OPTIMAL AGGLOMERATION AND

REGIONAL POLICY

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ABSTRACT

This paper studies the social desirability of agglomeration and the efficiency arguments for regional policy in a simple, analytically solvable 'new economic geography' model with two trade integrating regions. The location pattern emerging as market equilibrium is Ω-shaped, featuring dispersion of firms both at high and low trade costs and stable equilibria with partial agglomeration of firms in addition to core periphery equilibria for intermediate levels of trade costs. Our central finding is that the market equilibrium is characterised by over-agglomeration for high trade costs and under-agglomeration for low trade costs. For an intermediate level of trade costs, the market equilibrium yields the socially optimal degree of agglomeration. An important implication of this result is that, on efficiency grounds, regional policy should foster the dispersion of firms for a range of high trade costs only, but agglomeration for a range of low trade costs. Hence, regional policies, such as those pursued by the European Union (which are aimed at fostering dispersion in general), is counterproductive when trade integration is deep enough

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1   Introduction

Regional policies, notably those pursued by the European Union, have attracted a considerable amount of attention, recently, both in terms of their performance (e.g. Boldrin and Canova 2001; Braunerhjelm et al. 2000; Midelfart-Knarvik and Overman 2002) and in terms of their theoretical foundation (e.g. Puga 2001; Martin 1998). The 'new economic geography' which was launched with the seminal papers by Krugman (1991), Krugman and Venables (1995) and Venables (1996) is of particular relevance for the theoretical re-examination of regional policies. This research program shows how the interactions among transport costs, increasing returns at the firm level, and supply and demand linkages shape and change the location of economic activity and it derives a good deal of its appeal from its potential to throw light on economic policy (Neary 2001). However, the first wave of this research has been remarkably silent about policy conclusions, partly out of the fear that the new theories might be hijacked on behalf of interventionist policies (Fujita et al. 1999: 348ff) and partly because the policy implications had simply not been worked out, yet (Neary, 2001; Ottaviano and Puga 1998). Recently though, there has been an explosion of work directed at policy analysis.[1] This development owes much to the fact that the standard core-periphery model (e.g. Fujita et al. 1999) has been supplemented by a kit of easier to solve agglomeration models.[2] The analysis of policy questions has been considerably facilitated by these models.[3]

This paper analyses the welfare effects of agglomeration and the efficiency arguments for regional policy in a simple, analytically solvable 'new economic geography' model with two trade integrating regions. This question has also been raised in recent contributions by Ottaviano and Thisse (2001, 2002), Ottaviano, Thisse and Tabuchi (2002) and Baldwin et al. (2003). The first three forementioned papers study this question in the 'linear model' of Ottaviano, Thisse and Tabuchi (2002). Due to the quadratic quasi-linear utility of agents, this model is characterised by 'catastrophic' agglomeration in the sense that at a certain threshold level of trade costs, a symmetric equilibrium - where an equal amount of firms locate in the

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[1] Much the same can be said about empirical work on the new economic geography. See Neary (2001: 553ff.) and the surveys by Hanson (2001) and Overman, Redding and Venables (2001).

[2] Many of these newer models which, to a large part, can be solved analytically are presented in Baldwin et al. (2003). See also Ottaviano and Thisse (2003)

[3] Important early work dealing with infrastructure policies and drawing on the "footloose capital model" was provided in Martin and Rogers (1995a, 1995b). Other policy issues concern tax policies and tax competition - (Ludema and Wooton 2000, Kind et al. 2000, Andersson and Forslid 2003, Baldwin et al. 2003, Baldwin and Krugman 2004 and Borck and Pflüger 2004), trade policy (Baldwin et al. 2003), and wage and social policies (Pflüger 2004b).

two regions - breaks up and gives rise to an agglomeration of firms in one of the regions.[4] It is shown in these papers, that the market equilibrium may exhibit excessive agglomeration, leading to the conclusion that active policy intervention in order to foster the dispersion of the manufacturing sector is justified. However, once urban costs are introduced, there is also a re-dispersion of firms at low trade costs. In this case the welfare implications of agglomeration are not clear-cut any longer in this model, as the market allocation may be characterised by too little or too much agglomeration, depending on the set of exogenous parameters (Ottaviano, Thisse and Tabuchi 2001). A similar set of results is provided in Baldwin et al. (2003) who address the allocative efficiency of the market equilibrium with agglomeration forces in a model of the Forslid-Ottaviano-type, i.e. an analytically solvable model which mimics the behaviour of the standard core periphery model. These different contributions share the characteristic that the underlying models imply 'catastrophic agglomeration' or 'bang-bang' outcomes in the sense that the locational equilibria are either ones with full dispersion or with full agglomeration, a feature which, arguably, is extreme and not very realistic (Ottaviano and Thisse 2003).

The contribution of the present paper is twofold. Firstly, we address the efficiency question in a model that allows for stable equilibria with partial agglomeration as well. Such equilibria have been obtained in a class of models which enrich the standard core-periphery model by incorporating additional centrifugal forces.[5] We use a particularily simple model out of this class which has the property that it features an Ω-shaped location pattern as trade costs are reduced.[6] Whereas dispersion of firms is a stable equilibrium at both high and low trade costs, the bifurcation is smooth for an intermediate range of trade costs, featuring stable equilibria with partial agglomeration of firms. Our second and major contribution is to show that the market equilibrium is characterised by over-agglomeration for high trade costs and under-agglomeration for low trade costs. For an intermediate level of trade costs, the market equilibrium yields the socially optimal degree of agglomeration. That is, in contrast to the previous literature, our analysis allows us to provide a clear-cut answer to the question of the social desirability of agglomeration as the economy goes through different stages of the trade integration process. On efficiency grounds, regional policy should foster the dispersion of

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[4] In contrast to the core-periphery model (Fujita et al. 1999), the break point and the sustain point coincide in this linear model.

