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Agglomeration in a Core-Periphery Model with Vertically and Horizontally Integrated Firms*

Karolina Ekholm** and Rikard Forslid***

Abstract

This paper analyses the effect of allowing for a more general production structure in the core-periphery (CP) model. Two special cases of fully horizontally and fully vertically integrated firms are treated. The case of horizontally integrated firms is a counter-example to the strong agglomeration effects found in the CP model. A symmetric equilibrium will always be stable, and, hence, agglomeration is prevented. The introduction of vertically integrated firms that can separate the location of headquarter activities from the location of production, has two effects. First, they tend to break the symmetry of the original CP model, and, in this sense, they lead to more agglomeration. Second, they tend to decrease the parameter space in which full agglomeration occurs. In this sense they lead to less agglomeration.

JEL Classification: F12, F15, R12

Keywords: economic geography, agglomeration, horizontally integrated firms, vertically integrated firms

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1. Introduction

The recent literature on economic geography offers a theoretical basis for one common worry of politicians in peripheral regions, namely that industrial production has a tendency to agglomerate in central regions. For instance, in Krugman (1991) and Krugman & Venables (1995), the interaction between scale economies and transportation costs gives rise to linkages between firms and labour/customers or between the firms themselves via their demand for intermediate products. This, in turn, may at certain levels of trade costs produce a core-periphery structure where industrial production is concentrated in one region.

Models of this kind have been used in several papers to analyse the effects of regional economic integration on the location of industrial activity and on real incomes in different regions (for a survey, see Baldwin & Venables 1996). Because a production structure with dispersed industrial activity can be sustained with high trade costs, while low trade costs may induce complete agglomeration of industrial activity, a straightforward implication is that integration in the form of reductions in trade costs can yield agglomeration and under certain circumstances increased inequality in real incomes.[1]

However, the strong effects on the location of industrial activity in these models seem to some extent to be a consequence of the rather restrictive assumptions about the firm's production function. Scale economies are assumed only to be present at plant level, which implies that each variety of a differentiated product will be produced at a single location. In Markusen & Venables (1996) horizontally integrated firms are introduced by assuming that there are scale economies at both firm and plant level, implying that each variety will be produced by a single firm, but may be produced in several plants at several locations. They

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[1] Krugman & Venables (1995) find a U-shaped relationship between trade costs and similarity in real incomes so that reduced trade costs first lead to divergence in real incomes as industrial activity becomes concentrated in the core region, while with further reductions in trade costs, industrial activity starts to shift back to the periphery inducing convergence in real incomes.

show that the tendency for concentration of industrial activity may be weaker when we allow firms to set up production plants both at home and abroad. More specifically, they show that the set of factor allocations consistent with equilibria without complete agglomeration is larger using these assumptions compared to when firms do not have the option of becoming multinationals.

In this paper we study the effects on agglomeration tendencies of allowing firms to become multi-region firms, i.e. firms that locate activities in more than one region. We use the core-periphery (CP) model with mobile labour developed by Krugman (1991), and make the simplest possible modification of the assumptions to allow firms to have activities in both regions. We focus on two special cases. First, horizontally integrated firms are introduced by assuming multi-plant economies of scale that make it profitable to set up plants in both regions. Second, vertically integrated firms are introduced by allowing for a separation of the location of headquarters from the location of actual production.

The introduction of horizontally integrated firms leads unambiguously to less agglomeration since production will, typically, not be concentrated in one of the regions, but instead will spread to both regions. We show that when multi-plant economies of scale are as large as possible, this always prevents agglomeration.

With vertically integrated firms it is profitable to keep headquarters operations in the larger region where nominal wages are lower. In the original CP model, a symmetric equilibrium, where total industrial production is divided equally between two regions that are identical in all other respects, is stable for trade costs over a certain threshold level. With vertically integrated firms headquarters will always move to the region with more firms and lower nominal wages. Thus, one effect of the introduction of vertically integrated firms is to destabilise the completely symmetrical equilibrium. However, there is also another effect. With vertically integrated firms it becomes relatively cheaper to move production out of the agglomerated region because the total cost of compensating workers in the peripheral region for the higher price level in that region is smaller when headquarters can be retained in the central region. This effect will work against full agglomeration.

