside countries, but mainly from countries that are close to the bloc. In addition to confirming this, our analysis will show that when geography matters, the formation of countries or trading blocs has qualitatively new effects on location.

Consider, therefore, that we start from a situation with spatial as well as non-spatial trading costs present, as described in Section 4. Then let the 9 countries of order 2-4 in both dimensions integrate by removing non-spatial trading costs between them. The outcome is described in Diagram 8, which shows the changes in manufacturing production compared to a base case with d=0.4 and z=0.2:

Diagram 8: The impact of a regional trading bloc: Changes in manufacturing production from base case



The corresponding values, as well as the welfare results, are given in Table A3 in the Appendix.

"Production-shifting" thus occurs, but with several important modifications compared to the non-spatial trading bloc model:

- As expected, *the adverse effect of the trading bloc is strongest for non-participating countries that are close to the bloc*. A belt of countries surrounding the bloc are adversely affected, while remote countries are hardly - and even positively - affected. This applies to manufacturing production as well as welfare.
- Regional integration leads to *central agglomeration inside the bloc*, with a considerable production increase in country (3,3). The key to understanding this is the development of price levels inside the bloc. All integrating countries gain in welfare terms; so their price levels for manufactured goods become lower. The central country can import manufactured goods at low spatial trading costs from all its partners inside the bloc. It will therefore have a lower price level than its neighbours partners. Since exports to a market is positively

[20] An example is provided by the analysis of country size differences in the spatial model used in Section 3 (Melchior 1996, Chapter 3): If a country grows in size, its neighbours become be deindustrialised. For countries one step further away, the increased competition from the larger country is offset by reduced competition from its neighbours. As a result, the net effect for countries further away is zero.

related to its price level, the different price levels will tend to shift the trade balance for trade in manufactured goods inside the bloc in favour of the central country. This will turn the country (3,3) into a net exporter of manufactured goods inside the union - like Germany in the EU.

- Observe also that the impact inside the bloc depends on the size of the adjacent "hinterland" outside the bloc, from which production-shifting may take place. This creates asymmetries between the bloc members. For this reason, country (4,4) is e.g. better off than country (2,2). For the latter, the impact of integration on manufacturing production is negative. In spite of this, all integrating countries obtain a welfare gain (see Table A3).

In order to shed more light on the impact of country formation, we now undertake the experiment of dividing our entire landscape into four different nations or blocs, by removing MFN barriers between regions inside each of them. The simulations were undertaken with different base cases, but the results were qualitatively similar in all cases, so only one case is reported, with d=0.4 and z=0.2 in the base case. Table 1 shows the changes in manufacturing production and welfare when the non-spatial barrier is eliminated within the four countries within the bold lines.[21]

Table 1: Simulation results on the formation of countries or trading blocs (changes from base case, with d=0,4 and z=0,2)

Manufacturing production

	1	**2**	**3**	**4**	**5**	**6**	**7**
1	-0,34	-0,09	-0,44	-0,46	-0,34	-0,24	-0,36
2	-0,10	1,82	0,12	0,01	0,88	1,15	-0,24
3	-0,45	0,22	-0,75	-0,11	0,55	0,90	-0,33
4	-0,45	0,18	-0,66	-0,66	-0,31	-0,06	-0,45
5	-0,34	1,23	-0,11	-0,75	-0,27	-0,06	-0,45
6	-0,24	1,48	0,01	0,12	1,26	1,50	-0,10
7	-0,35	-0,10	-0,46	-0,44	-0,33	-0,24	-0,35

Welfare (based on average before integration = 1)

	1	**2**	**3**	**4**	**5**	**6**	**7**
1	0,06	0,21	0,05	0,05	0,19	0,21	0,06
2	0,21	0,75	0,26	0,28	0,68	0,73	0,21
3	0,05	0,29	-0,04	0,23	0,61	0,68	0,19
4	0,05	0,27	-0,03	-0,05	0,19	0,25	0,05
5	0,19	0,69	0,25	-0,05	0,21	0,27	0,05
6	0,21	0,74	0,29	0,25	0,69	0,74	0,21
7	0,06	0,21	0,05	0,04	0,19	0,21	0,06

The results show that *country formation tends to create cores and peripheries inside each country*, for the same reasons as when a single bloc is formed. The shaded areas in the table show that within each country, a central area is created with manufacturing agglomeration and higher welfare gains than the rest of the country.[22] By our experiment, we are in fact approaching a spatial structure for manufacturing that resembles the Cristaller-Lösch market areas. Observe, however, that trade liberalisation within countries or blocs improve welfare in most regions even if the distribution of manufacturing activity becomes more unequal.

