Agglomeration and Regional Costs-of-Living

Jens Suedekum *)
University of Konstanz

ABSTRACT
Standard models of the ´new economic geography´ predict that costs-of-living are lower in the core than in the periphery. But in reality they tend to be higher in agglomeration areas, mainly because of regional differences in housing costs. In this paper we add a home goods-sector to the seminal NEG-model of Krugman (1991). We show that a core-periphery structure can endogenously emerge in which the core is the more expensive area in equilibrium. This result has an important normative implication. Higher costs-of-living imply falling real wages if there is no nominal wage premium. Thus, it is not necessarily desirable for everybody to live in the core region.

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***) CORRESPONDENCE ADDRESS:** Jens Suedekum, University of Konstanz, Fach D 132, 78457 Konstanz, Germany. e-mail: jens.suedekum@uni-konstanz.de . Phone: +49/7531/88-3615. The author is grateful to Andreas Haufler, Bernd Hayo, Michael Pflueger, Peter Ruehmann, Ian Wooton, and two anonymous referees for helpful comments. Of course I am fully responsible for all remaining errors.

1. INTRODUCTION

In the core-periphery model of the "new economic geography" (NEG), Krugman (1991) has shown that a combination of increasing returns, transportation costs and factor mobility can lead to an asymmetric geographical equilibrium structure. In the present paper we deal with one empirically questionable implication of this seminal approach. The Krugman-model (as well as of most other NEG-models) predicts that the *overall costs-of-living* are higher in the peripheral and lower in the central region.[1] The reason is that the cost-of-living index (COLI) is identical to the composite price index for manufacturing goods, which is lower in the centre partly because competition is stiffer in the manufacturing sector, partly because producers are located nearby (thus saving on transportation costs).[2] Yet, this result is at odds with real world experiences. S*ome* products are certainly cheaper in agglomeration areas like New York, London or Tokyo. But *on aggregate* these regions tend to have higher costs-of-living than the remote rural periphery.

Essentially, most NEG-models make this prediction, because they abstract from housing scarcity and other forms of urban costs, which are the main reasons why agglomerations are more expensive (Tabuchi, 2001). Models that incorporate these factors deviate in other fundamental respects from the Krugman-approach and/or do not derive the implications for regional COLIs. Helpman (1998) replaces the standard agricultural sector with an immobile housing stock. His model naturally implies higher costs-of-living in the centre. But he finds that agglomeration is more likely to occur the *higher* are interregional transportation costs, which sharply contradicts the notion of Krugman (1991) that secularly *falling* transportation costs result (at least initially) in regional divergence. A different approach is to relax the assumption of costless transportation in the competitive sector (FKV, ch.7).[3] With this modification, however, the crucial property of "symmetry breaking" gets lost (FKV, p.103). That is, a c-p-equilibrium can no longer develop endogenously. More importantly, this approach neglects the role of housing scarcity as the main determinant of regional price differentials. Finally, a number of papers add city structures and urban costs to the NEG, which also results in a trade-off between agglomeration economies (i.e., lower manufacturing prices) and higher housing and commuting costs in the centre. Yet, these frameworks deviate in several other aspects from the Krugman-model, and none has explicitly analysed overall regional costs-of-living so far.[4]

The aim of this paper is to present a slightly generalized version of Krugman (1991) that preserves its main features, while making reasonable predictions with respect to regional COLIs.[5] Instead of replacing the agricultural sector with an immobile housing stock, we add home goods as a third sector. [6] We show that the endogenous emergence of a c-p-structure in spirit of the original model now prevails, but with the important difference that there is a subset of parameter constellations for which the core has higher costs-of-living. For this to emerge, not only transportation costs, but also the expenditure share for home goods must be on an intermediate level. Higher nominal wages and lower manufacturing prices in the centre dominate over higher home goods prices in this case. But even though housing costs do not over-compensate both centripetal forces, they are substantial enough to make the centre the more expensive area. This feature also has an important normative implication. The immobile workers in the centre, who do not earn a nominal wage premium, are confronted with falling real wages due to the higher central COLI. This suggests that some individuals can lose out from agglomeration.

2. REGIONAL COSTS-OF-LIVING: THE EVIDENCE

Before we turn to the model, we briefly present some empirical motivation in this section. Since comprehensive regional cost-of-living data is not available from a governmental source, neither for US states, nor for European regions, we are restricted to use comparative costs-of-living for US metropolitan areas compiled by the American Chamber of Commerce Researchers Association (ACCRA). This data set entails local costs-of-living for 399 metropolitan statistical areas (MSAs) relative to the US average in 2000. We will relate this with information from the Bureau of Economic Analysis that reflects the degree of economic agglomeration in the MSAs. Available data are the size of the local population (POPULATION) and the number of jobs (JOBS), the average nominal wage per job (WAGE) and the average personal income per capita relative to the US average (INCOME), all for 2000. In total, there are 208 observations. Due to possible endogeneity problems in a regression analysis, we suffice with reporting correlations.