The rest of the paper is organised as follows: in section 2 we describe the CP model and present the modifying assumptions made in order to introduce horizontally and vertically integrated firms. Section 3 analyses the location of industrial production for horizontally integrated firms and section 4 presents the simulation results for vertically integrated firms. In section 5 we look at the welfare effects from introducing multi-region firms, and, finally, in section 6, we present our conclusions.

2. The Model

There are two regions in the economy, region 1 and 2, and two types of labour: farmers and workers. Farmers are immobile and produce a homogenous good with a unit labour input coefficient equal to one. Workers produce differentiated products and can move between the regions.

Individuals derive utility from a utility function of the following form:

$$U=C_M^{\mu}C_A^{1-\mu}; \quad C_M=\left(\sum_{i=1}^{N}c_i^{1-1/\sigma}\right)^{\frac{1}{1-1/\sigma}};$$

where C_A is the consumed quantity of the homogenous agricultural good, C_M is the consumed quantity of a CES-index of manufactured products, N is a large number of potential products and $\sigma>1$ the elasticity of substitution between each pair of manufactured products. The parameter m is the constant share of expenditure on manufactured goods. The total population is normalised to one and we follow Krugman (1991) in assuming that there are m workers and 1-m farmers, which ensures that farmers and workers earn the same wage rate in long-run equilibrium in the CP-model. Furthermore, farmers are initially assumed to be equally divided between the two regions.

Assume a production structure where there is a fixed cost associated with setting up production and a constant marginal cost. The firm's cost function can then be written as:

$$w_j L_{ij} + w_k L_{ik} = \alpha w_j + \beta x_{ik} w_k \; ; \qquad j = 1, 2; \;\; k = 1, 2 \tag{1}$$

where w_j and w_k are the wage rates in region j and k, respectively, L_{ij} and L_{ik} are the amounts of labour used by firm i in region j and k, respectively, α is a fixed cost, β is the marginal cost, and x_{ik} is the output level of firm i. Region j is assumed to be the region where fixed costs are incurred, while k is the region where actual production takes place.

Where $j = k$, we have the usual case of single region firms undertaking all their activities in one region as analysed by Krugman (1991). However, if we allow the firms to separate those activities leading to fixed costs, such as R&D and other so-called headquarter activities, from actual production, firms do not necessarily have to be single-region firms. If there are no additional costs for within-firm transfers of headquarter services between the two regions, the firm may as well choose to locate production and headquarters in different regions, thereby becoming a vertically integrated multi-region firm.

If the headquarter activities yielding fixed costs at the firm level can serve more than one plant, there will be multi-plant economies of scale. In that case, the firm's cost function could instead be expressed as:

$$w_j L_{ij} + w_k L_{ik} = \alpha w_j + \beta (x_{ij} w_j + x_{ik} w_k) \tag{2}$$

where α is the fixed cost of starting production of the good and the marginal cost, β, is assumed to be identical in both regions. In the simple case represented by the cost function in (2) it is assumed that the firm can set up a second production site in another region without any additional fixed costs at all. Thus, in this case the multi-plant economies of scale are as large as they can be.

Shipments of manufactured goods between regions are assumed to require transportation costs of the iceberg type. To deliver one unit of x to the other region one has to ship $t>1$ units. Agricultural goods, on the other hand, are assumed to be traded without cost so that the price of agricultural goods is equalised between the two regions. This price will be used as numeraire.

Manufacturing firms operate under large group monopolistic competition and a typical firm producing in region j will set price as a mark-up on marginal cost according to,

$$p_k=\left(\frac{\sigma}{\sigma-1}\right)\beta w_j \tag{3}$$

where p_k is the price set by the producer on products sold in region k, $k = 1, 2$. Setting $b=(1-1/s)$ implies that $p_k = w_j$. Free entry implies that profits must be driven to zero.