[21] While the results here are presented as *changes* from some base case, and these changes are similar for different points of departure, the original differences, as outlined in part 5, will still influence the levels of production and welfare.

[22] Observe that the sharp increases in production in some central regions may lead to complete specialisation if manufacturing represents a large share of consumption. We assume that this will not be the case.

While regions that border to other countries, are generally worse off than the cores in all simulations, there are important variations. The corner regions within each country or bloc face the highest spatial trading costs within the country. As a result, these regions are worse off, but their neighbours benefit from this and we thus observe that some border regions increase their manufacturing production – see, for example, regions (3,2) and (4,2). In the example above, six out of the 40 border regions increase their manufacturing production.

All the simulations that have been undertaken, give similar results in terms of core-periphery patterns. There are, however, details that vary according to the parameters chosen. Observe, for example, that among the central regions of each country, the regions that are most distant from other countries, benefit most (compare, for example, regions (3,5) and (2,6), or (5,2) and (6,2)). Country formation may thus create polarisation of economic activity; the centres of agglomeration are not located close to the borders. This is, however, not a general result; other simulations show that the outcome may be different.

In the example above, the core-periphery pattern inside countries or blocs is monocentric. With another shape of the countries, other outcomes are possible. If we, for example, let the 3 by 7 upper part of the surface, simulations (not shown here) show that we obtain a duocentric outcome, with agglomeration in the same areas as shown in the table above.

Looking at Europe, it is frequently the case that capitals and economic centres are located centrally inside the countries, and not along their borders. Even at the centre of the European continent, we find backward regions. The mechanisms studied here may contribute to explaining such phenomena.

When countries are no longer dimensionless point, an interesting question is how regions inside each country are affected by reduced trading costs. Some results are presented in Table A4 of the Appendix. These show that *non-spatial liberalisation (reducing MFN barriers between the four countries) will make the distribution of production inside countries more even, while spatial liberalisation (reducing spatial barriers inside and between countries) will reinforce the core-periphery pattern inside each country.* The intuition is straightforward: A reduction of MFN barriers between countries makes countries less important and thus weakens the centralising force inside them. Spatial liberalisation, on the other hand, increases the *relative* importance of country formation and thus promotes centralisation inside countries. If the EU internal market is primarily a matter of non-spatial liberalisation, it should work to the advantage of peripheral areas inside the EU countries. Cheaper transports and communication costs, on the other hand, could strengthen inequality inside countries. At the global level, multilateral liberalisation in the WTO should make trading blocs less important and be to the advantage of peripheral areas within each bloc.

We also observe from Table A4 that *MFN trade liberalisation promotes relocation of manufacturing production from the peripheries of the square landscape to regions that are centrally located.* In order to get some intuition, recall from Table 1 that country formation had the most adverse impact on manufacturing production in the central regions of the landscape. MFN trade liberalisation undermines the importance of country formation and therefore reverses this original effect. The result contradicts that of Section 5, which said that MFN liberalisation, for a given level of spatial barriers, tends to weaken centralisation. Hence, *the presence of countries implies that the impact of trade liberalisation is fundamentally changed*. The results here and those of Section 5 have only in common that if spatial and non-spatial liberalisation proceed in parallel, the impact on manufacturing agglomeration is ambiguous.

7. Concluding remarks

In this paper, three sets of results have been presented. First, it was shown analytically that if only spatial trading costs matter, and countries are located in a core-periphery landscape, the peripheries will be deindustrialised and manufacturing clusters will be developed close to the periphery. While the central countries or regions have the "best" location, they are too far away from the periphery to exploit its decline. The demand from the peripheries thus constitutes a centrifugal force, and regions adjacent to the peripheries benefit from this.

When non-spatial trading costs are added, the relative importance of distance is reduced, and the locational advantage of the central regions becomes more important for the location of manufacturing production. This advantage works as a centripetal force, and if non-spatial barriers are relatively high, manufacturing is agglomerated in the central regions. Since it is the relative importance of spatial versus non-spatial barriers that matter, spatial trade liberalisation promotes centralisation, while non-spatial liberalisation promotes manufacturing belts. For the peripheries, however, both types of liberalisation leads to deindustrialisation, even if welfare is generally improved.

Finally, we showed that when countries form trading blocs, or regions form countries, a core-periphery pattern emerges within each bloc or country. Even regions near the centre of the landscape may be turned into peripheries inside their own country. In the presence of countries, the impact of reduced trading costs is fundamentally altered. Non-spatial trade liberalisation undermines the importance of countries and weakens centralisation within them, while the opposite is the case for spatial trade liberalisation.

