EUROPEAN REGIONAL POLICY: AN ASSESSMENT IN THE CONTEXT OF A GROWTH MODEL

Ingrid Ott
Kiel Institute for the World Economy (IfW)
Düsternbrooker Weg 120
24105 Kiel, Germany
ingrid.ott@ifw-kiel.de

and Hamburg Institute of International Economics (HWWI)
Heimhuder Str. 71
20148 Hamburg, Germany
ott@hwwi.org

Susanne Soretz
University of Greifswald
Institute of Economics
Friedrich-Loeffler-Str. 70
17489 Greifswald, Germany
soretz@uni-greifswald.de

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ABSTRACT

This paper analyzes, within a regional growth model, the impact of productive governmental policy and integration on the spatial distribution of economic activity. Integration is understood as enhancing territorial cooperation between the regions, and it describes the extent to which one region may benefit from the other region's public input, e.g. the extent to which regional road networks are connected. Both integration and the characteristics of the public input crucially affect whether agglomeration arises and if so to which extent economic activity is concentrated: As a consequence of enhanced integration, agglomeration is less likely to arise and concentration will be lower. Relative congestion reinforces agglomeration, thereby increasing equilibrium concentration. Due to the congestion externalities, the market outcome ends up in suboptimally high concentration.

INTRODUCTION

Supporting convergence and intensifying European territorial cooperation are among the key objectives of European regional policy for the period of 2007-2013. One of the instruments to reach these goals is the further improvement of the transport infrastructure which is funded from structural and cohesion funds. Considering whether such an instrument is apt to reach the goal of convergence is part of both theoretical and empirical analysis. Aschauer (1989) provided a seminal work in which he derives a strong positive relationship between infrastructure and growth. This could basically speed up convergence. However, more recent contributions in the macroeconomic literature find more modest returns to infrastructure investment (see e. g. Gramlich (1994) for an overview). Within endogenous growth theory, those models strongly influenced by Barro (1990) analyze fiscal policies if a productive governmental input serves as a growth determinant. These models have been continuously refined to allow for different characteristics, especially congestion, of the public input (see e. g. Glomm and Ravikumar (1994a, 1994b) or Turnovsky (2000) for an overview): However, all these considerations focus on the view of a single country and, if they analyze convergence at all, they view it as the process leading to an equilibrium growth path. Consequently it is not possible to explain the distribution of economic activity across space as a mere consequence of interacting regions.

This concern lies at the heart of models known as 'new economic geography' (see Krugman (1995)). These models single out imperfect competition, increasing returns and transportation costs as fundamental resources shaping the economic landscape, but few focus on governmental activity. An exception is the work of Martin and Rogers (1995): They focus on the role of infrastructure as facilitating transactions, i. e. the trade within and between countries. Consequently agglomeration is reinforced as result of governmental activity. Puga (2002) analyzes the impact of regional policy expenditures on mitigating regional disparities and highlights that a undifferentiated consideration of infrastructure neglects that different characteristics of infrastructure also operate differently. Consequently, a thorough analysis of the impact of regional productive governmental policy also requires a sophisticated modelling of the public input.

However, though all these new economic geography

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models include regional governmental policies, they exclusively consider infrastructure in reference to reduced transportation costs; by contrast, the Barro type models assume a productive governmental input but neglect regional interaction. The European Union primarily regards infrastructure as production input that enhances the productivity of the other local inputs. Consequently, viewing infrastructure as reducing transportation costs is too narrow if one wishes to analyze whether the newly intended European regional policy will be successful in reducing regional disparities.

These shortcomings of the existing literature are the starting point for this model: We analyze the impact of regional policy on agglomeration. In doing so, regional policy thereby includes the provision of infrastructure that basically may be interpreted in a broad sense as comprising any facility, good or institution provided by the government that enhances the productivity of the other private inputs. This allows for a consideration of physical infrastructure such as roads, airports, telecommunication networks, but also basic research and training networks of education infrastructure. These different types formally may be represented by integrating a congestion function adopted from Eicher and Turnovsky (2000) which includes relative and absolute congestion as well as capital spillovers. We use this modelling of the governmental input and implement it in a modified version of the regional growth model of Bröcker (2003), who for his part focuses on learning-by-doing and interregional knowledge diffusion.