We assume a simple law of motion according to which workers move to the location with higher real wages (w) and away from the location with lower real wages. The real wage of each region j is given by,

$$\omega_j=w_j P_j^{-\mu} \tag{4}$$

where P_j is the CES price index of manufactured goods for consumers in region j.[2] With $\lambda \equiv L_1/L_2$, the law of motion of the economy is given by

[2] I.e., this price index is defined as $P_j \equiv \left[n_j p_j^{1-\sigma} + n_k(\tau p_k)^{1-\sigma}\right]^{1/(1-\sigma)}$, where n_j is the number of firms that are producing in the region and n_k is the number of firms that are exporting to the region .

$$\frac{d\lambda}{dt} = \lambda(\omega_1 - \omega_2) \tag{5}$$

3. Horizontally Integrated Firms

The effect of horizontally integrated multinationals on location has been simulated in a fairly general model by Markusen and Venables (1996). In our model, therefore, we will just consider a very simple case, which allows us to derive some analytical results which are roughly in line with the results of Markusen and Venables.

Assume that the firm's cost function is given by (2). For positive trade costs, an equilibrium where total manufacturing production is divided equally between the regions will then always be stable. It is easily understood that the firm will always find it profitable to avoid trade costs by producing in both regions when there are no additional fixed costs involved in setting up a plant in the second region. This, in turn, implies that an equilibrium with symmetric production in the two regions is the only stable equilibrium. To see why consider the case when all manufacturing production is agglomerated in one region, say region 1. If any equilibrium in addition to the symmetric one is stable, this is the most likely candidate since the cost of producing manufactures in region 2 is highest when everything is agglomerated in region 1. To set up a subsidiary in region 2, a manufacturing firm must draw workers from the larger region by paying a nominal wage premium, equal to τ^{μ}, to compensate for the fact that all manufactures must be imported into the small region. The value of sales of the first firm that sets up a subsidiary in region 2 is given by,

$$V_2 = \left(\frac{P_1}{w_1}\right)^{\sigma-1} \mu Y_1 + \left(\frac{P_2}{w_2}\right)^{\sigma-1} \mu Y_2 \tag{6}$$

where P_j is the price index in region j. This should be compared to the value of sales of a firm producing only in region 1, which is given by,

$$V_1=\left(\frac{P_1}{w_1}\right)^{\sigma-1}\mu Y_1+\left(\frac{P_2}{\tau w_1}\right)^{\sigma-1}\mu Y_2 \tag{7}$$

Using the relationship $w_2 = \tau^{\mu} w_1$, it is easy to show that $V_2 > V_1$ for all $t > 1$. This means that it will always be profitable for the firm to start producing in region 2, and complete agglomeration cannot be a stable equilibrium. Workers only have to be compensated by $t^m w$, rather than tw, to move into the small region since they also consume agricultural products. Therefore it will always be cheaper to produce manufactured goods in the region where they are sold.

Finally, given that all firms produce in both regions, we must determine where the firms locate their headquarters. Since the price indices are equal in the two regions only nominal wages will determine where to put the headquarters. This implies that the location of headquarters is undetermined for horizontally integrated firms.

In this simple example horizontally integrated firms will guarantee a symmetrical allocation of manufacturing production and, thus, it constitutes a clear-cut counter-example to the case analysed in the original CP-model. If firms have to pay an additional fixed cost for their second plant, the symmetrical allocation is no longer guaranteed for low trade costs. However, the general effect would be to decrease the parameter space in which we get full agglomeration compared to the CP-model.

4. Vertically Integrated Firms

Now, we turn to the case with vertically integrated firms and assume that the firm's cost function is given by (1). Firms then have two location decisions to make:

where to locate production and where to locate the headquarters (i.e. where to incur the fixed costs). Consider first the location of headquarters. The output from headquarter activities can here be regarded as a traded good without transportation costs. In the symmetric case with manufacturing production equally divided between the regions the location of headquarters is indeterminate. As soon as one region has one firm more, however, all headquarters will end up in that region because workers will be willing to accept a slightly lower nominal wage here in exchange for a lower price index. All configurations of headquarters except where there is complete agglomeration are therefore highly unstable. We will not explicitly model the dynamics of both of these location decisions. It is, however, clear that the dynamics of the system will depend on how fast headquarters are relocated in comparison to how fast production is relocated.