Table 1 here

The numbers in the first line in table 1 indicate that there is a strong positive correlation between the COLI and each of the agglomeration indicators. All coefficients are significantly positive at the 1%-confidence level. The nominal earnings indicators (WAGE, INCOME) tend to be stronger correlated with the COLI-level than the size measures. This descriptive evidence clearly runs counter to the implications of Krugman (1991).

Two caveats must be raised, however. Firstly, the c-p-model does not really apply to urban areas. But also on a larger geographical scale the data suggest that the COLI e.g. in California is higher than in, say, Arkansas.[7] More importantly, the ACCRA data do not take into account that metropolitan areas are characterised by a greater variety and a higher quality of goods, e.g. of cultural events (Koo/Phillips/Sigalla, 2000). The high COLI in New York is thus overstated, because local amenities are materialized in market prices (Rosen, 1974). Nevertheless, existing studies that correct for this effect agree that agglomeration areas tend to have higher costs-of-living (Kakwani/Hill, 2002; Slesnik, 2002; Walden, 1998). Tabuchi (2001), who obtains the same result for Japan, shows that the higher metropolitan COLIs are mainly caused by higher housing cost and land values. A supportive casual observation is that housing prices in New York City are 325% above the US average, even though the aggregate COLI is only 99% above the mean.

3. DEMAND AND SUPPLY

The economy under consideration is a generalized version of FKV, ch.4+5. It is composed of two regions, a "domestic" and a "foreign" one. The notation is for the domestic region, but everything is analogous for the foreign region, whose variables will be distinguished by an asterisk (*). The representative consumer maximizes

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

where H are units of a non-tradable home good, A is the standard agricultural good, and M is a symmetrical CES aggregator over n domestic and n* imported consumption varieties, denoted by m(i) and m(j)* respectively, with a constant elasticity of substitution given by σ = 1/(1-ρ).

(2) $$M = \left[n\left(m(i)\right)^{\rho} + n^{*}\left(m(j)^{*}\right)^{\rho} \right]^{\frac{1}{\rho}} \qquad 0 < \rho < 1$$

The budget constraint is

(3) $$p^{A} A + p^{H} H + \left(n \cdot p \cdot m(i) + n^{*} \cdot T \cdot p^{*} \cdot m(j)^{*} \right) = Y$$

where Y is total regional income, p^A and p^H are the prices of the agricultural good and the home good, respectively, and T > 1 is the ´iceberg´-transportation cost. We stick to the assumption of costless transport in the A-sector, thus p^A is the numeraire and equal to one. The mill prices for the manufacturing varieties are the same within a region, i.e. p(i) = p and p(j)* = p* for all i, j. Maximizing (1) subject to (2) and (3) yields the following set of demand curves

(4) $$A = (1-\mu-\gamma)Y \qquad H = \gamma Y / p^{H} \qquad M = \mu Y / G$$

$$m(i) = \mu Y \frac{p^{-\sigma}}{G^{-(\sigma-1)}} \qquad m(j)^{*} = \mu Y \frac{(T\, p^{*})^{-\sigma}}{G^{-(\sigma-1)}}$$

where G is the composite regional price index for manufactured goods

(5) $$G = \left[n(p)^{1-\sigma} + n^{*}(T\, p^{*})^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

Production

Input factors are assumed to be sector-specific, but there are now three types of workers in this economy: Manufacturers L^M, farmers L^A, and home goods producers L^H. The two latter groups are immobile and equally distributed across regions. We normalize factor endowments such that $L^H=L^{H*}=\gamma/2$ and $L^A=L^{A*}=(1-\mu-\gamma)/2$. The sectors A and H are operating under perfect competition and constant returns to scale such that one unit of labor is transformed into one unit of output. Hence, $p^H = w^H$, $p^{H*}=w^{H*}$ and $w^A = w^{A*}= 1$. Production in the manufacturing sector is set up as in the standard model. To produce q units a firm has a labor requirement of

(6) $$\ell = F + \beta q$$

manufacturing workers, where F is a fixed and β a variable cost. Maximizing profits $\pi = p \cdot q - w(F + \beta \cdot q)$, where w denotes the nominal wage in the M-sector, yields the familiar result that prices are a constant mark-up over marginal costs, $p(1-1/\sigma) = \beta w$. But profits will be equal to zero in equilibrium due to free entry. All firms thus operate at a unique output scale. Using the standard normalizations $L^M=\mu$, $\beta=(\sigma-1)/\sigma$, and $F=\mu/\sigma$ we can derive that output and labor demand per firm are identically given by $q=\ell=\mu$. The number of active firms is then equal to the share $0<\lambda<1$ of manufacturing labor in the respective region, so that $n=\lambda$ and $n^*=(1-\lambda)$.