[5] Relevant contributions include Helpman (1998), Fujita et al. (1999, ch. 14 and ch. 18), Puga (1999), Ludema and Wooton (1999) and Pflüger (2004a). Ottaviano and Thisse (2003) provide an overview.

[6] Such an Ω-shaped location pattern has also been obtained in Puga (1999) and in Tabuchi (1998). Analytically, their models are not very tractable, however. The plausibility of the Ω-shaped location pattern is discussed in these works and in Ottaviano and Puga (1998), Puga (2001) and Ottaviano and Thisse (2003).

firms for a range of high trade costs only, but agglomeration for a range of low trade costs. Hence, regional policies, such as those pursued by the European Union - which are aimed at fostering dispersion in general -, is counterproductive when trade integration is deep enough.

The structure of the paper is as follows. The next section introduces the model. Section 3 characterises the location pattern emerging as market equilibrium. The socially optimal spatial pattern is derived and characterised in section 4. The two location patterns are compared in section 5 which presents our central result. Section 6 concludes.

2 The model

Our theoretical analysis draws on a simple extension of the two-region quasi-linear 'footloose entrepreneur model' described in Pflüger (2004a).[7] This model deviates from the standard Krugman (1991) core-periphery model in two respects. As in Forslid (1999) and Forslid and Ottaviano (2003) the model assumes that the fixed cost in the manufacturing sector consists of a separate internationally mobile factor – the compensation for a 'footloose entrepreneur'.[8] This makes the core-periphery model analytically solvable without changing its basic features. In contrast to Forslid and Ottaviano (2003), the Cobb-Douglas upper-tier utility is replaced by a widely used logarithmic quasi-linear utility function (e.g. Dixit, 1990, ch.3). By removing income effects from the manufacturing sector, and hence weakening the demand linkage of the CP model, this second modification allows for stable asymmetric equilibria with only partial agglomeration of firms.[9] Furthermore, in the spirit of Helpman (1998), we introduce the non-traded good housing into the consumer's utility function. To keep the model as simple as possible, the subutility for housing is modeled as an additively separable term of the logarithmic form in the consumer's utility function.[10]

The model is composed of two regions, 1 and 2 (denoted by an asterisk (*)). For simplicity, in order to neutralise the housing rental income, we assume that the housing stock, H and $H*$ respectively, is owned by citizens of a country outside the two-region economy. This modification has the consequence that, due to the deglomerative force of rising housing

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[7] This terminology as well as a detailed classification and exhibition of simple and (partially) solvable agglomeration models is provided in Baldwin et al. (2003).
[8] This assumption was introduced by Flam and Helpman (1987) in the context of a model of international trade (i.e. a model without the agglomerative forces of the new economic geography). Baldwin et al. (2003) provide a handy statement of Forslid and Ottaviano's 'footloose entrepreneur model'.
[9] This is shown and explained in detail in Pflüger (2004a).

prices, there is a resdispersion of firms at low trade costs. There are two goods in this economy, manufacturing (X) and agriculture (A), that are produced with an identical technology in both regions. The agricultural good is homogeneous, traded without costs and produced perfectly competitively under constant returns with labor L as the only input. One unit of labor is transformed into one unit of output and we use the price for the agricultural good as the numeraire. The manufacturing aggregate consists of a large variety of differentiated products. Each variety is produced with labor and entrepreneurs (K). Labor is the only variable input and the marginal costs are constant. Entrepreneurs enter only the fixed cost. One entrepreneur is needed (for R&D or headquarter services) to produce at all. Trade in X is inhibited by iceberg costs. Labor is intersectorally mobile, but immobile across regions. Entrepreneurs, of which there are K_W in the economy, are assumed to be responsive to differences in indirect utilities derived across regions. The variable λ denotes the share of entrepreneurs who locate in region 1, and $1-\lambda$ is the share settling in the other region. The following model description is for region 1 only. All expressions for region 2 are analogous.

The two types of households are indexed by $z = L, K$. Each is endowed with and inelastically supplies one unit of their respective type of labor. Preferences are homogenous and characterised by:

$$U_z = \alpha \ln C_X + \beta \ln C_H + C_A \qquad\qquad C_X = \left(\int_0^N x_i^{\frac{\sigma-1}{\sigma}} + \int_N^{N*} x_j^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \qquad (1)$$

$$\alpha > 0, \qquad \beta > 0, \qquad \sigma > 1$$

where C_X is the manufacturing aggregate, C_H is the demand for housing and C_A is the consumption of the agricultural good. The quantity consumed of a domestic variety i is denoted by x_i, the quantity of a variety produced in the other region is x_j. N and N^* are the number of varieties produced in region 1 and 2 respectively, and σ is the elasticity of substitution between manufacturing varieties. The budget constraint of households is given by

$$PC_X + P_H C_H + C_A = Y_z, \qquad P = \left[NP_i^{1-\sigma} + N^* \left(\tau P_j \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \qquad \tau > 1 \qquad (2)$$

where Y_z denotes the household's income, P is the perfect CES-price index, P_i (P_j) is the producer price for domestic (imported) varieties and P_H denotes the price of housing. Iceberg

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[10] This deviates from Helpman (1998) who uses a Cobb-Douglas upper-tier utility.

