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Home Goods and Regional Price Indices: A Perspective from New Economic Geography

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Home Goods and Regional Price Indices: A Perspective from New Economic Geography

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ABSTRACT

In standard models of New Economic Geography the overall regional price index in the centre is lower than in the periphery, because trade in manufacturing imposes transportation costs whereas trade in agriculture is assumed to be costless. Since real world observations suggest higher overall CPIs in the centre than in the periphery, this paper presents a model where a home goods sector is added. The model is able to explain a sustainable core-periphery structure with higher aggregate CPI in the centre. This structure can emerge endogenously out of the system itself and does not need to exist initially. Hence, the standard model of New Economic Geography can gain realism by the modification proposed in this paper.

JEL Classifications: R 12, R 13.

Keywords: Economic Geography, Agglomeration, Home Goods.

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1. Introduction

In the last few months one could find some articles in popular German newspapers dealing with the socio-economic situation of Munich. The capital of Bavaria and the surrounding area is a booming region. Lots of modern enterprises have settled here, employment and population growth was rapid.

In fact, too rapid as the mayor Christian Ude has pointed out: “My problem is that apparently everybody wants to live in Munich.” (Süddeutsche Zeitung, 6.3.2001, p. 3). And so, the downside of this boom are dramatic increases of rents. At the moment, so the mayor, even the worst apartments cost a fortune. ‘So what?’, one could say, if these are the market prices. But the price explosions are gradually labelled as “damaging the city’s prospects for economic development in the long run” (FAZ 13.7.2001, p. 14).

This paper is really concerned with that statement and tries to shed some light on it from the point of view of Economic Theory, more precisely “New Economic Geography”. What we observe in Munich is a nice example of regional agglomeration; the building and reinforcement of an economic core where mobile production pools. This process is the concern of the core-periphery (c-p-)models of New Economic Geography as presented for example in Fujita/Krugman/Venables (1999) [hereafter F/K/V].

In the basic model, the geographic structure of an economy is explained by an interplay of increasing returns to scale and transportation costs. In the simplest version (F/K/V, ch. 5) the economy consists of two regions, two sectors (manufacturing and agriculture) and two sector specific types of workers. The manufacturing sector exhibits increasing returns to scale. The market structure that follows is one of monopolistic competition. Manufacturers are regionally mobile, whereas the farmers are not only sectorally but also regionally assigned. Trade in manufacturing across regions imposes transportation costs, but trade in agriculture is assumed to be costless. For low and intermediate trade costs, the agglomerative forces of the manufacturing sector form an economic core in which all mobile workers locate and where all manufacturing production is carried out. In the periphery only immobile workers remain who engage in agricultural production under constant returns and perfect competition. Otherwise, if transport costs are too high, the geographic structure is completely symmetrical.

So far, so good. Apparently New Economic Geography can tell one possible story about why economic cores can arise in the first place (something that is rather hard to do within a purely neoclassical world of constant returns and perfect competition): the presence of increasing returns and the secular decline in transportation costs. But the standard model fails to account for the downside of agglomeration as described above. One not too appealing result of the basic approach is that the *overall regional price index* (CPI) is higher in the periphery and lower in the centre. The reason is that the hinterland needs to pay transportation costs for its imports of manufacturing goods, whereas the centre can import the agricultural products costless. This is a so called *forward linkage* of agglomeration that further increases the sustainability of a c-p-structure once it is established.

Certainly, we expect goods to be cheaper near by the location where they are produced. But nevertheless, we expect the *overall* price level to be higher in the centre(s) of an economy and lower in the periphery. Costs of living are surely higher in Munich than for example in Mecklenburg-Vorpommern. The same can be said about aggregate price levels in the city of New York compared to, say, Nebraska, or for the case of London versus the Scottish Highlands. The example of Munich clarifies that these higher price levels in the centres are due to the scarcity of land, higher rents and so forth.

The idea that this type of scarcity is a centrifugal force that limits regional agglomeration is by far not new. It has been pointed out by several old location theorists such as Isard (1956) or even Weber (1909). However, it has not yet been integrated in the standard approach of New Economic Geography. This paper aims to do so. Only a minor change is necessary to make the basic c-p-model take account for higher overall CPI in the centre. I add to the model a third good, which is a non-tradeable home good with a fixed quantity supplied. In the process of regional concentration, demand for home goods increases and so will prices. In a sense, the demand for housing and land is subsumed under this category. But the sector is more general. It also can contain other things, such as any item for which transportation and transaction costs are prohibitively expensive so that nobody would ever try to trade this good between regions.