4. EQUILIBRIUM CONDITIONS

The regional supplies of home goods are fixed at $H = H^* = \gamma/2$. In equilibrium home goods prices must adjust such that supply equals demand, $H=\gamma Y / p^H$. The market clearing conditions are

(7) $$p^H = w^H = 2Y \qquad p^H{}^* = w^H{}^* = 2Y^* \; .$$

The regional income levels, inclusive income generated by housing expenditure, are given by

(8) $$Y = \lambda\mu w + \frac{\gamma}{2} w^H + \frac{1-\mu-\gamma}{2} \qquad Y^* = (1-\lambda)\mu w^* + \frac{\gamma}{2} w^{H^*} + \frac{1-\mu-\gamma}{2} ,$$

The equilibrium condition for the manufacturing sector is that the markets for all consumption varieties must simultaneously clear. Since all M-firms supply q=μ, this needs to equal total sales per firm to both regions. Using (4) and manipulating terms yields the well known manufacturing wage equations that depict the equilibrium nominal wage that can be paid in either region

(9) $$p = w = [Y\,G^{\sigma\text{-}1} + Y^*(G^*)^{\sigma\text{-}1}\,T^{1\text{-}\sigma}]^{\,1/\sigma} \qquad p^* = w^* = [Y^*(G^*)^{\sigma\text{-}1} + Y\,(G)^{\sigma\text{-}1}\,T^{1\text{-}\sigma}]^{\,1/\sigma}$$

Finally, the manufacturing price indices (5) can be rewritten as

(10) $$G = [\lambda(w)^{1\text{-}\sigma} \;+\; (1\text{-}\lambda)\;(Tw^*)^{1\text{-}\sigma}]^{\frac{1}{1\text{-}\sigma}} \qquad G = [\lambda(Tw)^{1\text{-}\sigma} \;+\; (1\text{-}\lambda)\;(w^*)^{1\text{-}\sigma}]^{\frac{1}{1\text{-}\sigma}}$$

Ultimately we are interested in *real wages*. Contrary to the standard model the regional deflator is no longer given only by the manufacturing price index, since now also home goods prices must be included. Let ψ and ψ* denote the regional COLIs. Real wages are then

(11) $$\omega = \frac{w}{\psi} = \frac{w}{(G)^{\mu}(p^H)^{\gamma}} \qquad \omega^* = \frac{w^*}{\psi^*} = \frac{w^*}{(G^*)^{\mu}(p^H{}^*)^{\gamma}}$$

Instantaneous equilibrium is determined by equations (7)-(11). The adjustment dynamics have a simple ad hoc-form: the mobile manufacturing workers simply migrate to the region that offers the higher real wage, i.e. $\dot{\lambda} = a\cdot(\omega - \omega^*)\cdot\lambda\cdot(1-\lambda)$. It turns out that only two geographical structures can prevail in the long run. The economy is either characterised by complete agglomeration of all manufacturing labor in one region (λ=1), or the two regions are completely symmetrical (λ=½).[8] The equilibrium outcome depends on the set of exogenous parameters (μ, γ, σ) and most notably on the level of transportation costs T. The way we proceed is analogous to FKV.

First we take a situation as initially given where all manufacturing labor is pooled in the home region and check if this is sustainable. Using (7) and (8) with λ=1, we have

(12) $$Y = \mu \mathrm{w} + \frac{\gamma}{2}\mathrm{w}^{\mathrm{H}} + \frac{1\text{-}\mu\text{-}\gamma}{2} \qquad Y^* = \frac{\gamma}{2}\mathrm{w}^{\mathrm{H}}{}^* + \frac{1\text{-}\mu\text{-}\gamma}{2}$$

(13) $$p^H = w^H = \frac{2\mu}{1-\gamma} w + \frac{1-\mu-\gamma}{1-\gamma} \qquad p^H{*} = w^H{*} = \frac{1-\mu-\gamma}{1-\gamma} < 1.$$