transport costs are formalised by the constant parameter τ. These imply that only $1/\tau$ of a unit of a variety produced in the other region arrives for consumption and that the consumer price of an imported variety is τP_j. Utility maximisation yields the demand functions and indirect utility, V_z:[11]

$$C_X = \alpha P^{-1}, \quad C_H = \beta P_H^{-1}, \qquad C_A = Y_z - \alpha - \beta, \tag{3}$$

$$x_i = \alpha P_i^{-\sigma} P^{\sigma-1}, \qquad x_j = \alpha (\tau P_j)^{-\sigma} P^{\sigma-1}$$

$$V_z = -\beta \ln P - \beta \ln P_H + Y_z + [\alpha(\ln \alpha - 1) + \beta(\ln \beta - 1)] \tag{4}$$

Equilibrium in the housing markets commands the aggregate demand for housing to be equal to the supply of housing. Hence, equilibrium housing prices are given by:

$$P_H = \beta(L + \lambda K_W)/H \tag{5}$$

It can be seen from eq. (5), that the price of housing increases with the size of the local population, i.e. with λ. The converse holds with respect to the other region.

The production function of the agricultural good is $X_A = L_A$. Since this good is the numéraire, the wage rate is unity, $W = 1$.

Market clearing for a domestic variety i is expressed by $X_i = (L + K)x_i + (L^* + K^*)\tau x_i^*$, where X_i is production and x_i^* is the demand of the representative household from the other region. Part of demand is indirect, caused by transport losses. Each product type is supplied by a single firm. With $W = 1$ and the technology $L_i = cX_i$ ($c > 0$, a constant), the marginal cost is given by c. The fixed cost due to the requirement of one unit of human capital is given by R. Let the producer prices charged to households in the own (the other) region be denoted P_i (P_i^*). Profits of the representative firm in region 1, Π_i, are then given by:

$$\Pi_i = (P_i - c)(L + K)x_i + (P_i^* - c)(L^* + K^*)\tau x_i^* - R \tag{6}$$

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[11] We assume that $\alpha + \beta < Y_z$ in order to assure that both types of goods are consumed (cf. Dixit 1990).

With the Chamberlinian large group assumption, profit maximising prices are constant markups on marginal costs:

$$P_i = P_i^* = c\sigma / (\sigma - 1) \tag{7}$$

The compensation of human capital adjusts so as to ensure zero profit equilibrium. Using the market clearing condition, a relationship between firm scale X_i and fixed costs R obtains:

$$X_i = R(\sigma - 1)/c . \tag{8}$$

3 Market equilibrium

For a given allocation of entrepreneurs λ between these two regions, the nominal returns accruing to entrepreneurs in region 1 and 2, R and R^*, can then be determined by imposing the condition of zero profits on (6) together with the demand functions (3), the price level (2) and firm's optimal prices (7) and the analogue conditions in region 2. This gives:

$$R = \frac{\alpha}{\sigma} \left[\frac{\rho + \lambda}{\lambda + (1-\lambda)\phi} + \frac{\phi(\rho + 1 - \lambda)}{\phi\lambda + (1-\lambda)} \right] \qquad R^* = \frac{\alpha}{\sigma} \left[\frac{\phi(\rho + \lambda)}{\lambda + (1-\lambda)\phi} + \frac{\rho + 1 - \lambda}{\phi\lambda + (1-\lambda)} \right] \tag{9}$$

where $0 \le \phi \equiv \tau^{1-\sigma} \le 1$ is a parameter which captures the freeness of trade and which is inversely related to trade costs. The weight of the immobile factor in the two regions is assumed to be identical and is denoted by $\rho \equiv L / K_W$. Once nominal returns are derived, the firm scale X_i follows from (8) and the other endogenous variables can be derived in a straightforward way. The X sector employs $NcX_i = NR(\sigma - 1)$ units of labor which we assume to be less than L in order to ensure that both sectors are active after trade.[12]

In the long run, entrepreneurs are assumed to move across regions in response to differences in indirect utilities which they derive in the two locations. They locate where their indirect utility is maximised. The utility differential, $V_K - V_K^* = \alpha \ln(P^*/P) + \beta \ln(P_H^*/P_H) + (R - R^*)$ can be expressed analytically for general trade costs in the following way:

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[12] This implies the parameter restriction $\alpha < \rho\sigma /(2\rho + 1)(\sigma - 1)$ as in Pflüger (2004a). This coincidence follows from the fact that no labor input is needed for the housing sector.

$$V_K - V_K^* = \frac{\alpha}{1-\sigma}\ln\left[\frac{\lambda\phi+(1-\lambda)}{\lambda+(1-\lambda)\phi}\right] + \beta\ln\left[\frac{\rho+(1-\lambda)}{\rho+\lambda}\right] + \frac{\alpha(1-\phi)}{\sigma}\left[\frac{\rho+\lambda}{\lambda+(1-\lambda)\phi} - \frac{\rho+(1-\lambda)}{\phi\lambda+(1-\lambda)}\right] \quad (10)$$