Integration between the two regions is modelled as the extent to which one region may benefit from the other region's public input. With this formulation we rely on Alesina and Spolaore (2003, chapter 6) and are broader than the usual approach of the new economic geography which assumes that integration predominantly reduces transport costs and thereby strengthens agglomeration. Our setting is in line with the goal of the European regional policy mentioned before, namely of enhancing European territorial cooperation. Integration may be also achieved, for example, by increasing the flow of ideas between regions as already argued by Rivera-Batiz and Romer (1991) and others. We assume identical production technologies with constant returns to the private inputs for the two regions. Labor is immobile while capital accumulation is taking place in the region with the higher productivity. The resulting equilibrium is based on equalized productivities of capital, and it determines the equilibrium capital distribution. Depending upon the interaction between agglomeration and dispersion forces, multiple equilibria with different stability characteristics may arise. It is shown that the bifurcation point is a function of congestion, capital spillovers and integration. The endowment with immobile labor acts as threshold value that determines which equilibrium capital distribution finally results. Agglomerations reflect equilibrium capital distributions with different regional capital stocks. In analogy to Krugman (1991), the region displaying the bigger capital stock may then be interpreted as being the core, while the other region is the periphery.

In the light of this model, convergence in the sense of the European Union may be interpreted as a reduction in concentration. Basically this may be derived by integration or by the type of the governmental input provided, i. e. the choice about the degrees of congestion and spillovers. The following relationships become evident from numerical simulations: Integration reduces concentration since it allows the periphery to access the core's public input and hence to benefit from its productivity. In contrast to this, relative congestion is associated with a negative capital externality and aggravates concentration. As a consequence, the resulting market equilibrium ends up in suboptimally high concentration. The impact of capital spillovers may be ambiguous: Basically agglomeration forces are strengthened by capital spillovers since the productivity advantage of the core gains importance. Nevertheless, strong spillovers may smooth concentration if combined with a high degree of relative congestion. This is the consequence of decreasing marginal returns in the governmental input.

THE ANALYTICAL FRAMEWORK

Firms in both regions $\iota = 1,2$ produce the homogenous good, Y_ι, by the same Cobb-Douglas technology. The inputs used in each region are immobile labor, L_ι, and private capital, K_ι. We eliminate mobile labor from the analysis, because it essentially follows the distribution of capital. Furthermore, output depends upon regional access to a global public input that is measured by an index, D_ι. The production function for a representative firm in region ι is given by

$$Y_\iota = L_\iota^\lambda K_\iota^\alpha D_\iota^\gamma, \quad \lambda > 0, \quad 1 > \alpha > 0, 1 > \gamma > 0 \quad (1)$$

The global public input, D_ι, includes the regional public inputs, $G_{s\iota}$, that are separately provided by both regions. The firm's access to the other region's public input may be limited as parameterized by $0 < \beta < 1$, and we assume

$$D_1 = G_{s1} + \beta G_{s2} \quad (2a)$$

$$D_2 = G_{s2} + \beta G_{s1} \quad (2b)$$

Correspondingly, the parameter β may be interpreted as a measure for the extent of integration between the two regions: If $\beta = 0$, firms in each region only benefit from the public input provided by their local governments, and consequently the scope of governmental policy is restricted to their own region. In contrast to this, $\beta > 0$ implies that firms in one region also have (at least partial) access to the other region's public input. What we have in mind is the following: If the government of a certain region provides education for the early

childhood, with the goal to increase the productivity in its own region, the impact on the other region's productivity probably will not be affected significantly (at least if labor is immobile). Formally, β will be close to zero. The same argument applies to the provision of a university that restricts the access to students stemming from its own region. If, in contrast to this, the government of region 1 provides universities which are open to students from region 2 (and if graduates return to their home region), productivity in both regions will increase as consequence of governmental activity in one single region. Then, β will be positive.