Since a fraction μ of total national income (Y+Y*) – given by (12) – is spent on manufacturing, and this needs to equal manufacturing earnings μw, we can derive that w=1. This makes it easy to compute the manufacturing price indices. Using (10) they are simply given by G=1 and G*=T>1. Thus, the *manufacturing price index* is indeed lower in the core than in the periphery, unlike the prices for home goods, equation (13). The *aggregate costs-of-living* are $\psi = \left((1+\mu-\gamma)/(1-\gamma)\right)^\gamma$ and $\psi{*} = \left((1-\mu-\gamma)/(1-\gamma)\right)^\gamma$, so that the relative COLI of the periphery is

(14) $$\frac{\psi{*}}{\psi} = T^\mu \left(\frac{1-\mu-\gamma}{1+\mu-\gamma}\right)^\gamma$$

If a single manufacturing worker were to migrate from the home to the foreign region in this initial c-p-equilibrium, she could earn a nominal wage w* that by (9) is equal to

(15) $$w{*} = \left[\frac{1+\mu-\gamma}{2(1-\gamma)} T^{1-\sigma} + \frac{1-\mu-\gamma}{2(1-\gamma)} T^{\sigma-1}\right]^{1/\sigma}.$$

Using (14), (15) and w=1, the relative real wage in the initial situation with λ=1 is thus

(16) $$\frac{\omega{*}}{\omega} = \left(\frac{1+\mu-\gamma}{1-\mu-\gamma}\right)^\gamma T^{-\mu} \left[\frac{1+\mu-\gamma}{2(1-\gamma)} T^{1-\sigma} + \frac{1-\mu-\gamma}{2(1-\gamma)} T^{\sigma-1}\right]^{\frac{1}{\sigma}}$$

Equation (16) is the sustainability condition for a c-p-equilibrium. The asymmetric geographical structure is stable if no manufacturing worker is better off when migrating from the core to the periphery, i.e. if ω*/ω < 1. However, condition (16) does not ensure that a c-p-structure emerges endogenously when starting from a symmetrical initial situation with λ=½.

To warrant this property of "symmetry breaking" the symmetrical configuration λ=½ (which is always an equilibrium with all endogenous variables identical in both regions) must be unstable. If this is so, a small disturbance triggers a cumulative process at the end of which the whole manufacturing labor force is concentrated in one location, the home region. Formally, the condition for instability can be obtained by computing all endogenous variables (7) - (10) for λ=½, substitute those into the real wage equation (11) and then differentiate with respect to λ.[9] This complicated derivation is deferred to the appendix and yields

$$\text{(17)} \qquad \frac{d\omega}{d\lambda}\left(\lambda=\tfrac{1}{2}\right) = 2G^{-\mu}Z\left[\frac{(1-\mu Z-\frac{\gamma\mu}{1-\gamma})(\mu-Z(1-\gamma))}{\sigma(1-\gamma)-\mu Z-Z^{2}(\sigma-1)(1-\gamma)} - \frac{\mu}{Z}\left(\frac{Z}{1-\sigma}+\frac{\gamma}{1-\gamma}\right)\right]$$

The symmetrical equilibrium is unstable for given parameters if (17) is positive.

5. THE GEOGRAPHICAL EQUILIBRIUM STRUCTURE

We can now derive the geographical equilibrium structure. For a c-p-equilibrium to emerge and persist, two conditions must be met. Expression (16) must be smaller than one (so that the c-p-configuration is stable), and expression (17) must be positive (so that the symmetrical equilibrium is unstable). If, in addition, equation (14) turns out to be less than one, then it is shown that an asymmetric equilibrium can develop in which the core area is more expensive on balance. At first we will derive the spatial equilibrium structure, and then analyse the regional COLIs in a second step. Figure 1 plots the sustainability condition (16) as a function of T for different values of γ and for given exogenous parameters μ and σ.

Figures 1 and 2 about here

As can be seen, the function ω*/ω has a U-shape with respect to T and a c-p-equilibrium is stable if the curve runs below the thick horizontal line. For the case with γ=0 (the Krugman-model) sustainability is warranted for low and intermediate values of T. In cases with a home goods sector (γ>0), the curve shifts up and the c-p-structure is sustainable only for intermediate levels of T. If the home goods sector becomes too important (if γ is too large) a c-p-structure can never be sustainable. Turning to the issue of endogenous emergence, figure 2 graphs the stability condition (17) as a function of T for the same set of parameters γ, ρ and μ. This function has a reversed U-shape with respect to T and shifts down as γ increases. Symmetry breaking occurs if the curve runs above the thick horizontal line, which (again) is the case for low and intermediate values of T if γ=0, for no value of T if γ is too large, and for intermediate values of T if γ is on an intermediate level. Taken together, the numerical simulations imply a shape of the bifurcation diagram as in figure 3, where we have chosen γ on an intermediate level.