First, consider the case where headquarters are much slower to relocate than production facilities. The symmetric equilibrium, where exactly half of all headquarters and production plants are located in each country, will now be stable for exactly the same parameter values as in the original core-periphery model.[3] As soon as this equilibrium becomes unstable and a small deviation leads firms to start moving production into the larger region, all headquarters will also eventually end up in this region. Second, consider the case when headquarters relocate faster than production. The symmetric equilibrium will now be unstable since all headquarters will quickly move into the slightly bigger region. Workers moving together with the headquarters increase the size of this region, which in turn tends to draw more production into the area. We then get a (possibly stable) asymmetric equilibrium.

In the following we are assuming that all headquarters are agglomerated in one region (region 1). This means we are treating a case where headquarters

[3] If we start at a point well away from equilibrium, it is feasible that not all production has time to relocate before the headquarters start to move into the larger region. Therefore the symmetric equilibrium will only be locally stable unless we assume that all production does have time to relocate before headquarters can move.

relocate faster than production facilities or that we are investigating cases where the symmetric equilibrium is unstable in the CP-model.

Free entry implies that fixed costs for headquarters located in region 1 must equal operating profits for firms in both regions,

$$(p_1 - \beta w_1)x_1 = (p_2 - \beta w_2)x_2 = \alpha w_1 \tag{8}$$

which gives

$$x_1 = \sigma\alpha, \quad x_2 = \sigma\alpha\frac{w_1}{w_2} \tag{9}$$

Full employment implies that

$$L_1 = n_1(\sigma - 1)\alpha + (n_1 + n_2)\alpha, \qquad L_2 = n_2(\sigma - 1)\alpha\frac{w_1}{w_2} \tag{10}$$

where L_j is the total amount of workers in region j. In equilibrium the income of all workers in a firm must equal the expenditures on that firm's good, which gives

$$(w_1L_1 - n_2\alpha w_1)/n_1 = \mu\left(\frac{w_1^{1-\sigma}}{n_1w_1^{1-\sigma} + n_2(\tau w_2)^{1-\sigma}}Y_1 + \frac{(\tau w_1)^{1-\sigma}}{n_1(\tau w_1)^{1-\sigma} + n_2 w_2{}^{1-\sigma}}Y_2\right) \tag{11}$$

$$(w_2L_2 + n_2\alpha w_1)/n_2 = \mu\left(\frac{(\tau w_2)^{1-\sigma}}{n_1w_1^{1-\sigma} + n_2(\tau w_2)^{1-\sigma}}Y_1 + \frac{w_2^{1-\sigma}}{n_1(\tau w_1)^{1-\sigma} + n_2 w_2{}^{1-\sigma}}Y_2\right) \tag{12}$$

where Y_j is income in region j, given by

$$Y_1 = \frac{1-\mu}{2} + w_1L_1, \quad Y_2 = \frac{1-\mu}{2} + w_2L_2 \tag{13}$$

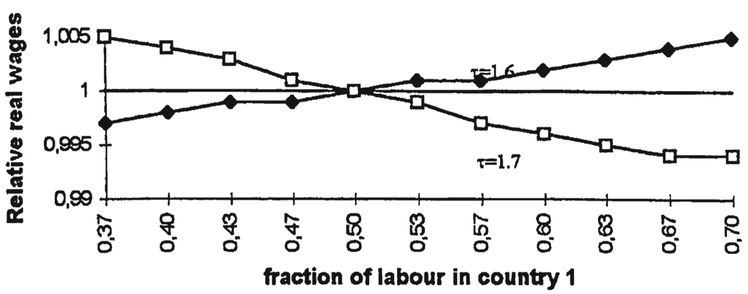
Equations (8) to (11) together with the assumption that $L_1 + L_2 = \mu$ determine the short-run equilibrium levels for Y_1, Y_2, w_1, w_2, n_1, n_2 and L_1/L_2.

Simulation Results

The simulations for vertically integrated firms are performed with all headquarters located in one region (region 1). Moreover, for comparison purposes we use the same parameter values including the fixed costs as in the CP-model.