The existence of non-tradeables adds to the row of disagglomerative force that makes regional concentration less likely *ceteris paribus*, beneath for example congestion (see Junius (1999), Brakman et. al. (1996)) or preferences for specific regions (Ludema/Wooton, 2000). I show in this paper that the endogenous emergence and the sustainability of a c-p-structure can prevail

even with home goods. The core can exhibit higher real wages for the mobile manufacturing workers, but the overall CPI is higher in the centre and lower in the periphery. Hence, this model setup also can not only tell a story about why Munich is an economic core, but also why it is becoming such an expensive place. And it gives rationale to the concern expressed above that it might eventually get harmed if rents are too high: if the quantitative importance of the home goods sector is too large, a region in the model can very well lose its status of being the economic core.

One final remark before the model: F/K/V later in their book (ch.7) introduce a model version with agricultural transportation costs that as a by-product also can reveal c-p-equilibria with a higher CPI in the centre, even though the authors do not mention this property at all. But because F/K/V undertake this modification on another purpose (that is, to relax the strange assumption of costless agricultural trade) and because the endogenous emergence of a c-p-structure is only possible with additional assumptions that are not necessary in this approach¹, it seems appropriate to pursue the path of introducing a home goods sector to the model to specifically address the issue of regional price indices..

The following model is an expanded version of the basic approach from ch. 4 and 5 in the F/K/V-book. For convenience of the reader (and for own convenience) the same notation as in the book is used.

2. *The Model*

The basic approach of New Economic Geography is a spatial version of the Dixit and Stiglitz (1977) model of monopolistic competition. In this model, there are two regions ($i=1,2$) with identical technology, preferences and endowments. In each of the regions there are three sectors, two of which are standard. There is a perfectly competitive agricultural sector with constant returns and a manufacturing sector with increasing returns to scale that provides a large variety of n differentiated goods. The market structure that follows is one of

¹ The introduction of agricultural transportation costs can produce sustainable c-p-equilibria with a higher CPI in the centre. But F/K/V find that symmetry breaking would then no longer occur (p. 103). Hence, a c-p-structure would not result from the endogenous dynamics of the model anymore, but would at best be sustainable in the case that it had existed initially. The property of symmetry breaking can only be restored by assuming differentiated agricultural products. Still, the implications for regional CPIs are not noted at any point from F/K/V.

monopolistic competition where each single variety is produced by only one firm. What is added here is a home goods sector with perfect competition and constant returns.

First we lay out the behaviour of consumers and producers in the two identical regions respectively. After the introduction of the standard transportation costs we can determine the equilibrium conditions and the geographic structure of the economy as a function of exogenous parameters.

Consumer demand

The representative consumer in each region respectively maximizes a Cobb-Douglas utility function

$$(1) U = M^\mu H^\gamma A^{1-\mu-\gamma}$$

subject to the budget constraint

$$(2) p^A A + p^H H + GM = Y$$

where Y is total regional income, p^A is the price of one unit of agriculture, p^H the price of one home goods unit. M is the aggregate of manufactured goods. The aggregate M is a symmetric CES function with a continuous range of n single varieties.

$$(3) M = \left[\int_0^n m(i)^\rho di \right]^{1/\rho}, \quad 0 < \rho < 1$$

The parameter ρ measures how close substitutes the single varieties are. The lower is ρ , the more differentiated are the single goods. The expression G is the composite regional price index for manufacturing goods,

$$(4) G = \left[\int_0^n p(i)^{1-\sigma} di \right]^{1/(1-\sigma)}$$

where $\sigma = 1 / (1-\rho)$ is the elasticity of substitution between two varieties $m(i)$.

Since the utility function (1) is homothetic, it is ensured that expenditure on each of the three aggregates is always a constant share of income. The demand for every single variety in manufacturing is

$$(5) m(j) = \mu Y \frac{p(j)^{-\sigma}}{G^{-(\sigma-1)}} \quad \text{for } j \in [0, n]$$

Assuming that each single variety has the same price p^M simplifies (4) to

$$(6) G = p^M n^{1/(1-\sigma)}$$

The price index G is decreasing in n. Every increase in n shifts the demand for each existing variety downwards and utility increases – consumers value variety.