Figure 3 here

Our model predicts the emergence of a c-p-equilibrium in the range $T_1<T<T_2$. The tomahawk bifurcation at the transition from high to intermediate trade costs (between T_2 and T_3) as well as the stable symmetrical equilibrium for trade costs higher than T_3 occur for the same reasons as in Krugman (1991) and shall not be repeated here. But, in our model there is a critical level T_1 below which the c-p-structure can not be sustained and symmetry re-emerges.[10] This is a feature also of other NEG models, e.g. Krugman/Venables (1995), Venables (1996), Tabuchi (1998) or Puga (1999), and is in general seen as being more realistic than the set-up of Krugman (1991), where re-dispersion is missing (Tabuchi/Thisse, 2003). Apart from that, however, our model exhibits all the compelling features of the Krugman-mode. In particular, it does not result in a complete reversal of the bifurcation diagram as in Helpman (1998). The intuition for the re-dispersion is straightforward. Nominal wages in the M-sector do not differ markedly between core and periphery if T is low, nor do manufacturing price indices. But home goods are cheaper in the periphery, making it worthwhile to leave the centre. Hence, a c-p-equilibrium can not be stable. On an intermediate level of T, however, c-p-equilibria can emerge endogenously even if γ is strictly positive. The centre can exploit the increasing returns in production and pay higher nominal

wages. Moreover, the manufacturing price index G is lower than G*. In opposite to these forward and backward linkages there are the higher home goods prices in the core.[11]

We can now turn to the central question of this paper. Is it possible that a c-p-equilibrium emerges endogenously in which the peripheral region has lower costs-of-living? From (14) it is straightforward to see that the relative COLI of the periphery is monotonously increasing in T, which is clear since the periphery needs to pay ever higher cif-prices for its manufacturing imports the higher transportation costs. It is lower than the COLI in the centre ($\psi^* < \psi$) if transportation costs are below a critical level T^{COLI}, given by

(18) $$T^{COLI} = \left(\frac{1+\mu-\gamma}{1-\mu-\gamma}\right)^{\frac{\gamma}{\mu}}$$

The range of T for which living expenses are lower in the periphery is larger the more important is the home goods sector, i.e. T^{COLI} is increasing in γ. In figure 4 we now show that symmetry breaking can occur and lead to a sustainable c-p-equilibrium at a trade cost level $T < T^{COLI}$.

Figure 4 here

The (U-shaped) thin solid line and the (reversed U-shaped) thick solid line depict the sustainability condition and the symmetry breaking condition, respectively. A c-p-equilibrium emerges endogenously in the trade cost range between T_1 and T_2. It is sustainable between T_1 and T_3. The thick dashed line depicts the relative COLI, ψ^*/ψ. The periphery is cheaper (more expensive) than the centre for all values of T below (above) T^{COLI}, which lies at the crossing point with the thick horizontal line. Therefore, in the trade cost range T_1-T^{COLI}, we have that $\omega^*/\omega<1$, $\psi^*/\psi<1$ and $d\omega/d\lambda(\lambda=½)>0$. This gives rise to our central result.

Proposition: *In the setting of the original Krugman-model augmented with a home goods sector, it is possible that an asymmetric c-p-equilibrium emerges endogenously and persists where the core region has higher overall costs-of-living than the periphery.*

In the trade cost range $T^{COLI}<T<T_2$ the centre has a lower COLI, i.e. in this range the original Krugman-result ($\psi^*>\psi$) holds. Let us briefly discuss the effect of various parameter changes. As we have shown in figure 2, symmetry breaking is more likely the lower is γ. On the other hand, $\psi^*<\psi$ requires that T is low enough to fall short of T^{COLI}, which is more likely the higher is γ. Hence, γ must be large enough since otherwise the periphery can never be the cheaper area.[12] But it must also not be too large, since otherwise symmetry breaking does not occur. Such a trade-off does not exist for the parameters μ and ρ. As shown by FKV (p.71), symmetry breaking occurs over a larger range of T the higher is μ and the lower is ρ. But T^{COLI} is independent of ρ and is increasing in μ.[13] Therefore a c-p-equilibrium with higher central COLI is more likely to emerge the larger is μ and the smaller is ρ.[14]

6. LOSING FROM AGGLOMERATION?

The Krugman-model implies a real wage premium for *all* individuals in the central region that consists of higher nominal wages for industrial workers *and* of lower costs-of-living. That is, the model implies that it is unambiguously desirable for everybody to live in the core region. In his influential review, Neary (2001, p.556) calls this implication “too stark to be true”.