Figure 1 shows the relationship between relative real wages and relative country size in the original CP model with s = 4 and m = 0.3. With the economy's law of motion given by (5), this figure can be used to gauge the stability of the symmetric equilibrium. For $\tau=1.6$ the relative real wage in region 1 increases with an increased share of the total labour force located in that region. As soon as we are out of the symmetric equilibrium, workers have an incentive to move to the larger region, i.e. the region with a larger share of the total labour force. The symmetric equilibrium is therefore in this case unstable. For $\tau=1.7$ we have the opposite relationship between relative wages and agglomeration, which makes the symmetric equilibrium stable. The critical value of trade costs when the symmetric equilibrium stops being stable is $\tau=1.64$.[4]

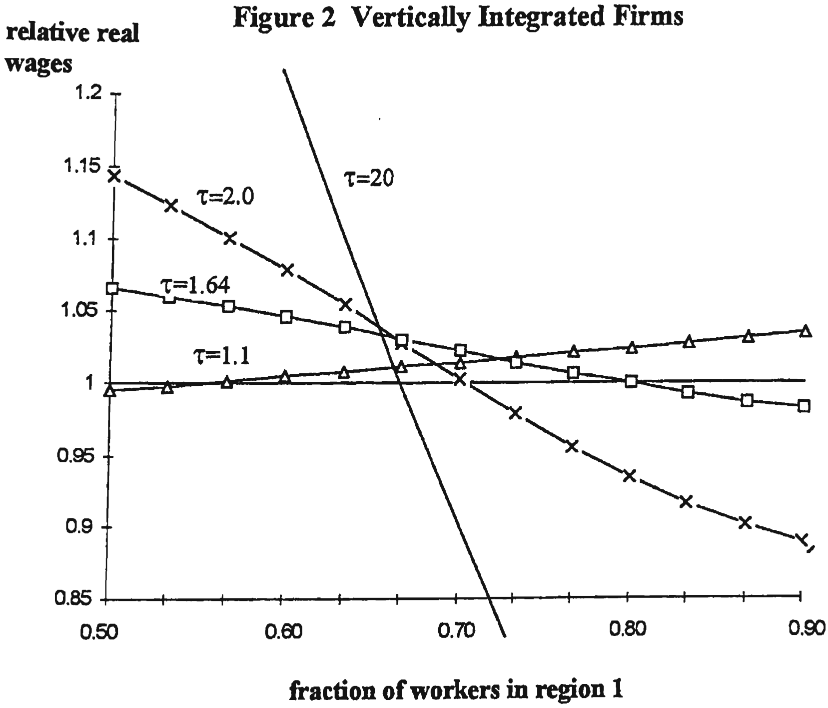
Figure 1 The Core-Periphery Model



[4] As illustrated by Helpman (1996), for specific parameter values this model also displays two unstable non-symmetric equilibria while full agglomeration and the symmetric equilibrium are locally stable. In our case this occurs for trade costs close to 1.66.

Next compare the result in the CP-model with the simulation results in Figure 2 where all companies have their headquarters in region 1 and they can choose to locate production in region 1 or region 2. In this case the perfectly symmetric equilibrium ceases to be stable. Instead, as long as τ is not so low as to lead to complete agglomeration, each level of trade costs corresponds to one stable equilibrium which is neither fully agglomerated nor symmetrical. Figure 2 shows how the curve depicting the relationship between the relative real wage and the distribution of labour rotates anti-clockwise for lower trade costs. For prohibitive trade costs this line will be vertical and region 1, which has all the headquarters, will have 67 percent of the workers. As trade costs fall the stable equilibrium will move to the right with more and more resources concentrated in region 1.

Figure 2 Vertically Integrated Firms



For $\tau = 1.64$ the CP-model leads to complete agglomeration, while the model with vertically integrated companies produces a stable equilibrium with some 20 percent of manufacturing production in the smaller region as illustrated in Figure 2. For complete agglomeration to occur in the model with vertical firms, trade costs have to be lower than in the original CP model. Vertical companies therefore decrease the parameter space for which full agglomeration is a stable equilibrium.