Production

Agricultural goods A and Home Goods H are produced under constant returns and perfect competition. For simplicity it is assumed for both sectors that one unit of labour is transformed into one unit of output. Therefore the product price is equal to the nominal wage: $p^A=w^A$ and $p^H=w^H$. Each worker is assigned to an industry and can not change professions.

The labour requirement l^M for the quantity q^M of each manufacturing variety produced is

$$(7) \quad l^M = F + c^M q^M$$

where F is a fixed and c^M a marginal input requirement. The increasing returns and people's preference for variety ensure that every single variety will be produced by only one firm and hence the number of firms and the number of variety is identical.

The equilibrium number of firms n will be determined by profit maximization. There is free entry on the markets for each single commodity. Profits are given by

$$(8) \quad \pi = p^M q^M - w^M (F + c^M q^M)$$

and will always be competed down to zero. Using the familiar pricing rule $p^M(1-1/\sigma) = c^M w^M$, the zero-profit condition implies that the equilibrium output q^* , the associated labour requirement l^* and the equilibrium number of firms and products n^* respectively are

$$(9a) \quad q^* = F(\sigma-1)/c^M \quad (9b) \quad l^* = F + c^M q^* = F\sigma \quad (9c) \quad n^* = L^M/l^* = L^M / F\sigma$$

One can choose units freely. If $c^M=(\sigma-1)/\sigma$ and $F = \mu / \sigma$, it follows that

$$(10a) \quad q^* = l^* = \mu, \quad (10b) \quad n^* = L^M / \mu, \quad (10c) \quad p^M = w^M$$

Trade between the two regions

The missing piece for the determination of the geographic structure are transportation costs. I stick to the original assumption of F/K/V that agricultural products can be traded costless. Trade of manufactured goods imposes a cost. Transportation costs are modelled by assuming Samuelson's iceberg form

$$(11) \quad p^M_{1,2} = T p^M_1 \quad \text{with } T > 1$$

The price for manufactures produced in region 1 and shipped to and consumed in region 2 ($p^M_{1,2}$) [or the other way round] is T times the mill price p^M_1 . A fraction $1/T$ simply melts away during shipping.

Hence, consumer demand in region 2 for one single manufacturing variety produced in region 1, denoted $m_{1,2}$ is according to demand function (5)

$$(12) m_{1,2} = \mu Y_2 \frac{(p_1 T)^{-\sigma}}{G_2^{-(\sigma-1)}}$$

To serve this demand, T times this amount needs to be shipped. Hence, total sales for this particular variety produced in region 1 is the sum of sales in the two regions and is given by

$$(13) q_1^M = \mu \left(Y_1 \frac{p_1^{-\sigma}}{G_1^{-(\sigma-1)}} + T Y_2 \frac{(p_1 T)^{-\sigma}}{G_2^{-(\sigma-1)}} \right)$$

Total sales depends on the two regional income levels, the price indices, the transportation costs and the mill price.

Equilibrium conditions

There are three types of workers: Manufacturers, Farmers and Home goods producers. Farmers and Home Goods Producers are assumed to be regionally immobile². Units are chosen such that the labour force of these two sectors is equally distributed across regions: $L^H_1=L^H_2= \frac{1}{2}\gamma$ and $L^A_1=L^A_2= \frac{1}{2}(1-\mu-\gamma)$. On the contrary, manufacturers are mobile across regions. The size of the total manufacturing workforce is $L^M = \mu$. A fraction λ is living in region 1, $(1-\lambda)$ in region 2. According to (10b) this will limit the equilibrium level of national manufacturing production to unity.

With these assumptions total regional incomes are

$$(14a) Y_1 = \lambda \mu w^M_1 + \frac{1}{2} \gamma w^H_1 + \frac{1}{2} (1-\mu-\gamma) w^A_1$$

$$(14b) Y_2 = (1-\lambda) \mu w^M_2 + \frac{1}{2} \gamma w^H_2 + \frac{1}{2} (1-\mu-\gamma) w^A_2$$

Using (6), (10c) and the specification of transportation costs, the composite manufacturing price indices are respectively

$$(15a) G_1 = [\lambda w_1^{1-\sigma} + (1-\lambda) (w_2 T)^{1-\sigma}]^{1/1-\sigma}$$

$$(15b) G_2 = [\lambda (w_1 T)^{1-\sigma} + (1-\lambda) w_2^{1-\sigma}]^{1/1-\sigma}$$