The model comprises two agglomerative and two deglomerative forces and their balance is crucially influenced by the level of trade costs. Hence, although $\lambda = 1/2$ is always a long-run equilibrium when both regions are identical (it is easily seen that $V_K - V_K^* = 0$ in this case), this equilibrium is not necessarily stable because of the two agglomerative forces. There is a supply linkage as the region with the higher share of entrepreneurs has a larger manufacturing sector and therefore a lower price index. This is captured in the first term in (10). There is also a demand linkage since increasing the share of entrepreneurs in one region implies a larger market. This raises the profitability of firms as expressed by the differential $(R - R^*)$, the third term of (10), and thus attracts more entrepreneurs. A stabilising (deglomerative) effect in the model derives from the fact that, shifting firms from the region 2 to region 1 increases competition among firms for given expenditures on domestic products while lowering competition in the other region, thereby reducing the profitability of the market in region 1 in relation to the market in region 2. This local competition effect can be seen in the third term of (10) holding the denominator of (10) constant. In addition to these three forces which are already contained in Pflüger (2004a), there is a fourth effect, a deglomerative effect deriving from rising relative housing prices (cf. eq. (5)) which is contained in the second term of (10). When trade costs are large, the deglomerative local competition effect prevails and the symmetric equilibrium is stable. However, when trade costs are continuously reduced, the symmetric equilibrium becomes unstable and two stable and increasingly asymmetric equilibria emerge in which a larger part, and finally all, of the differentiated goods industry is located in one or the other region. For still lower trade costs, the deglomerative force of rising housing prices takes over leading to a gradual redispersion of firms until a symmetric equilibrium is reached again. Hence, the bifurcation diagram reveals an Ω-shaped bifurcation pattern as shown in figs. 1 and 2. To rule out that the agglomerative forces become so strong that the symmetric equilibrium is unstable even at infinite trade costs, we impose the condition $\left[\partial(V - V^*)/\partial\lambda\right]_{\lambda=1/2,\phi=0} < 0$. This yields the 'no black hole-condition' $\sigma/(\sigma-1) < 2\rho - \gamma\sigma/(2\rho+1)$, where $\gamma \equiv \beta/\alpha$ is a measure for the size of the housing sector relative to the manufacturing sector.

(Fig. 1 and Fig. 2, Page 18)

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The simplicity of the model allows us to calculate the two levels of trade freeness ϕ (and hence also the associated level of trade costs) at which the bifurcation fork opens and closes under the assumption of identical regions. We shall denote the bifurcation point which emerges at low levels of trade freeness (i.e. high trade costs) the 'market break point', ϕ_b^M, and the bifurcation point, where the symmetric equilibrium becomes stable again, the 'market redispersion point', ϕ_r^M. Analytically, these can be obtained by taking the derivative of the utility differential in (10) with respect to λ at $\lambda = 1/2$. This is a quadratic equation which can be solved for the two bifurcation levels. In order to obtain a real root that warrants the existence of two solutions we need to assume that $1 - \gamma(\sigma - 1) > 0$, i.e. that the degree of increasing returns is strong enough (σ is low enough) and the relative size of the housing sector is not too large (γ is not too large)

$$\phi_b^M = \left(E_1 - \sqrt{J} \right) \big/ E_2 \tag{11}$$

$$\phi_r^M = \left(E_1 + \sqrt{J} \right) \big/ E_2 \tag{12}$$

where
$$E_1 \equiv (\sigma - 1)\left[(2\rho + 1)^2 - \gamma\sigma \right]$$

$$E_2 \equiv (\sigma - 1)\left[(2\rho + 1)^2 + \gamma\sigma \right] + (2\rho + 1)(2\sigma - 1)$$

$$J \equiv (2\rho + 1)^2 \{ 1 + 4\sigma(\sigma - 1)[1 - \gamma(\sigma - 1)] \}$$

The market break point and the market redispersion point range symmetrically around $\hat{\phi}^M = E_1 / E_2$. It is easy to derive that for $\gamma = 0$ these bifurcation points coincide with those in Pflüger (2004a). The two bifurcation points can be related to the underlying parameters. Start with the market break point. Straightforward, yet tedious, calculations give:

$$\frac{\partial \phi_b^M}{\partial \sigma} > 0, \ \frac{\partial \phi_b^M}{\partial \rho} > 0, \ \frac{\partial \phi_b^M}{\partial \gamma} > 0 \tag{13}$$

For the market redispersion point, we obtain in a similar manner:

$$\frac{\partial \phi_r^M}{\partial \sigma} < 0, \ \frac{\partial \phi_r^M}{\partial \rho} > 0, \ \frac{\partial \phi_r^M}{\partial \gamma} < 0 \tag{14}$$

Our findings (13) and (14) are summarised in:

Proposition 1: *The range of trade costs for which the market does not deliver a symmetric equilibrium shrinks with the relative size of the housing sector ($\gamma \equiv \beta / \alpha$) and rises with the degree of increasing returns at the firm level ($1/\sigma$). Increasing the proportion of immobile workers, $\rho \equiv L / K_W$, has the effect that both the market break point and the market redispersion point occur at a lower level of trade costs (higher level of trade freeness).*

The intuition of these effects is straightforward. As in other agglomeration models (Fujita et al. 1999), increasing the degree of returns to scale at the firm level, $1/\sigma$, fosters agglomeration. Hence, the market break point occurs at a higher level of trade costs (i.e. lower level of trade freeness) and the market redispersion point at a lower level of trade costs (higher level of trade freeness). Increasing the proportion of immobile workers $\rho \equiv L / K_W$ bolsters up the dispersion forces at high trade costs which has the effect that it takes lower trade costs (a higher trade freeness) to break the symmetric equilibrium (as in Pflüger 2004a). That the market redispersion point obtains at a lower level, too, is most easily understood by thinking of an increase in ρ as due to a fall in K_W, for a given L. From eq. (5) it is clear that this lowers the price of housing in region 1 and thus mitigates the deglomerative force of housing prices. Hence, the market redispersion point can only obtain at a lower level of trade costs (higher level of trade freeness). The relative size of the housing sector, $\gamma \equiv \beta / \alpha$, acts as a dispersion force. Increasing its size has the effect that both the market break point and the market redispersion point obtain at lower levels of trade costs (higher levels of trade freeness).