The modelling of the governmental input is adopted from Eicher and Turnovsky (2000), and the public input provided by the local government in region ι may be characterized as follows

$$G_{s\iota} = G_\iota \left(\frac{K_\iota}{\bar{K}_\iota}\right)^{\varepsilon_R} \bar{K}_\iota^{\varepsilon_A}, \quad 0 \leq \varepsilon_R \leq 1, \quad -\alpha \leq \varepsilon_A \leq 1 \quad (3)$$

Thereby $\bar{K}_\iota$ denotes the aggregate stock of private capital in region ι, and G_ι denotes the aggregate flow of government expenditure. Function (3) incorporates the potential for the public good to be associated with alternative types and degrees of scale effects or congestion as denoted by ε_A and ε_R. In contrast to Eicher and Turnovsky (2000), we do not restrict the sign of ε_A to be negative, but we allow for positive and negative externalities at the aggregate level. Note that the integration parameter β is also a measure for the extent to which the arising externalities of one region have a bearing on the other region. Above, the actual level of ε_A is of major importance for the resulting equilibria.

BALANCED STEADY STATES

The equilibrium is based on equalized productivities of private capital. Individuals in the two regions are able to hold capital in region 1 or in region 2. Physical capital is only mobile as long as it is not yet nailed down. Hence, the adjustment process of marginal capital returns takes time.

Denote the ratio of marginal capital productivities with

$$R \equiv \frac{\partial Y_1}{\partial K_1} \Big/ \frac{\partial Y_2}{\partial K_2} \quad (4)$$

A balanced steady state is characterized by a stationary capital distribution, i. e. by $R = 1$. In case of initial productivity disparities (i. e. $R \neq 1$), the prevailing capital ratio is not stationary; but over time transitions to a steady state with k increasing (if $R > 1$) or decreasing (if $R < 1$) will take place. Hence an equilibrium is only attained after a certain transition period, but k converges to a stable equilibrium in finite time. Since we assumed that capital is immobile once it has been nailed down, a transition with increasing k implies that during the transition period there is only investment in region 1 and no investment in region 2. The capital stock in region 2 then declines with the depreciation rate, δ.

DETERMINANTS OF AGGLOMERATION: CORE AND PERIPHERY

Note that since we focus on a growing economy, we assume that the governments in both regions set the aggregate expenditure levels, G_ι, as a constant fraction, θ_ι, of aggregate capital, $\bar{K}_\iota$,

$$G_\iota = \theta_\iota \bar{K}_\iota, \quad 0 < \theta_\iota < 1 \quad (5)$$

An expansion in government expenditure is then parameterized by an increase in the capital share, θ_ι. Additionally we have to take into account that in equilibrium $\bar{K}_\iota = N_\iota K_\iota$ applies. Then

$$\tilde{g}_s = \theta k^{1+\varepsilon_A} n^{1+\varepsilon_A-\varepsilon_R} \quad (6)$$

defines the equilibrium ratio of governmental activity, and $\theta \equiv \theta_1/\theta_2$.

In equilibrium the ratio of marginal capital productivities turns out to equal

$$R = l^\lambda k^{\alpha-1} \left(\frac{\tilde{g}_s+\beta}{1+\beta\tilde{g}_s}\right)^{\gamma-1} \cdot \left(\frac{\alpha(\tilde{g}_s+\beta)+\gamma\varepsilon_R\tilde{g}_s}{\alpha(1+\beta\tilde{g}_s)+\gamma\varepsilon_R}\right) \quad (7)$$

Taking logarithms, after some simple manipulations, yields

$$R \gtreqless 1 \quad \Longleftrightarrow \quad i(k) \gtreqless -\lambda \ln l \quad (8)$$

with

$$i(k) \equiv (\alpha-1)\ln k + (\gamma-1)\ln\left(\frac{\tilde{g}_s+\beta}{1+\beta\tilde{g}_s}\right) + \ln\left(\frac{\alpha(\tilde{g}_s+\beta)+\gamma\varepsilon_R\tilde{g}_s}{\alpha(1+\beta\tilde{g}_s)+\gamma\varepsilon_R}\right) \quad (9)$$

Depending on the characteristics of $i(k)$ it is possible to attain either one unique equilibrium or multiple equilibria, the latter showing different stability characteristics.