With equations (12) and (13) we can now define a manufacturing wage equation. It is already known from equation (10a) that firms produce q^* . Equilibrium implies that q^* needs to equal total sales for every commodity, equation (13). Rearranging terms and expressing the equilibrium condition in terms of the mill price gives the critical price at which firms break even. Using the familiar pricing rule for monopolistic competition and the normalizations

² Alternatively one could allow for some regional mobility of home goods producers which is less than perfect. In this case the supply of home goods in region 1 would gradually increase with demand and prices of home goods in both regions would converge. But for simplicity this case is not analysed further.

made above, the equilibrium condition can then be expressed in terms of the nominal manufacturing wage in each single region.

$$(16a) w_1 = [Y_1 G_1^{\sigma-1} + Y_2 G_2^{\sigma-1} T^{1-\sigma}]^{1/\sigma}$$

$$(16b) w_2 = [Y_1 G_1^{\sigma-1} T^{1-\sigma} + Y_2 G_2^{\sigma-1}]^{1/\sigma}$$

This wage equation determines a critical level of nominal manufacturing wages at which firms in every location break even. These wage equations hence give actual levels of nominal wages in locations with a non-zero number of firms, but they also hold in locations without manufacturing.

Real wages in the mobile manufacturing sector are given by deflating the nominal wages with the aggregate regional price index.

$$(17a) \omega_1 = \frac{w_1}{G_1^\mu p_{H1}^\gamma p_{A1}^{1-\mu-\gamma}}$$

$$(17b) \omega_2 = \frac{w_2}{G_2^\mu p_{H2}^\gamma p_{A2}^{1-\mu-\gamma}}$$

Real wages are the important determinant for the locational decision of manufacturing workers, since we simply impose that manufacturing workers move to the region that offers higher real wages.

Numerical equilibrium determination

With these eight equations (14)-(17) the geographical structure of this economy is fully determined. The solution can be obtained by applying numerical techniques. Since a symmetric distribution of manufacturing workers ($\lambda = 1/2$) is surely an equilibrium, the only task is to analyse if this economy will indeed operate under a symmetric geographical structure or if there will emerge a c-p-structure with all mobile manufacturing production carried out in one region.

To proceed, the reference situation is one where all manufacturing is pooled in region 1 ($\lambda=1$). We then check under which parameter constellations this is sustainable. If there are sustainable c-p-structures the next step is to ask whether this economy can be driven to this equilibrium by the dynamics of the system itself. This is done by checking the stability around the symmetric steady state. If the symmetric equilibrium is stable, the system will not converge towards a c-p-equilibrium in response to changes in exogenous parameters. These parameters in particular will be the transportation costs T and the importance of the home

goods sector γ . If on the other hand for some parameter values symmetry breaking occurs, we can expect the c-p-emergence. It is then interesting to compare break and sustain points.

Due to the constant returns and the costless trade in agriculture it is ensured that agricultural workers always earn the same nominal wage everywhere, which can be set to unity and serve as a numeraire ($w^A_1=w^A_2=1$). With $\lambda=1$ the regional income Y_2 is

$$(18) Y_2 = \frac{1}{2} \gamma w^H_2 + \frac{1}{2} (1-\mu-\gamma)$$

Since the expenditure on home goods γY_2 must in equilibrium equal the income from home goods $\frac{1}{2} \gamma w^H_2$ we find that $w^H_2 = 2Y_2$ and

$$(19a) p_2^H = w_2^H = \frac{1-\mu-\gamma}{1-\gamma} < 1$$

Analogously we find that $w^H_1 = 2Y_1$, which implies

$$(19b) p_1^H = w_1^H = \frac{2\mu}{1-\gamma} w_1^M + \frac{1-\mu-\gamma}{1-\gamma}$$

Of course the prices and nominal wages in the home goods sector are higher in the centre since the supply is the same in both regions but the demand is higher in region 1.