While some of our results were derived analytically, numerical simulations had to be used for analysing the more complex patterns of trading costs. The robustness of these results was checked by running simulations for a wide range of parameter values, so they are not special cases.[23] Nevertheless, they have been derived in an extremely stylised model where the outcome depends only on differences in trading costs. There is ample scope for extensions. A model with two production factors, allowing for different factor prices, might be applied. If e.g. factor prices are equalised within countries but not between them, or if labour migration is allowed within but not between countries, we would obtain a richer and more realistic picture. Trading costs could be introduced for both sectors and allowed to vary between them, and there could be imperfect competition in both sectors.

By analysing trade policy in a landscape where geography matters, and by addressing the impact of trade liberalisation within as well as between countries, the paper has tried to shed light on some dimensions so far neglected in the literature. Since geography obviously matters, and since countries are not dimensionless points, the issues are important, and further research in the area is warranted. This should include theoretical as well as empirical research, and the analysis here provides a number of hypotheses that may be tested empirically.

References

Baldwin, R.E. and A.J. Venables, 1995. Regional economic integration. In: Grossman, G. and K. Rogoff (Eds.). Handbook of International Economics. Vol. III. North-Holland, Amsterdam, pp. 1597-1644.

Beckmann, M.J. and Thisse,F., 1986. The Location of Production Activitites. In: Nijkamp, P. (Ed.). Handbook of regional and urban economics, Vol. 1. North-Holland, Amsterdam, pp. 21-95.

Dixit, A. and Stiglitz, J, 1977. Monopolistic competition and optimum product diversity. American Economic Review 67, 297-308.

Fujita, M., 1988. A monopolistic competition model of spatial agglomeration. Differentiated products approach. Regional Science and Urban Economics 18, 87-124.

[23] A full examination has not been undertaken concerning different values of the elasticity of substitution, which has been set at 5 in all simulations. While the results hold for lower values, they have not been checked for very high values.

Fujita, M. and Krugman, P., 1995. When is the economy monocentric? Von Thünen and Chamberlin unified. Regional Science and Urban Economics 25, 508-28.

Fujita, M. and Mori, T., 1997. Structural stability and evolution of urban systems. Regional Science and Urban Economics 27, 399-442.

Fujita, M. and Thisse, J.-F., 1996. Economics of agglomeration. Discussion Paper No. 1344 . Centre for Economic Policy Research, London.

Fujita, M., Krugman, P. and Mori, T., 1999: On the evolution of hierarchical urban systems. European Economic Review 43, 209-251.

Judge, G.G., Hill, R.C., Griffiths, W.E., Lütkepohl, H. and Lee, T., 1988. Introduction to the theory and practice of econometrics. Wiley, New York.

Krugman, P., 1980. Scale economies, product differentiation and the pattern of trade. American Economic Review 70, 950-959.

Krugman, P., 1992. A dynamic spatial model. Working Paper No. 4219. National Bureau of Economic Research (NBER), Cambridge, Massachusetts.

Krugman, P., 1993. On the number and location of cities. European Economic Review 37, 293-298.

Krugman, P., 1995. Increasing returns, imperfect competition and the positive theory of international trade. In: Grossman, G. and Rogoff, K. (Eds.). Handbook of International Economics, Vol. III. North-Holland, Amsterdam, pp. 1243-1280.

Krugman, P. and Venables, A.J., 1995. The seamless world: A spatial model of international specialisation. Discussion Paper No. 1230 (Centre for Economic Policy Research (CEPR), London.

Melchior, A., 1996. On the Economics of Market access and International Economic Integration. Ph.D. Dissertation, University of Oslo, Department of Economics, Oslo.

Ottaviano, G.I.P. and Puga, D., 1998. Agglomeration in the Global Economy: A Survey of the "New Economic Geography". The World Economy 21, 707-732.

Puga, D. and Venables, A.J., 1997. Preferential trading arrangements and industrial location. Journal of International Economics 43, 347-68.

Tirole, J. , 1988. The theory of industrial organisation. MIT Press, Cambridge, Massachusetts/London.

Torstensson, J., 1995. Economic integration, market size and the location of industries. Mimeo.

Venables, A., 1987a. Trade and trade policy with differentiated products: A Chamberlinian-Ricardian model. The Economic Journal 97, 700-717.

Venables, A., 1987b. Customs union and tariff reform under imperfect competition. European Economic Review 31, 103-110.

Venables, A., 1996. Geography and Specialisation: industrial belts on a circular plain. Mimeo, London School of Economics/ CEPR, London.