Formally, the underlying equilibrium is unstable whenever function $i(k)$ is positively sloped in the equilibrium capital. If then, starting from the steady state capital ratio, the relative capital productivity in region 1 increases ($R > 1$), the resulting capital productivity advantage in region 1 attracts investment and induces further increases of k. Hence the capital distribution departs continuously from the initial steady state and the system diverges from the unstable equilibrium. The argumentation holds analogously if, starting from an initially unstable equilibrium, the capital ratio is reduced and then declines continuously. If on the contrary the function $i(k)$ is negatively sloped for equilibrium capital ratios, an increase in k reduces the ratio of capital productivities ($R < 1$), thus giving rise to a productivity advantage

in region 2. Then k declines and converges again to its original steady state value.

Following Krugman (1991), the region which holds the higher capital stock then represents the core of the entire economy, whereas the other region is the periphery. The analysis will be carried out for equally distributed immobile labor, $l = 1$; hence the threshold value is given by $-\lambda \ln l = 0$. The argumentation focuses on those determinants that affect the run of function $i(k)$ and the underlying economic effects will be discussed. Two aspects gain especial importance: the sign of $i'(k)$, which determines whether agglomeration forces ($i'(k) > 0$) or dispersion forces ($i'(k) < 0$) prevail; and the multiplier that decides on the extent of the arising forces.

NUMERICAL SIMULATIONS

As argued before, agglomeration only occurs if regional spillovers are sufficiently high. Concerning this argument, the bifurcation point separates conditions in which one unique equilibrium arises from those that go along with multiple equilibria.

Nevertheless, higher values of ε_A do not automatically result in more concentration. The following calculations and simulations illustrate the sensitivity of the model with respect to those parameters that represent the externalities, ε_A and ε_R, as well as integration, β. We show their impact on the number of equilibria in the context of Table 1 and analyze their impact on concentration within Figures 1 and 2.

Table 1: Bifurcation points $\bar{\varepsilon}_A(\beta, \varepsilon_R)$

	$\varepsilon_R = 0.2$	$\varepsilon_R = 0.23$	$\varepsilon_R = 0.35$
$\beta = 0.2$	-0.7	-0.72	-0.76
$\beta = 0.25$	-0.1	-0.28	-0.5
$\beta = 0.3$	1.78	0.56	-0.22

Tables 1 and 2 show values of the threshold values $\bar{\varepsilon}_A$. For scale effects which exceed this level, agglomeration takes place. The tables illustrate how the levels of the bifurcation points $\bar{\varepsilon}_A$ are affected by integration and relative congestion. The gray values in Table 1 refer to the bifurcation points indicated in Figure 1, while the gray values in Table 2 correspond to Figure 2.

The tables could be interpreted as follows: Increasing integration unequivocally raises the value of the bifurcation point and thus supports the hypothesis that integration mitigates agglomeration forces. The contrary applies with respect to ε_R: There the level of the bifurcation point is reduced with increased congestion, and agglomeration becomes more likely.

Within the graphical simulations in Figures 1 and 2, we

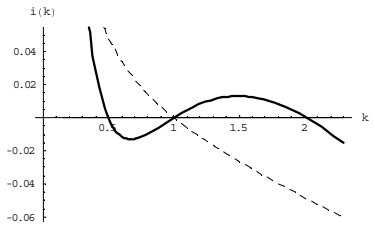
Table 2: Bifurcation points $\bar{\varepsilon}_A(\beta, \varepsilon_R)$

	$\varepsilon_R = 0.4$	$\varepsilon_R = 0.5$	$\varepsilon_R = 0.6$
$\beta = 0.5$	0.9	0.29	0.06
$\beta = 0.6$	2.11	0.7	0.3
$\beta = 0.7$	5.22	1.26	0.58