The next step is to determine the manufacturing wages. To do so we first look at total national income

$$(20) Y_1+Y_2 = \mu w^M_1 + \frac{1}{2} \gamma (w^H_1 + w^H_2) + 1-\mu-\gamma = w_1^M \left(\frac{\mu}{1-\gamma} \right) + \frac{1-\mu-\gamma}{1-\gamma}$$

Since a fraction μ of total income is spend on manufacturing and this expenditure needs to equal total manufacturing income μw^M_1 we can easily derive that

$$(21) w^M_1 = 1$$

With (21) the prices and nominal wages of home goods in region 1, equation (19b), are

$$(22) p_1^H = w_1^H = \frac{1+\mu-\gamma}{1-\gamma} > 1$$

The manufacturing price indices are $G_1=1$ and $G_2=T$ respectively (from (15)). Since in the basic model there is no home goods sector, this manufacturing price index there also is the aggregate price index and thereby cost of living are higher in the periphery than in the centre. But now there is a second component to the regional aggregate price indices (beneath the agricultural prices which are always equal to unity in both regions): the prices for home goods. These are lower in the periphery, so that the total consumer price index can be higher

in the centre than in the periphery. We define ψ_i as the regional aggregate price index. These are $\psi_1 = G_1^\mu p_1^\gamma$ and $\psi_2 = G_2^\mu p_2^\gamma$, where we have now dropped the superscript H.

The nominal wage in manufacturing in region 2 can be derived from the wage equation (16b).

$$(23) \quad w_2 = \left[\frac{1 + \mu - \gamma}{2(1 - \gamma)} T^{1-\sigma} + \frac{1 - \mu - \gamma}{2(1 - \gamma)} T^{\sigma-1} \right]^{\frac{1}{\sigma}}$$

But the relevant terms to compare are the regional *real wages* $\omega_i = w_i / \psi_i$. They are given by

$$(24a) \quad \omega_1 = \left(\frac{1 - \gamma}{1 + \mu - \gamma} \right)^\gamma \quad \text{and} \quad (24b) \quad \omega_2 = \frac{w_2}{T^\mu \left(\frac{1 - \mu - \gamma}{1 - \gamma} \right)^\gamma}$$

Sustainability

Now we check if under this condition a c-p-structure can be sustainable. This is done by checking whether ω_2 / ω_1 is greater or less than unity.

$$(25) \quad \frac{\omega_2}{\omega_1} = \left(\frac{1 + \mu - \gamma}{1 - \mu - \gamma} \right)^\gamma T^{-\mu} \left[\frac{1 + \mu - \gamma}{2(1 - \gamma)} T^{1-\sigma} + \frac{1 - \mu - \gamma}{2(1 - \gamma)} T^{\sigma-1} \right]^{\frac{1}{\sigma}}$$

Figure 1 plots the real wage quotient (25) as a function of T and γ . The other parameters are set $\mu=0.4$ and $\rho=0.8$, so that the “no black hole”-condition³ holds.

On the vertical axis we have the real wage quotient between region 2 and 1. A c-p-structure is sustainable if $\omega_1 > \omega_2$, hence for all situations below the thick horizontal line. With no transport costs (T=1), the pooling is clearly not sustainable, since home goods are cheaper in region 2. As transport costs increase, this will be offset by the advantage of the core to exploit the increasing returns in production. But if transportation costs exceed some critical value, the equilibrium will again be symmetric since it is inefficient to serve national demand from only one location. Economic intuition suggests that a c-p-structure is less likely to be sustainable the more important the home goods sector is. The price index in the centre would increase relatively more with high importance of the home goods sector. These high costs of living can exceed the productivity advantage in the centre that brings about higher nominal wages. Hence, real wages for manufacturing workers are lowered to an extent that they would rather move to the cheap periphery. The equilibrium resulting would be a symmetric one. This is verified in the picture.

³ This condition imposes some limit on the strength of agglomerative forces, which theoretically could be infinitely large in which case the economy would always collapse into one point. The condition is $\rho > \mu$, i.e. the single varieties shall not be too differentiated.

With a rising value of γ , the familiar u-shaped curve is shifted upwards. For a value of $\gamma=0.15$ there are no c-p structures sustainable any more. If one increases μ (always provided that $\rho>\mu$), the curve rotates downwards clockwise and gets stretched. More c-p structures become sustainable.

The important difference in this model compared to the basic one is that the total consumer price index can be higher in the centre than in the periphery in sustainable c-p-structures.

The price index ratio is given by $\frac{\psi_2}{\psi_1} = T^\mu \left(\frac{1-\mu-\gamma}{1+\mu-\gamma} \right)^\gamma$. There are parameter constellations in which both ω_2/ω_1 and ψ_2/ψ_1 are less than unity. Figure 2 verifies this for the case of $\gamma=0.05$ (look at the area within the circle). An increase in μ enlarges the relevant area.

Stability

Sustainability only ensures that once a complete pooling is established it remains intact under given parameter values. This, however, does not cope with the process of agglomeration, that is whether an economic structure of centre and periphery can emerge endogenously out of the model starting from a symmetric situation.