The introduction of vertically integrated firms in the CP-model thus has two effects. First it breaks the symmetry of the original model and therefore makes the symmetric equilibrium unstable.[5] In this sense it leads to more agglomeration than in the CP-model. Second it decreases the parameter space for which we get full agglomeration. In this sense vertical firms lead to less agglomeration.

The result that the symmetric equilibrium ceases to be stable once all headquarters are agglomerated in region 1 seems fairly intuitive, but why is it that we do not always get full agglomeration? In order to start producing in the smaller region firms must attract workers by paying a higher nominal wage to compensate for the higher price index. When firms can split production and headquarters it becomes cheaper to move production into the small area, since the firm can then go on paying the lower nominal wage to headquarter workers that stay in the bigger region. It will therefore be profitable to break away from full agglomeration at a lower trade cost than in the CP model. Obversely the cost saving from moving production into the bigger region is less with vertically integrated firms since the headquarters are already in this region.

The important difference between the CP-model and the model with vertically integrated firms is that in the CP-model, the only two possible stable equilibria are either complete symmetry or full agglomeration, while the model with vertically integrated firms yields outcomes that lie between these two extremes. This is an attractive feature of the model with vertically integrated firms.

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[5] The symmetry of the original CP-model could, of course, also be broken by making the two regions inherently asymmetrical by assuming that farmers are unequally divided between the two regions.

Figure 3 Fraction of workers at different trade costs

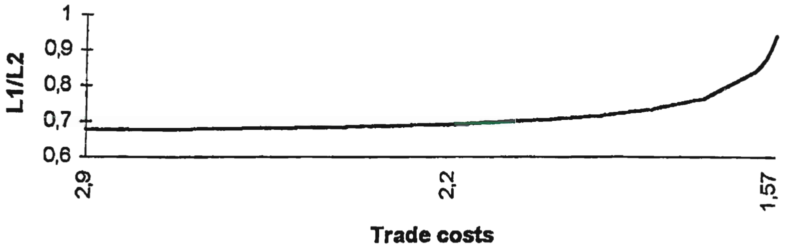

Figure 3 shows the relation between trade costs and the distribution of workers between the two regions in stable equilibria for the model with vertically integrated firms. The stable equilibrium moves towards increased agglomeration gradually, but non-linearly as trade costs fall. When trade costs are low, the stable equilibrium is very sensitive to further trade cost changes, with small changes producing strong agglomeration effects.

5. Welfare

In this section we examine the welfare implications of the models with horizontally and vertically integrated firms and we compare these with the welfare effects in the original CP-model. One region's welfare will depend both on the workers' and the farmers' real wages.

Horizontally integrated firms

The welfare implications of introducing horizontally integrated firms are straightforward in our stylised example. Changes in trade costs do not have any effect at all on production patterns, and, hence, not on real wages either. All goods will be produced in both regions, so the price index will be identical in the two regions with no trade. Nominal wages of workers that can move between the regions must therefore be equal in equilibrium. Nominal wages of farmers are equal in both regions because of free trade in agricultural goods. All groups in both regions will therefore enjoy the real wages of the fully agglomerated equilibrium in the original CP-model.

Vertically integrated firms

The case of vertically integrated firms is also the more interesting one in terms of welfare effects. Figure 4 shows how the equilibrium real wage of workers in region 1 changes with trade costs. Only stable equilibria are considered. The real wage in the original CP-model is plotted by a thick black line and in the model with vertically integrated firms (VI-model) with a thin grey line. We continue to use $s = 4$ and $m = 0.3$. Consider first the CP-model. The symmetric equilibrium is stable as long as $t > 1.64$. With lower trade costs all firms agglomerate in region 1, which leads to a real wage hike in region 1 because of a fall in the price index. With vertically integrated firms the equilibrium real wage instead continuously move as trade costs are lowered and we draw nearer to the situation where manufacturing production is completely agglomeration in region 1. Consequently, the real wages of workers shift gradually towards the wages of full agglomeration.