4   The optimal (second-best) spatial structure

4.1   Welfare

This section studies welfare. We start with the observation that there are two inefficiencies in this model. First, firms have market power. Due to the monopolistic competitive market structure, prices exceed marginal costs and, hence, the output of firms is too low from a social perspective. Second, the model features pecuniary externalities which have non-negligible welfare effects when markets are imperfectly competitive (see e.g. Ottaviano and Thisse 2001 for an elaboration). In particular, a mobile entrepreneur, faced with the decision whether to migrate or not, does not take into account the effects of her decision on the welfare of the other (immobile and mobile) agents which are mediated through the profits of firms (rents)

and through the price levels in the two regions. The distortion arising from the deviation of prices from marginal costs could in principle be addressed by subsidising the output of firms. However, this would necessitate the availability of lump-sum taxes (or further inefficiencies arising from distortionary taxation would emerge).[13] Such lump-sum finance of firm subsidies appears unlikely in practice. Hence, we rule this out in our welfare analysis. Rather, we turn to the question of the second-best optimal spatial structure where the social planner is able only to address the inefficiencies resulting from the location decision of entrepreneurs, i.e. the pecuniary externalities under imperfect competition.[14]

The social planner maximises the joint welfare of the two regions. The social welfare function is the simple utilitarian one, i.e. the sum of the (indirect) utility functions of all agents:

$$\Omega = K_W \left[\lambda V_K + (1-\lambda)\lambda V_{K*} + \rho(V_A + V_{A*}) \right] \tag{15}$$

It should be noted that this welfare criterion is precise in the present model context, since all agents' utility functions are quasi-linear, and hence they all have an identical marginal utility of income which is equal to one.[15] The indirect utility functions of the agents are characterised in eq. (4). The nominal incomes of mobile entrepreneurs are R and $R*$, respectively, and the nominal income of the immobile laborers given by $W = W* = 1$ (see section 2). The social planner chooses λ so as to maximise Ω in (15). It is straightforward to show that the first-order condition $\partial\Omega/\partial\lambda$ is always equal to zero at $\lambda = 1/2$. However, it has to be checked whether $\lambda = 1/2$ is a welfare maximum or a welfare minimum. Moreover, the social welfare function may have further extrema at values different from the symmetric distribution of industries, i.e. at $\lambda \in \{[0,1]; \lambda \neq 1/2\}$. By standard analysis one can show that Ω has at most three extrema, where at most two of these may be local or global welfare maxima. Figure 3 illustrates the possible shapes of Ω.[16]

(Fig. 3, Page 19)

The upper graph in fig. 3 illustrates the case where the symmetric equilibrium ($\lambda = 1/2$) is a (local and) global welfare maximum. This requires the second derivative of Ω with respect

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[13] See e.g. Haufler and Pflüger (2003, 2004) for an analysis in the ‚footloose capital‘ version of the monopolistic competition model, i.e. a model which is identical to the one used in this paper except for the fact that the profit accruing the entrepreneurs is repatriated to the country, where the entrepreneurs originate.

[14] Ottaviano and Thisse (2001) and Baldwin et al. (2003) cover first-best solutions as well.

[15] This also holds true for the quadratic-quasi-linear model of Ottaviano, Thisse and Tabuchi (2002) which is used for their welfare analysis and for the welfare analysis in Ottaviano and Thisse (2002).

to λ to be negative (i.e. $\partial^2\Omega/\partial\lambda^2\big|_{\lambda=1/2} < 0$). The bottom of fig. 3 illustrates a case where the symmetric equilibrium is a welfare minimum. In this case, the welfare optimum is a border solution of full agglomeration in one of the two regions (i.e. $\lambda = 1$ or $\lambda = 0$). The panel in the middle illustrates the third possible case. Here, the symmetric equilibrium is a local minimum and the social optima are characterised by partial agglomeration of firms in one region. Both in the second and the third case $\partial^2\Omega/\partial\lambda^2\big|_{\lambda=1/2} > 0$. In order to distinguish between these two cases it suffices to evaluate $\partial\Omega/\partial\lambda\big|_{\lambda=1}$. If this derivative is positive, we are in the bottom case of fig. 3 and full agglomeration is optimal from a social point of view. If this derivative is negative, the social optimum is characterised by partial agglomeration (middle panel of fig. 3).

4.2   The social break and the social redispersion point

In the first step we discriminate between the cases where the social planner chooses symmetry (top panel case in fig. 3) and where she chooses (partial or full) agglomeration (two cases in the lower panels in fig. 3) leaving the distinction between the cases of partial and full agglomeration to the next section. In accordance with the terminology established in our analysis of market equilibrium, we will speak of a 'social break point' and a 'social redispersion point'. The 'social break point', ϕ_b^S, occurs at the (low) level of trade freeness (or, equivalently, the (high) level of trade costs) at which symmetry is no longer the social optimum. The 'social redispersion point', ϕ_r^M, is the (high) level of trade freeness (equivalently: low level of trade costs), at which the symmetric equilibrium re-emerges as the social optimum. We derive these two bifurcation points by taking the second partial derivative of Ω with respect to λ at $\lambda = 1/2$, setting this expression equal to zero and then solving for ϕ. Again, this yields a quadratic equation. Provided that $1 - \gamma(\sigma - 1) > 0$, as in the case of the market equilibrium (see the interpretation of this condition there), this yields the following two solutions with a real root Δ:

$$\phi_b^S = \left(Z_1 - \sqrt{\Delta}\right)/Z_2 \tag{16}$$

$$\phi_r^S = \left(Z_1 + \sqrt{\Delta}\right)/Z_2 \tag{17}$$

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[16] The reasoning here is similar to the logic of this analysis in Baldwin et al. (2003, ch. 11). It should be noted however, that due to the differences in the the underlying model, we obtain stable equilibria with partial agglomeration both in the market equilibrium and in the second-best solution whereas Baldwin et al. do not.