In our generalized version the overall costs-of-living can now be higher in the centre. This nominal property has important implications in real terms. The higher COLI is harmful for the immobile agricultural workers who do not earn a nominal wage premium. Peripheral “farmers” are better off in a c-p-equilibrium, since $w^A = 1$ in both regions, but they enjoy lower costs-of-living. One can think of the “farmers” in more general terms as immobile low-skilled workers. As shown by Giannetti (2003), nominal wages differ little across locations within the same industry in particular for the less skilled. These workers can thus lose from economic agglomeration, because rents and home goods prices are driven up, but nominal wage do not increase. The welfare implications for the home goods producers are quite different. The landlords in the centre benefit from agglomeration since their nominal wage is equal to the price for home goods. Additionally they enjoy the lower manufacturing prices. Their real wages are

$$\omega^{H} = \left(\frac{1+\mu-\gamma}{1-\gamma} \right)^{1-\gamma} \quad > \quad \omega^{H}* = T^{-\mu} \left(\frac{1-\mu-\gamma}{1-\gamma} \right)^{1-\gamma}$$

The third group of individuals, the manufacturing workers, also earns a real wage premium, but it is smaller than in the original Krugman-model. If the core is the more expensive area on balance, the nominal wage premium is sufficiently high to over-compensate the higher home goods prices. But the real wage premium no longer consists of higher nominal wages *and* lower costs-of-living.

7. CONCLUSION

In this paper we have presented a generalized version of the seminal NEG-model by Krugman (1991) with a third sector, home goods. Unlike other NEG-models that also introduce some form of agglomeration cost (e.g. Helpman, 1998), our approach maintains the crucial features of Krugman (1991), while explicitly analysing and making realistic predictions with respect to the spatial dimension of overall costs-of-living. We show that a c-p-structure can endogenously emerge and persist in which the core region is on aggregate more expensive than the periphery. This case is the empirically relevant one, as local agglomeration and local costs-of-living are positively correlated in reality. This result also leads to an important normative implication that differs from the standard literature. It is not unambiguously desirable, always and for everybody, to live in the core region of an economy. If costs-of-living rise during the process of regional agglomeration, immobile workers in the centre, who do not earn a nominal wage premium, experience falling real wages and are consequently worse off.