As long as $t > 1.56$ some manufacturing production will be maintained in region 2. With all manufacturing production agglomerated in one region the two models are identical, and real wages therefore follow the same path. With trade costs high enough to avoid agglomeration in the CP-model welfare is higher in the model with vertical firms. The symmetric equilibrium in the CP-model maximises trade and therefore trade costs. An asymmetric equilibrium leads to less trade and higher real wages compared to a symmetric equilibrium. Note that while nominal wages are equal in the two regions due to normalisation in the CP-model, this is not the case in the VI-model.[6] To maintain equal real wages in an asymmetric equilibrium nominal wages must be higher in the smaller region.

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[6] Because the fraction of workers to population is normalised to m in the CP-model, the nominal wages of workers and farmers are equal in the long-run equilibrium. No such normalisation exists in

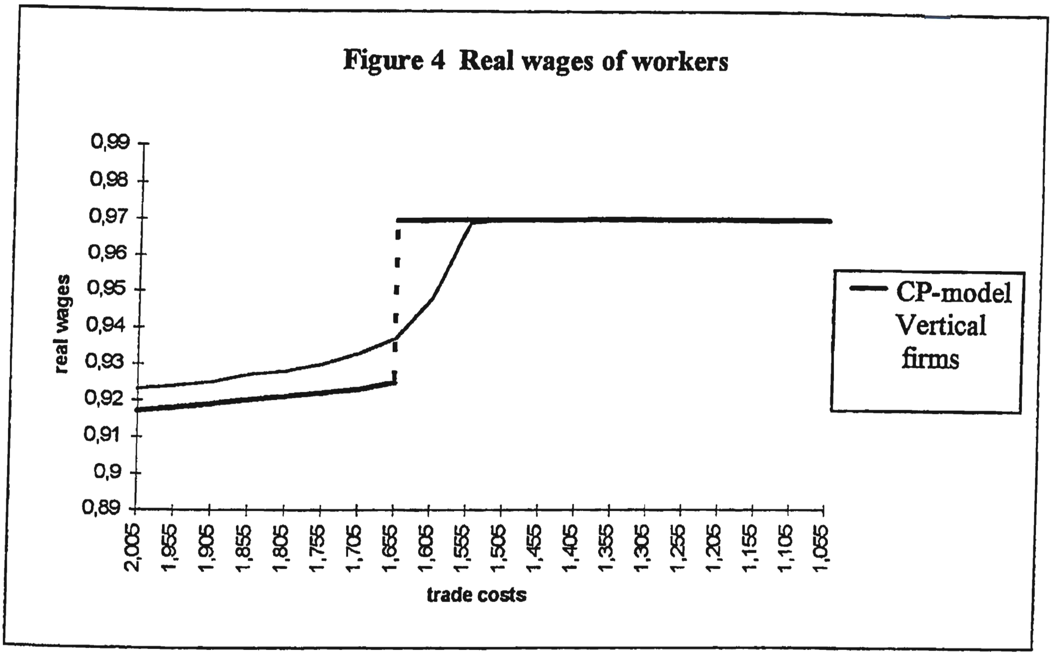

Figure 5 shows the equilibrium real wage of farmers in both regions as trade costs change. In the CP-model, shown by a bold black line, real wages of farmers are equal until agglomeration occurs. The real wage of farmers in region 1 then follows the wage of workers and increase with a jump. In the periphery the price index increases sharply when all manufactured goods suddenly have to be imported, and real wages fall sharply. In the VI-model, on the contrary, the real wages of farmers in the smaller region must be lower than the real wages in the larger region since nominal wages are equal because of the free trade in agricultural goods. Generally, the more asymmetric the equilibrium the better it is for farmers in the larger region and the worse for farmers in the smaller region. Therefore, the asymmetric equilibrium in the VI-model is better for farmers in the larger region than the symmetric equilibrium, but worse than the fully agglomerated equilibrium.