where
$$Z_1 \equiv (2\rho + 1)^2 - \gamma(\sigma - 1)$$

$$Z_2 \equiv (2\rho + 1)(2\rho + 3) + \gamma(\sigma - 1)$$

$$\Delta \equiv 4(2\rho + 1)^2 [1 - \gamma(\sigma - 1)]$$

It is easily seen that with $\gamma = 0$, the social redispersion (like the market redispersion point) is always equal to one. Figure 4 illustrates the behaviour of $\partial^2 \Omega / \partial \lambda^2$ for the possible ranges of trade freeness $\phi \in (0,1)$ and for the parameter constellation $\alpha = 0.4$, $\beta = 0.07$, $\sigma = 6$, $K_W = 2$ and $L = 1$, and hence i.e. $\rho = 2$. The 'social break point' and the 'social redispersion point' are the levels of ϕ where this curve cuts the horizontal axis.

(Fig. 4, Page 19)

The comparative statics of the 'social break point' and the 'social redispersion point' are straightforward, even if somewhat tiresome, to derive. We obtain:

$$\frac{\partial \phi_b^S}{\partial \sigma} > 0, \ \frac{\partial \phi_b^S}{\partial \rho} > 0, \ \frac{\partial \phi_b^S}{\partial \gamma} > 0 \tag{18}$$

$$\frac{\partial \phi_r^S}{\partial \sigma} < 0, \ \frac{\partial \phi_r^S}{\partial \rho} > 0, \ \frac{\partial \phi_r^S}{\partial \gamma} < 0 \tag{19}$$

These results mimic what we have found for the market equilibrium and the basic intuition of the comparative statics carries over. The results are summarised in

Proposition 2: *The range of trade costs for which the social planner does not choose symmetry is negatively related to the relative size of the housing sector ($\gamma \equiv \beta / \alpha$) and increasing with the degree of increasing returns at the firm level ($1/\sigma$). Increasing the relative endowment of immobile workers, $\rho \equiv L / K_W$, shifts both the social break point and the social redispersion point to lower levels of trade costs.*

4.3 Partial and full agglomeration

We now turn to the question for what levels of trade freeness the social planner chooses partial agglomeration and full agglomeration, i.e. the distinction between the two cases

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depicted in the lower panels of fig. 3. These two cases can be distinguished by an inspection of the derivative $\partial\Omega/\partial\lambda\big|_{\lambda=1}$. This expression is given by

$$\frac{\partial\Omega}{\partial\lambda}\bigg|_{\lambda=1} = \alpha K_W \left\{ \gamma \ln\left(\frac{\rho}{1+\rho}\right) - \frac{1}{\sigma-1}\left\{\ln\phi + (1-\phi)[1+\rho(1-1/\phi)]\right\}\right\} \qquad (20)$$

The social planner chooses full agglomeration if this derivative is positive and partial agglomeration if it is negative (cf. section 4.1). The threshold levels of trade freeness, where the social planner shifts from partial to full agglomeration and vice versa are determined in implicit form by setting $\partial\Omega/\partial\lambda\big|_{\lambda=1}$ in (20) equal to zero. Simulations reveal that the derivative in (20) is negative for very low and very high levels of trade freeness and positive for an intermediate range of trade freeness. This is illustrated in fig. 5 drawing on the same set of parameters as fig. 4:

(Fig. 5, Page 20)

Figure 5 suggests that the bifurcation diagram for the social planner's solution is *qualitatively* the same as the bifurcation diagram of the market equilibrium depicted in fig. 2. To be sure that this is true in general and not just the case for some selective simulations we provide the following

Proposition 3:(i) *In the vicinity of the social break point and the social redispersion point the social planner chooses partial agglomeration. (ii) There exists a range of levels of trade freeness ϕ between the social break point and the social redispersion point where full agglomeration is socially optimal.*

The proof of proposition 3 is straightforward. The first part follows from the fact that the derivative of (20) is negative if evaluated at the social break point. The same holds if this derivative is evaluated at the social redispersion point. To proof the second part of proposition 3 it suffices to show that there exists an intermediate level of trade freeness, $\hat{\phi}$, in between the two social bifurcation points, $\phi_b^S < \hat{\phi} < \phi_r^S$, at which the derivative in (20) is strictly positive which is a straightforward exercise. Hence, on the basis of proposition 3 we can be sure that the bifurcation diagram for the social planner's solution follows *qualitatively* the same pattern as the bifurcation diagram of the market equilibrium.

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5   Market equilibrium and social optimum compared

The crucial question taken up in this section is the comparison of the market equilibrium and the social optimum. Since we have derived analytical expression both for the break points and the redispersion points for the market equilibrium and the social planner, this is a straightforward exercise.

Subtracting the 'market break point' from the 'social break point' yields:

$$\phi_b^S - \phi_b^M = \left(\frac{Z_1}{Z_2} - \frac{E_1}{E_2}\right) + \frac{\left(Z_2\sqrt{J} - E_2\sqrt{\Delta}\right)}{Z_2 E_2} \quad > 0 \tag{21}$$

as long as $1 - \gamma(\sigma - 1) > 0$, a condition which we have found to be necessary in order to derive break and sustain points. This result shows, that the social planner switches from a symmetrical equilibrium to partial agglomeration at a higher level of trade freeness (i.e. lower level of trade costs) than the market.