To check symmetry breaking, we have to evaluate the effects of a small change in the fraction of manufacturers located in region 1 around the symmetric equilibrium (that is $d\lambda$ at $\lambda=1/2$) on the real wage differential in manufacturing. Since the expression is evaluated around the steady state, all changes in endogenous variables in one region are exactly mirrored by a change in the opposite direction in the other region. That is $d\omega_1 = -d\omega_2$, so for simplification one can write $d\omega$. Thus, the expression $d\omega/d\lambda$ has to be evaluated. If $d\omega$ is negative, the symmetric equilibrium is stable and symmetry will not break. This is because a move of one manufacturer into region 1 is not advantageous in terms of real wages. If $d\omega$ is positive, the symmetric equilibrium is unstable and the economy will converge towards a c-p-equilibrium.

For the derivation of $d\omega/d\lambda$ we know that

$$(26) \quad \omega = w G^{-\mu} p^{-\gamma}$$

Total differentiation yields

$$(27) \quad \frac{G^{-\mu} p^{-\gamma}}{w} d\omega = \frac{dw}{w} - \mu \frac{dG}{G} - \gamma \frac{dp}{p}.$$

We know that around symmetric equilibrium the following values of endogenous variables hold:

$$\lambda = 1/2, w^M = 1, w^H = p = 1, Y = 1/2, G^{1-\sigma} = \left[\frac{1+T^{1-\sigma}}{2} \right]. \text{ Hence, we can rewrite (27) to}$$

$$(28) \quad G^\mu d\omega = dw - \mu \frac{dG}{G} - \gamma dp$$

The next step is to express the endogenous variables on the right hand side of the equation in terms of $d\omega$ and $d\lambda$, which is done by totally differentiating (15), (16) and (17) and using the equation $dp=2dY$. Total differentiation of equation (15) yields

$$(29a) \quad \frac{dG}{G} = \frac{2Z}{1-\sigma} d\lambda + Zd\omega \quad \text{where } Z \equiv \frac{(1-T^{1-\sigma})}{(1+T^{1-\sigma})} = \frac{(1-T^{1-\sigma})}{2G^{1-\sigma}}$$

The term Z is defined for notational convenience as an index of trade barriers which takes the value of 0 when there are no transportation costs ($T=1$) and the value 1 if $T \rightarrow \infty$. Analogously we find that

$$(29b) \quad \sigma dw = 2Z dY + (\sigma - 1)Z \frac{dG}{G}$$

$$(29c) \quad dY = \frac{\mu}{2(1-\gamma)} dw + \frac{\mu}{(1-\gamma)} d\lambda$$

$$(29d) \quad dp = \frac{\mu}{1-\gamma} dw + \frac{2\mu}{1-\gamma} d\lambda$$

After several lengthy but straightforward substitutions of (29 a-d) into (28) we reach the following messy expression

$$(30) \quad \frac{d\omega}{d\lambda} = 2G^{-\mu} Z \left[\frac{(1-\mu Z - \frac{\mu}{1-\gamma})(\mu - Z(1-\gamma))}{\sigma(1-\gamma) - \mu Z - Z^2(\sigma-1)(1-\gamma)} - \frac{\mu}{Z} \left(\frac{Z}{1-\sigma} + \frac{\gamma}{1-\gamma} \right) \right]$$

This formula can not be interpreted in any meaningful sense. But it can be numerically been checked whether $d\omega/d\lambda$ is greater or less than zero for different parameter values of Z and γ .

The “black hole condition” $\rho > \mu$ is always assumed to hold.

To prove the mere possibility of symmetry breaking it is sufficient to show that there is one parameter constellation in which a c-p-structure is sustainable and symmetry breaking occurs. In fact, there are many of those. But we restrict our representation to cases with $\mu=0.4$, $\rho=0.8$ and $\gamma=0.05$, since figure 2 is constructed for these numbers. Moreover, we are only interested in such cases where the aggregate price index is lower in the periphery than in the centre since that was the starting point of our analysis. As can be seen in figure 2 this is true for values of

T around 1.1. Figure 3 hence presents a table of numerical values for equation (30), the real wage ratio and the price index ratio as a function of T with the specified values for γ , μ and ρ .