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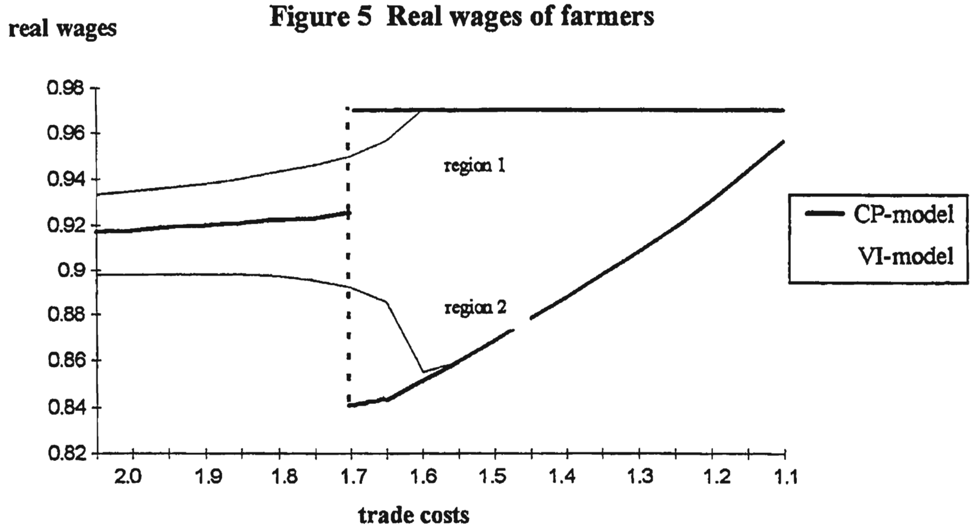
the VI-model with an infinite number of asymmetrical equilibria. Apart from the case when there is complete agglomeration the nominal wage of workers in the smaller region will always be higher than the nominal wages in the larger region. The nominal wage of farmers which is equal in the two regions is the numeraire. Whether the farmers wage is higher or lower than the nominal wage of workers depends on how large a fraction of the population workers are.

Figure 5 Real wages of farmers



For farmers, who operate in a perfectly competitive sector without trade costs, we thus get the result that farmers that become relatively more abundant in the smaller region lose while farmers that become relatively more scarce in the larger region gain. For manufacturing workers, who operate in a sector with increasing returns to scale, agglomeration is a win-win outcome with higher real wages in both regions.

6 Conclusions

This paper has analysed the effects of allowing for a more general production structure in the CP-model. Two stylised examples of horizontally and vertically integrated firms are treated. The case of horizontally integrated firms where the fixed costs of setting up a second production facility is zero is a clear-cut counter-example to the original CP-model in that agglomeration does not occur at any level of trade costs. The case of vertically integrated firms in which the location of headquarters activities is separated from the location of production is less clear-cut.

We find by simulation that the introduction of vertically integrated firms has two effects. First they tend to break the symmetry of the original core-periphery model. A fully symmetrical equilibrium where total manufacturing production is divided equally between the two regions is no longer stable. In this sense the introduction of vertically integrated firms can be said to lead to more agglomeration. However, another consequence of introducing vertically integrated firms into the CP model is that the parameter space in which full agglomeration occurs decreases because it becomes less advantageous to locate in the larger region. In this sense it leads to less agglomeration compared to the original CP model.

In general, the changes in production patterns as trade costs fall become less dramatic when we introduce multi-region firms. This is also true for the welfare effects of changes in trade costs. Whereas in the original CP-model, real wages for both farmers and workers change dramatically when trade costs fall below the threshold level under which full agglomeration occurs, real wages change in a more gradual fashion when firms are vertically integrated.

References

Baldwin R. and A.Venables (1996) "Regional Economic Integration". In *Handbook of International Trade, Vol. III*. Amsterdam: North-Holland.

Helpman E. (1996) "The Size of Regions", mimeo, University of Tel Aviv.

Krugman P. (1991) "Increasing Returns and Economic Geography", *Journal of Political Economy* 99, 483-99.

Krugman P. and A.Venables (1995) "Globalization and the Inequality of Nations", *Quarterly Journal of Economics*.60, 857-80.

Markusen J. and A.Venables (1996) "The Theory of Endowment, Intra-Industry and Multinational Trade", *CEPR* Working Paper No.1341.

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