In a similar manner we can compare the 'market redispersion point' and the 'social break point'. This yields:

$$\phi_r^S - \phi_r^M = \frac{Z_1 + \sqrt{\Delta}}{Z_2} - \frac{E_1 + \sqrt{J}}{E_2} \quad > 0 \tag{22}$$

as long as $1 - \gamma(\sigma - 1) > 0$. This result shows that the 'social redispersion point' emerges at a higher level of trade freeness (lower level of trade costs) than the market equilibrium. Our results are summarised in

Proposition 4: *Provided that $1 - \gamma(\sigma - 1) > 0$, the market break point is lower than the social break point, and the market re-dispersion point is lower than the social re-dispersion point.*

Proposition 4 implies that the market delivers over-agglomeration for low levels of trade freeness ϕ (i.e. for high trade costs) and it delivers under-agglomeration for high levels of trade freeness ϕ (i.e. for low trade costs). This result is illustrated in fig. 6 which superimposes the bifurcation diagrams of the market and of the social planner. Solid lines represent the equilibrium spatial structure of the economy and the broken lines the (second-best) optimal spatial structure.

6   Conclusion

This paper has addressed the theoretical foundations of regional policies. Drawing on a simple, analytically solvable new economic geography model we get the result that considerable doubt should be cast on the traditional wisdom that regional policies should always foster a dispersion of industries. Rather, from the perspective of allocative efficiency, it turns out that the market equilibrium is characterised by over-agglomeration for high trade costs and under-agglomeration for low trade costs. For an intermediate level of trade costs, the market equilibrium yields the socially optimal degree of agglomeration. Hence, the regional policy pursued by the European Union runs the danger to be counterproductive when trade integration has developped far enough. Future work should use this framework for a detailed welfare analysis of specific regional policy instruments, in order to obtain a hierarchical ranking of instruments.

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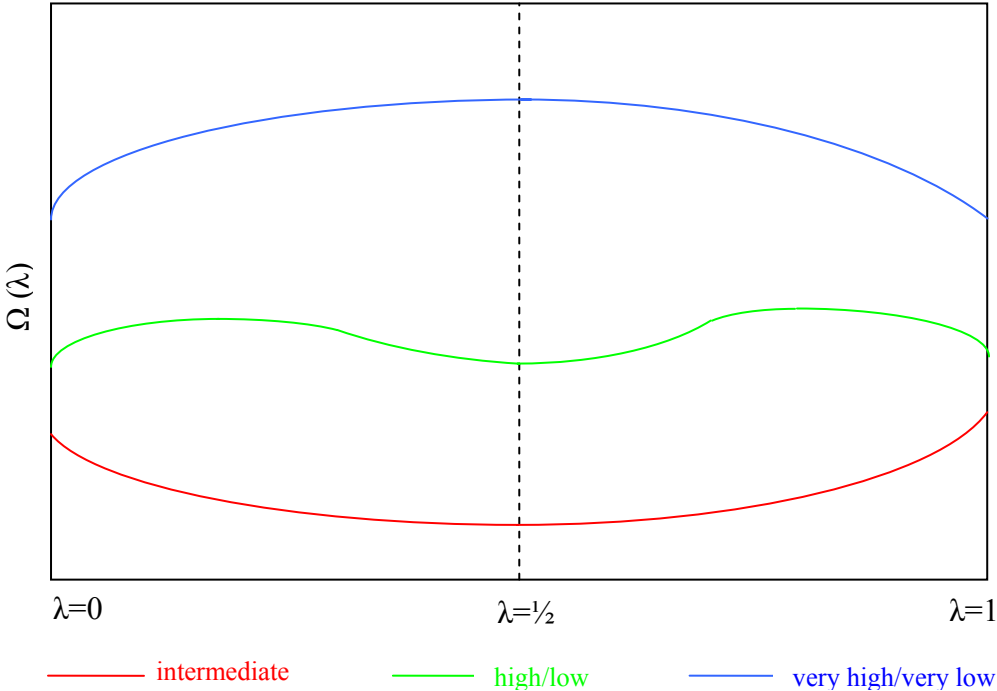Venables, A.J., 1996, Equilibrium location of vertically linked industries, International Economic Review 37, 341-359.