For $T=1.06$ a c-p-structure is not sustainable. For $T=1.12$ it is sustainable and symmetry breaking occurs, but the price index ratio is not as we want it to have. For $T=1.55$ symmetry breaking does not occur anymore, although sustainability still holds. For $T=1.7$ sustainability of c-p also vanishes. But the cases for $T=1.08$ and $T=1.1$ have all the properties that we like. Sustainability holds since $\omega_2/\omega_1 < 1$. Symmetry breaking occurs since the value of equ.(30) is positive. And the price index is higher in the centre than in the periphery ($\psi_2/\psi_1 < 1$).

These numbers replicate properties of the loci that we have seen above. The basic u-shape of the sustainability locus can be seen, because of starting from a situation of no sustainability the value of ω_2/ω_1 then goes below unity but returns to a value larger than one. The property of symmetry breaking follows the same pattern. Initially (for $T=1.06$) it does not occur, then it does roughly up to $T=1.55$. Hereafter symmetry breaking does not occur again. But apparently the break point lies before the sustain point, which is known as the *locking-in effect* of regional agglomeration. The price index ratio increases monotonously with T since the price ratio for home goods remains unchanged, but living at the periphery becomes more expensive the higher is T. One shortcoming in the table is that ψ_2/ψ_1 calculated always for a c-p-structure, even though it might not be sustainable (as in the case for $T=1.7$). But this does not matter for the two cases with $T=1.08$ and $T=1.10$.

These two cases (which stand out for an infinite number of other possibilities, especially if one changes μ and ρ) demonstrate, that the model with home goods is able to produce equilibria in which a c-p-structure is sustainable, the symmetric equilibrium is unstable and the aggregate price index is higher in the centre than in the periphery.

3. Conclusion

This paper suggested to undertake a small change in the seminal c-p-model of New Economic Geography presented in F/K/V (1999). To make the peculiarity vanish that in c-p-equilibria the price index in the periphery is higher than in the centre, we have introduced a perfectly competitive sector of non-tradeables. This small modification yields sustainable equilibria

with all mobile economic activity pooled in the centre that can emerge out of the endogenous dynamics of the model itself. Still, in equilibrium the aggregate price level in the centre can be higher than in the periphery. But the core's advantage in productivity and nominal wages outweighs the price level disadvantage and hence produces higher real wages for the mobile manufacturers.

The innovation of introducing a home goods sector makes the standard model of New Economic Geography fit the empirical facts better. We observe higher overall price levels in the centres of an economy rather than in the periphery. In this respect this model is closer to reality than the basic model of F/K/V. Moreover, the model justifies some concerns of policymakers that the core's advantageous position can get lost if the quantitative importance of non-tradeable home goods becomes too large.

References

Brakman, S.; H. Garretsen; R. Gigengack; C. v. Marrewijk; R. Waagenvoort (1996). "**Negative Feedbacks in the Economy and Industrial Location.**" *Journal of Regional Science*, Vol. 36, No. 4, pp. 631-652.

Dixit, A.; J. Stiglitz (1977). „**Monopolistic Competition and Optimum Product Diversity.**” *American Economic Review*, Vol. 67, pp. 297-308.

Fujita, M.; P. Krugman, A. Venables (1999). "***The Spatial Economy.***" MIT Press, Cambridge (Mass.)

Isard, W. (1956). "**Location and Space Economy.**" MIT Press, Cambridge (Mass.)

Junius, K. (1999). "**The Economic Geography of Production, Trade, and Development.**" *Kieler Studien*, Mohr Siebeck, Tübingen.

Krugman, P. (1991). "**Geography and Trade.**" MIT Press, Cambridge (Mass.)

Ludema, R.; I. Wooton (2000). "**Economic Geography and the Fiscal Effects of Regional Integration.**" *Journal of International Economics*, Vol. 52, No. 2, pp. 331-357.

Weber, A. (1909). "**Standort der Industrien.**" Mohr Siebeck, Tübingen.