ENDNOTES

[1] This implications also follows in most other NEG-models, e.g. in Krugman/Venables (1995), Venables (1996), Puga (1999), Forslid (1999), Ludema/Wooton (2000), Ottaviano/Tabuchi/Thisse (2002), Forslid/Wooton (2003) or Pflueger (2004). The different developments within the "new economic geography" are most comprehensively presented in the monographs of Fujita/Krugman/Venables (1999), hereafter labelled simply as FKV, and in the recent book of Baldwin et al. (2003) that specifically focuses on analytically solvable models. Surveys and independent reassessments of the NEG are also available, e.g. from Ottaviano/Puga (1998) or Neary (2001).
[2] This is a so-called "forward linkage" that strengthens the stability of a core-periphery equilibrium.
[3] FKV do not show this, but it is straightforward to see that if the degree of increasing returns in manufacturing is strong, and if agricultural transportation costs are sufficiently (but not infinitely) higher than transportation costs in the industrial sector, agglomeration can persist despite the higher overall costs-of-living in the core region.
[4] The earliest contribution in this respect comes from Tabuchi (1998), who combines the original setting of Krugman (1991) with the monocentric city structure of Alonso (1964). This analysis is closely related to ours, as it is also a direct extension of the c-p-model that in principal should be capable of generating similar results. However, Tabuchi (1998) does not look at regional COLIs. More recently, Tabuchi/Thisse (2003), Tabuchi/Thisse/Zeng (2003) and Cavailhès/Gaigné/Thisse (2004) have extended this line of research. They have added more elaborate city structures and moved beyond the usual NEG-setting with two regions and two industries. Moreover, these papers use different demand and supply functions than Krugman (1991) in order to warrant analytical solvability. However, even though these papers could also be used to analyse the implications of agglomeration for regional COLIs, none of them has actually looked at this issue.
[5] By working with the original set-up of Krugman (1991) we must accept the artificialities of the underlying IO model of Dixit/Stiglitz (1977) and the ´iceberg´ transportation costs. Ottaviano/Tabuchi/Thisse (2002), who have critically addressed these issues, show that these assumptions are not crucial to obtain Krugman-style results. Moreover, we have to rely on numerical solution techniques. However, the choice not to use more recent set-ups that allow for analytical solutions (e.g. Baldwin et al., 2003; Pflueger, 2004) was made in order to demonstrate that a generalization of the *original* NEG-framework is capable of accounting for the stylised fact of a higher central COLI.
[6] The term ´home good ´ is by and large synonymous to, but slightly more general than housing. The purpose of its use is only to point out the two basic properties that the new good in our model must have: it must be non-tradable, and it must be non-reproducible.
[7] The prices of the most expensive MSAs like San Francisco, San Jose etc. are entailed within the aggregate Californian COLI, which could be below the national average only if the more rural parts of this state were particularly cheap. This is not the case.
[8] Of course it is also possible that λ=0, and all mobile workers pool in the foreign region. But this completely analogous case will not be considered.
[9] We make use of the fact that small changes of endogenous variables in one region are exactly mirrored by changes in the opposite direction in the other region, i.e. $d\omega/d\lambda = -(d\omega^*/d\lambda)$
[10] The simulations reveal that (for given parameters) the critical level of T above which symmetry breaking ceases, the "break point" T_2, is strictly lower than the "sustain point" T_3, i.e. the level of T above which sustainability vanishes. This gives rise to the multiple equilibria extensively discussed at other places in the context of the Krugman-model. On the other hand, the critical lower value T_1 below which symmetry breaking no longer occurs is identical with the trade cost level below which the sustainability condition no longer holds, i.e. there is no local hysteresis in the re-dispersion process.
[11] The two other relevant parameters are μ and ρ. Ceteris paribus, the emergence of a c-p-equilibrium is more likely the more important are the increasing returns in manufacturing (the lower is ρ), and the more important is the manufacturing sector (the higher is μ). The intuition for this result is discussed in FKV, p.71.
[12] Note that T^{COLI} is equal to one with γ=0 and, thus, the periphery can never have lower COLI in the original Krugman-model.
[13] This can be seen directly from (18). For a given level of γ nominal manufacturing wages and home goods demand in the core rise rapidly if the manufacturing share μ is increased. Home goods prices are driven up, and the periphery is the cheaper area for a larger parameter range of T.
[14] Of course it is always understood that the "no-black-hole"-condition $\rho>\mu$ (see FKV, p.59) holds.

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APPENDIX: Derivation of (17)

For the derivation of dω/dλ we know that around symmetric equilibrium the following values of endogenous variables hold in both regions: λ= ½ , w=1, w^H=p^H=1, Y=½ , $G^{1-\sigma} = \left[\frac{1+T^{1-\sigma}}{2}\right]$. We further know that the real wage can be written as

(A1) $$\omega = wG^{-\mu} \; p_H^{-\gamma}$$

Total differentiation yields

(A2) $$\frac{G^{\mu} p_H^{\gamma}}{w} d\omega = \frac{dw}{w} - \mu \frac{dG}{G} - \gamma \frac{dp_H}{p_H} .$$

Hence, we can write

(A3) $$G^{\mu} d\omega = dw - \mu \frac{dG}{G} - \gamma \, dp_H$$

Now we express the endogenous variables on the right hand side of (A3) in terms of dω and dλ, which is done by totally differentiating equations (7) -(10). This yields

(A4) $$dp^H = 2\, dY$$

(A5) $$dw = \frac{2Z}{\sigma} dY + \frac{(\sigma-1)Z}{\sigma} \frac{dG}{G}$$

(A6) $$dY = \frac{\mu}{2(1-\gamma)} dw + \frac{\mu}{(1-\gamma)} d\lambda$$

(A7) $$\frac{dG}{G} = \frac{2Z}{1-\sigma} d\lambda + Zdw$$

where the term $Z \equiv \frac{\left(1-T^{1-\sigma}\right)}{(1+T^{1-\sigma})} = \frac{\left(1-T^{1-\sigma}\right)}{2G^{1-\sigma}}$ 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→ ∞. After several lengthy but straightforward substitutions of (A4)-(A7) into (A3) we reach the messy equation (17).

TABLE 1: Correlation matrix (N=208)

	COLI	POPULATION	JOBS	WAGE	INCOME
COLI	**1**	**0.53** **	**0.52** **	**0.66** **	**0.57** **
POPULATION		1	0.99 **	0.61 **	0.46 **
JOBS			1	0.65 **	0.52 **
WAGE				1	0.89 **
INCOME					1

** = significant at the 1 % level.
Note: For information about the definitions of MSAs and a full list of all areas used in this classification scheme consult http://www.bea.gov/bea/regional/docs/msalist.htm. For detailed information about the regional accounts data see http://www.bea.gov/bea/regional/reis/. More information about the COLI-data can be found under www.datamasters.com. The full list of all 208 metropolitan areas for which both COLI- and BEA-data exist is available upon request from the author.