Figure 1: Equilibrium geographical structure

$\lambda=0$ $\lambda=\frac{1}{2}$ $\lambda=1$

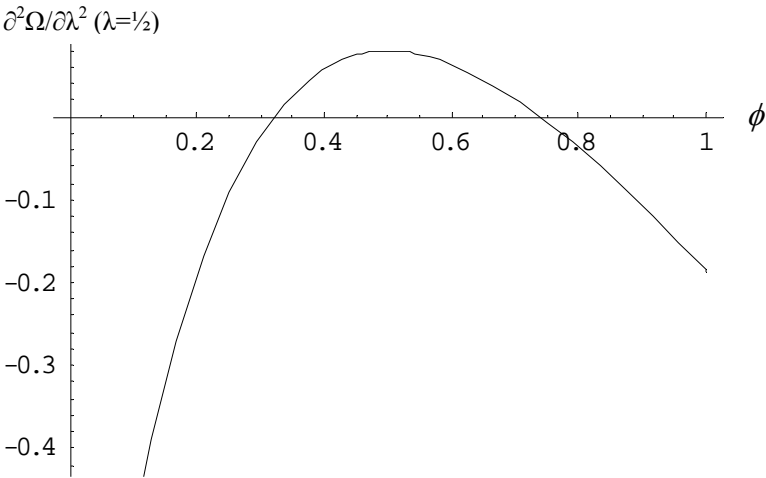intermediate   high/low   very high/very low
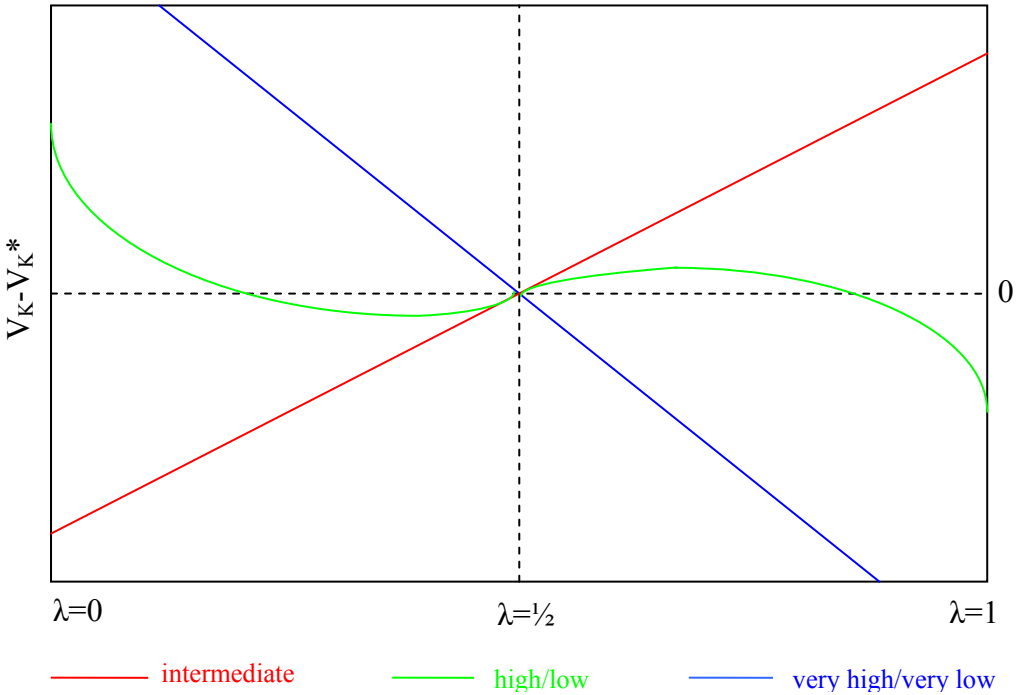
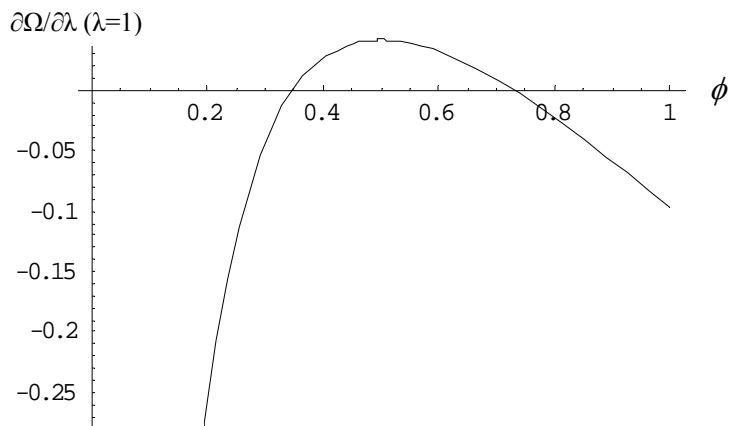**Figure 2: The bifurcation diagram**
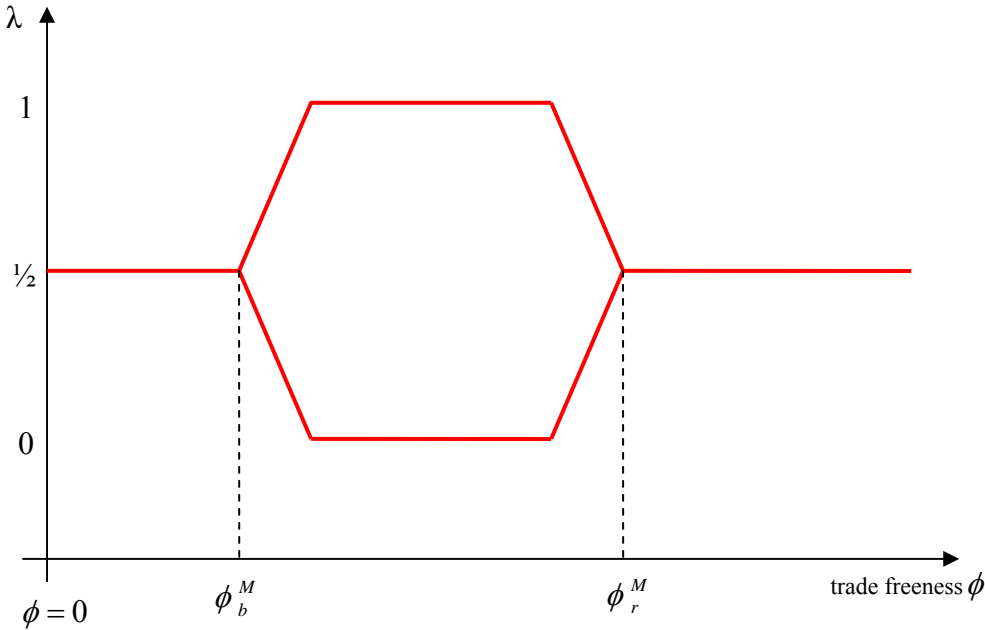
Figure 3: Social welfare

Figure 4: Is the symmetrical situation a welfare maximum or minimum?

Figure 5: Partial versus full agglomeration?

Figure 6: Market equilibrium and optimal spatial structure