Appendix: Simulation results

Table A1: Simulation results with only spatial trading costs (d=0.6)

Levels of manufacturing production

Dimension	**1**	**2**	**3**	**4**
1	0.78	0.88	0.82	0.81
2	0.88	1.27	1.19	1.18
3	0.82	1.19	1.09	1.08
4	0.81	1.17	1.08	1.07

Welfare levels

Dimension	**1**	**2**	**3**	**4**
1	0.65	0.81	0.84	0.84
2	0.81	1.13	1.18	1.19
3	0.84	1.18	1.23	1.24
4	0.84	1.19	1.24	1.25

Note: The table shows the results for one "corner" of the landscape. The three other corners will be mirror images. The average for all 49 regions is one in both cases.

Table A2: Spatial vs. non-spatial trading costs (d=0,4)

Levels of manufacturing production

	Reg. (1,1)	**Reg. (2,2)**	**Reg. (3,3)**	**Reg (4,4)**
z=0,5	0,84	1,04	1,16	1,19
z=0,4	0,79	1,07	1,21	1,23
z=0,3	0,73	1,14	1,27	1,26
z=0,2	0,63	1,28	1,32	1,25
z=0,1	0,49	1,60	1,33	1,20
z=0	0,26	2,41	1,13	1,13

Welfare levels (average for z=0,5 equal to one)

	Reg. (1,1)	**Reg. (2,2)**	**Reg. (3,3)**	**Reg (4,4)**
z=0,5	0,73	1,02	1,22	1,29
z=0,4	0,76	1,15	1,39	1,46
z=0,3	0,79	1,31	1,59	1,68
z=0,2	0,83	1,54	1,88	1,96
z=0,1	0,87	1,91	2,24	2,29
z=0	0,91	2,56	2,68	2,72

Note: For regions (5,5)-(7,7), the results for regions (1,1)-(3,3) apply in reverse order. Observe that the levels are expressed in terms of the average for all 49 countries for each level of trade barriers. For manufacturing production, this average is constant. For welfare, the average is changing, and we use the average level for z=0,5 as the basis.

Table A3: The impact of a regional trading bloc

Changes from base case (d=0,4, z=0,2)

Manufacturing production

	1	2	3	4	5	6	7
1	-0,01	-0,11	-0,19	-0,13	-0,02	0,01	0,01
2	-0,11	-0,14	0,27	0,00	-0,25	0,00	0,01
3	-0,19	0,27	1,00	0,59	-0,42	-0,01	0,01
4	-0,13	0,00	0,59	0,24	-0,31	0,00	0,01
5	-0,02	-0,25	-0,42	-0,31	-0,07	0,01	0,01
6	0,01	0,00	-0,01	0,00	0,01	0,01	0,00
7	0,01	0,01	0,01	0,01	0,01	0,00	0,00

Welfare (average before integration = 1)

	1	2	3	4	5	6	7
1	-0,01	-0,03	-0,05	-0,04	-0,02	0,00	0,00
2	-0,03	0,23	0,43	0,28	-0,08	-0,01	0,00
3	-0,05	0,43	0,75	0,54	-0,12	-0,02	0,00
4	-0,04	0,28	0,54	0,36	-0,09	-0,02	0,00
5	-0,02	-0,08	-0,12	-0,09	-0,04	-0,01	0,00
6	0,00	-0,01	-0,02	-0,02	-0,01	0,00	0,00
7	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table A4: The impact of trade liberalisation on manufacturing production, given that four countries have been formed.

Changes from base case in Table 1.

Spatial liberalisation

	1	2	3	4	5	6	7
1	-0,12	-0,09	-0,14	-0,14	-0,14	-0,11	-0,11
2	-0,09	0,53	0,05	0,03	0,25	0,33	-0,11
3	-0,15	0,08	-0,12	0,01	0,16	0,26	-0,14
4	-0,14	0,07	-0,10	-0,10	-0,04	0,02	-0,14
5	-0,15	0,35	0,00	-0,12	-0,03	0,01	-0,14
6	-0,12	0,43	0,02	0,06	0,36	0,43	-0,08
7	-0,11	-0,08	-0,14	-0,14	-0,14	-0,12	-0,11

Non-spatial liberalisation

	1	2	3	4	5	6	7
1	-0,01	-0,03	-0,01	-0,01	-0,03	0,00	0,00
2	-0,03	-0,12	0,07	0,11	-0,07	0,00	0,00
3	-0,01	0,07	0,07	0,03	-0,14	-0,07	-0,03
4	-0,01	0,07	0,09	0,09	0,04	0,11	-0,01
5	-0,03	-0,13	0,03	0,07	0,03	0,10	-0,01
6	0,00	-0,07	0,10	0,07	-0,13	-0,07	-0,03
7	-0,01	-0,03	-0,01	-0,01	-0,03	0,00	-0,01