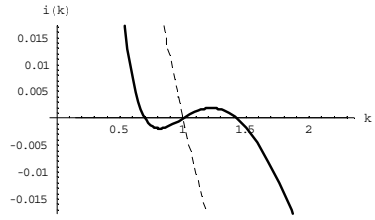
analyze how ε_A, ε_R and β impact on concentration as measured by the equilibrium capital distribution, k^*. As far as possible, we assume symmetry, $\theta = n = l = 1$. Hence the threshold value $i^*(k) = 0$ is represented by the horizontal axis. We consider constant returns to scale in the private inputs ($\alpha + \lambda = 1$) and make sure that the condition of endogenous growth is fulfilled ($\alpha + \gamma(1 + \varepsilon_A) = 1$). Under these conditions (at least) one equilibrium with equal distribution of capital, i. e. $k^* = 1$, results and no agglomeration takes place within it. If, instead, multiple equilibria arise, the region displaying the higher capital stock represents the core, whereas the other region may be interpreted as being the periphery. The equilibria are symmetric in the sense that one could easily change the region's indices and would have the same implications as before, but now from the point of view of the other region. Higher equilibrium values of k^* are interpreted as reflecting more concentration.

Figures 1(a)–1(c) plot the equilibrium capital distributions for alternative degrees of integration and assume intermediate relative congestion, $\varepsilon_R = 0.5$. The levels of the bifurcation points, $\bar{\varepsilon}_A$, are indicated next to the respective degrees of integration. Solid lines represent high regional spillovers ($\varepsilon_A = 0.9$), while the dashed lines correspond to low levels ($\varepsilon_A = -0.2$). Since the simulations assume $\alpha = 0.3$, we choose this lower benchmark for ε_A to fulfill the condition $-\alpha < \varepsilon_A$. In case of $\varepsilon_A = -0.2 < \bar{\varepsilon}_A$, the prevailing agglomeration forces are too low, capital is equally distributed across the regions, and $k^* = 1$. If, instead, $\varepsilon_A = 0.9$, agglomeration is basically possible (see Figures 1(a) and 1(b)). But more integration reduces concentration (lower k^*) since then the smaller region may also benefit from the spillovers of the bigger region. Consequently, capital accumulation does not move to the core. Figure 1(c) displays a situation in which dispersion forces dominate in either case and $k^* = 1$. As argued before, increasing integration reduces the agglomeration forces.

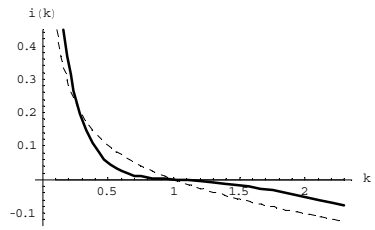
Figures 2(a) – 2(c) emphasize the model's sensitivity and focus on alternative levels of relative congestion for $\beta = 0.25$. Again the levels of the bifurcation points are included in parenthesis below each figure. Solid and dashed lines reflect ε_A in analogy to Figure 1, and equal distribution only arises if $\varepsilon_A < \bar{\varepsilon}_A$. The dashed function in Figure 2(a) is one example. All other combinations of β and ε_R lead to agglomeration, and the following structure may be observed: Increasing relative congestion fosters agglomeration in either case. But note that



(a) $\beta = 0.5 \quad (\Rightarrow \bar{\varepsilon}_A = 0.286)$

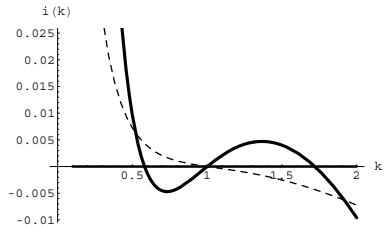


(b) $\beta = 0.6 \quad (\Rightarrow \bar{\varepsilon}_A = 0.699)$

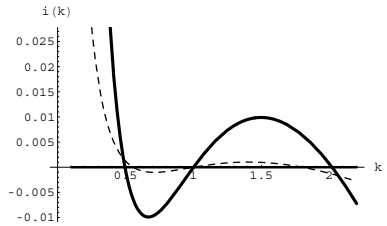


(c) $\beta = 0.7 \quad (\Rightarrow \bar{\varepsilon}_A = 1.251)$

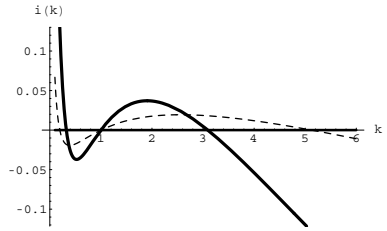
Figure 1: The impact of integration if $\varepsilon_R = 0.5$
parameters: $\alpha = 0.3$ $\lambda = 0.7$, $\theta = 1$, $n = 1$, $l = 1 \Rightarrow i^*$: horizontal axis
solid line: $\varepsilon_A = 0.9$, dashed line: $\varepsilon_A = -0.2$