Appendix

Figure 1

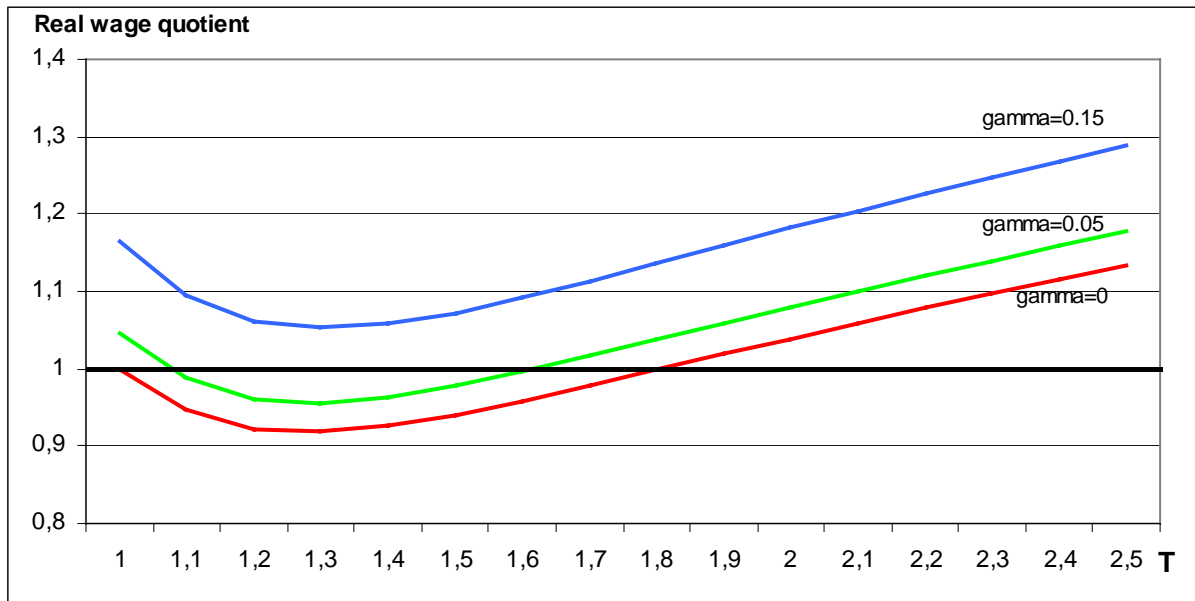


Figure 2

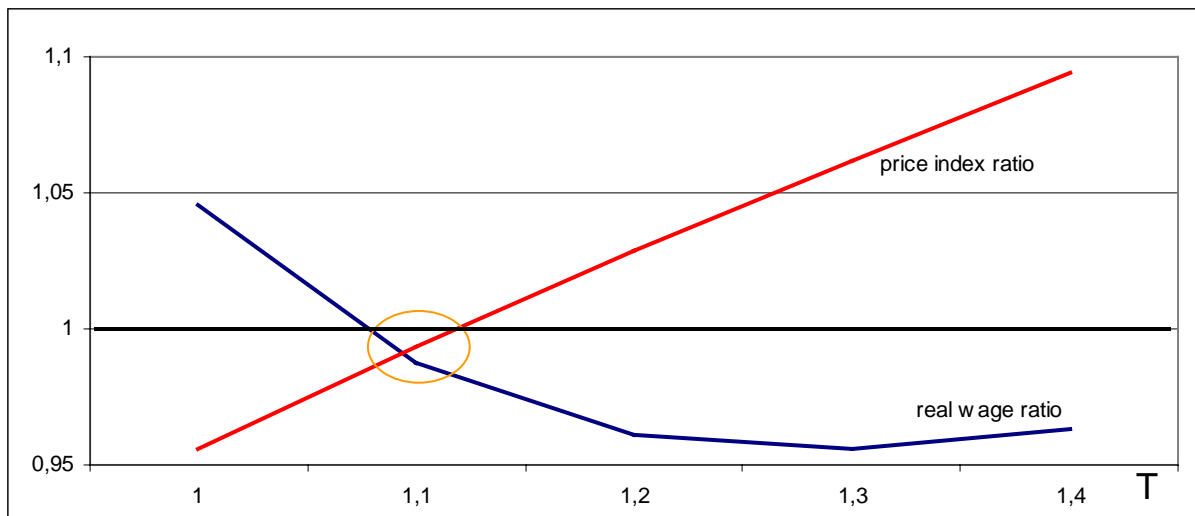


Figure 3 calculated for $\gamma=0.05$, $\mu=0.4$, $\rho=0.8$

T→	1.06	1.08	1.1	1.12	1.55	1.7
ω_2 / ω_1	1,006722738	0,996589008	0,987791942	0,980250538	0,986569268	1,016257316
ψ_2 / ψ_1	0,978641869	0,985986454	0,993249877	1,000434489	1,13928958	1,182172941
equ. (30)	-0,005366102	0,003917281	0,011931097	0,018781504	-0,003525597	-0,055204424