FIGURE 1: Sustainability condition ω^*/ω

ρ=0.7 ; μ=0.5

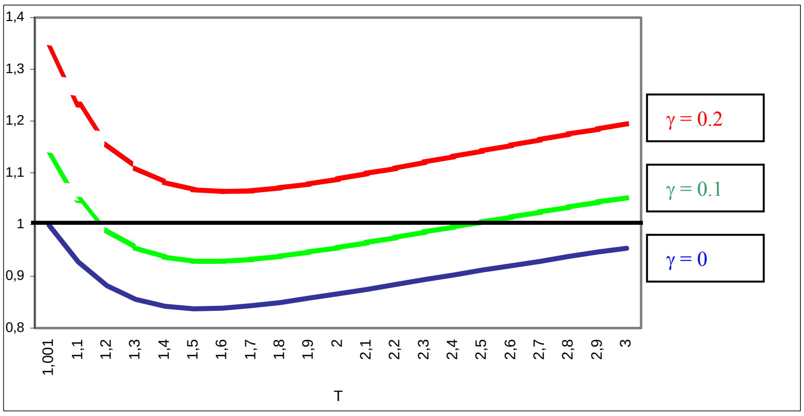

FIGURE 2: Stability of the symmetric equilibrium
$\rho = 0.7$; $\mu = 0.5$

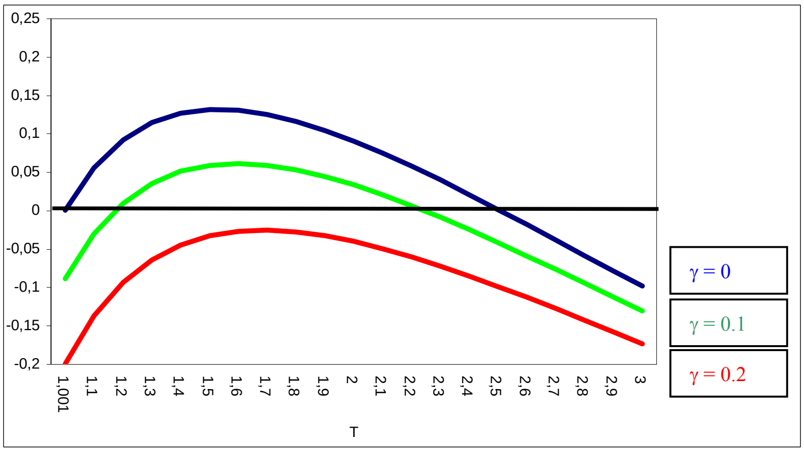

FIGURE 3: Bifurcation diagram (γ>0)

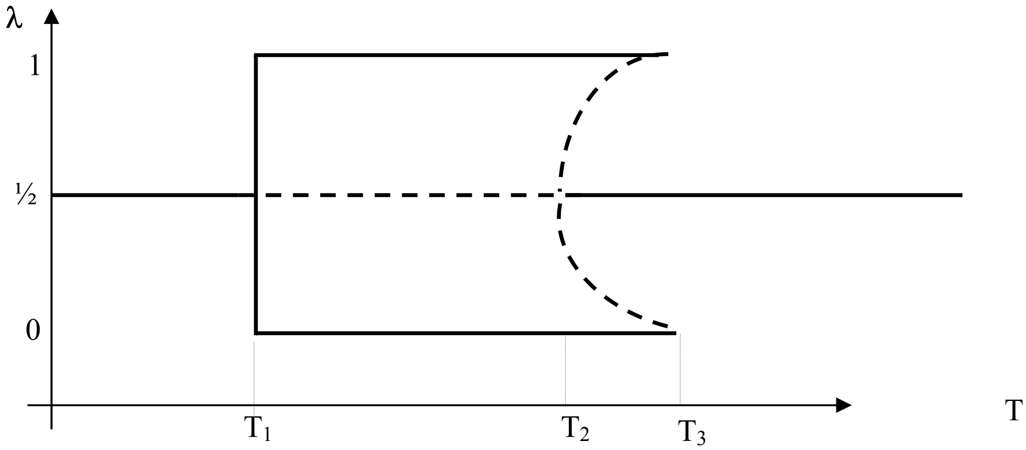

FIGURE 4: A core-periphery-equilibrium with higher COLI in the centre

ρ = 0.7; μ = 0.5; ρ=0.1