(a) $\varepsilon_R = 0.2$ $(\Rightarrow \bar{\varepsilon}_A = -0.104)$



(b) $\varepsilon_R = 0.23$ $(\Rightarrow \bar{\varepsilon}_A = -0.28)$



(c) $\varepsilon_R = 0.35$ $(\Rightarrow \bar{\varepsilon}_A = -0.502)$

Figure 2: The impact of relative congestion if $\beta = 0.25$
parameters: $\alpha = 0.3$, $\lambda = 0.7$, $\theta = 1$, $n = 1$, $l = 1 \Rightarrow i^*$: horizontal axis
solid line: $\varepsilon_A = 0.9$, dashed line: $\varepsilon_A = -0.2$

concentration is even more pronounced for low levels of ε_A. The intuition for this result is as follows: On the one hand, we have intra-regional spillovers which foster concentration due to ε_A. But on the other hand, there are decreasing returns not only in private capital but also in the governmental input. With an increase in spillovers, ε_A, the ratio of individually available governmental inputs, $\tilde{g}_s$, increases; hence decreasing returns gain importance and reduce concentration. However, as the simulations illustrate, the total effect always implies agglomeration, not only for low but also for high values of relative congestion. Since there is a negative capital externality which goes along with congestion, individuals overestimate private capital return. Hence, agglomeration may even become more concentrated due to an increase in congestion. Nevertheless, the congestion externalities induce a suboptimally high level of concentration.

CONCLUSION

The basic objective of this paper is to analyze the impact of regional policy on the spatial distribution of economic activity. We ask whether integration will increase concentration as usually shown in new economic geography models which mostly interpret integration as a reduction in transport costs. Additionally we ask whether the European regional policy to foster territorial cooperation will reach the goal to support convergence. Within the context of the model presented, regional policy includes the extent of inter-regional cooperation, as well as the type of the governmental input provided. This input affects output not only directly but also indirectly as it enhances the productivity of the other inputs. Since the governmental input is characterized by absolute and by relative congestion, the model may be adopted to a variety of interpretations; two examples are physical infrastructure or research networks. It is shown that either one unique or multiple equilibria arise, with the latter showing different stability characteristics. Whether or not this leads to convergence in the sense of the European Union's regional policy goals depends upon a variety of economic conditions.

The model is very sensitive to the assumed parameter constellations, but nevertheless some general results may be derived: Integration unequivocally reduces concentration since it allows the smaller regions access to the other regions' public input and hence to benefit from its productivity impact. This result stands in strong contrast to those analysis that model infrastructure as facilitating trade. Relative congestion is associated with

a negative capital externality and aggravates concentration. As a consequence, the resulting market equilibrium ends up with suboptimally high concentration. This argument reflects the typical discussion within growth literature about the impact of relative congestion. The effect of intra-regional capital spillovers is more complex. Agglomeration only arises if spillovers are strong enough to overweigh decreasing returns to private capital. Nevertheless, if a high level of capital spillovers applies in a situation of high relative congestion, the impact may be reversed and decrease the resulting concentration.

The model's policy implications could then be summarized as follows: More integration reduces regional disparities, while relative congestion operates in the opposite direction. These congestion externalities could be internalized by a fiscal policy that corrects for the distortions. With this, it is clear that much work is still left to be done.

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AUTOR BIOGRAPHIES

SUSANNE SORETZ was born in Hannover, Germany, and studied economics at the universities of Hannover and Alcalá de Henares, Madrid. She earned her doctoral degree in 1999 and her Habilitation in 2004. Since 2007 she works at the University of Greifswald, where she now holds the chair in growth, structural change and international economics.

INGRID OTT was born in Karlsruhe, Germany, and studied economics at the universities of Hannover and Alcalá de Henares, Madrid. She earned her doctoral degree in 2001 and her Habilitation in 2007. Currently she is leading the group innovation and growth at the HWWI in Hamburg, is research associate at the IfW in Kiel and professor of innovation and growth at the University of Lueneburg.