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Countries, regions and trade: On the welfare impacts of economic integration

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Abstract

We study the impact of falling international trade costs and falling national transport costs on the economic geography of countries involved in an integration process. Each country is formed by two regions between which labor is mobile, whereas there is no international mobility. Goods can be traded both nationally and internationally at positive, but different, costs. A decrease in trade costs and/or in transport costs has a direct impact on prices and wages, which allows us to account for the impact of changes in these parameters on the economic geography and welfare of each country. We show that, as trade barriers fall, the benefits of integration come after its costs. We also show that national transport policies are of the beggar-thy-neighbor type. On both counts, policy coordination is required in the process of economic integration.

JEL classification: F12; F16; R12

Keywords: Agglomeration; Economic geography; Regional integration; Trade costs; Transport costs

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1. Introduction

It is a well-documented fact that the growing openness of national economies to international trade has a significant impact on the location of economic activities within countries. First, using a cross-section of 85 countries, Ades and Glaeser (1995) show that higher tariff barriers lead to a higher degree of urban primacy. Second, studying the "cohesion group" of the European Union (Greece, Ireland, Portugal and Spain, but no regional data are available for Ireland), Quah (1996) notes that the two countries that have reached the highest rates of economic growth, Spain and Portugal, are those that have experienced the most striking rise in regional imbalances. This is consistent with the evidence reported by de la Fuente and Vives (1995) who observe that the process of economic integration within the EU fosters international convergence *across* countries rather than interregional convergence across regions *within* countries. Indeed, about half of the divergence across European regions is due to an increased polarization within some member-states.

All this evidence raises crucial policy issues that are often neglected when countries decide on trade agreements and the development of transportation infrastructure. For example, it suggests that the recent enlargement of the EU to 10 new countries and the planned infrastructural improvements are very unlikely to leave the economic geography of the new and the old members unaffected. Moreover, the ensuing changes will probably differ across countries, depending on their degree of internal integration and the quality of their already existing transportation infrastructure. Since "[t]here is undoubtedly a rich relationship between domestic and international trade costs, market structure, and political economy" (Anderson and van Wincoop, 2004, p. 748), major political disturbances and social turmoil could be triggered by a potentially uneven distribution of the gains and losses from enlargement as the geography of competition and employment changes.

While the practical importance of the foregoing issues is widely recognized, the understanding of the underlying economic mechanisms is still at an infant stage. The reason is the theoretical difficulty of characterizing the equilibrium spatial distribution of economic activity when many locations, as well as a genuine distinction between regions and countries, are simultaneously considered. At the very least, such an approach entails: (i) A distinction between international and interregional transaction costs and (ii) a distinction between interregional and international labor mobility. Moreover, the analysis requires some imperfectly competitive market structure. When taken together, these obstacles explain the existence of a very limited set of relevant contributions, all based on monopolistic competition, which either fail to distinguish between regions and countries or, being based on numerical simulations, fail to provide solid ground for comparative statics on policy sensitive parameters. For example, Martin and Rogers (1995) argue that a major determinant of national market size is the degree of interregional integration within countries. However, by ruling out any kind of labor mobility to focus on mobility of goods only, they neglect a defining dimension of interregional integration. Other studies introduce labor mobility between the regions of the same country. The associated results are mixed depending on the specificities of the models adopted. Krugman (1991) considers a two-region closed economy where agglomeration forces arise from demand linkages between firms and mobile workers, whereas dispersion forces arise from the costs that firms face to reach the exogenously dispersed demand of immobile farmers. In this setup, lower interregional trade costs foster agglomeration. Paluzie (2001) extends Krugman's model by adding a third 'foreign' region and assuming that labor is internationally immobile. She shows that falling international trade costs foster agglomeration in the country opening to trade. Krugman and Livas Elizondo (1996) replace dispersed immobile demand with congestion costs as the source of dispersion forces and show that this is enough to turn Paluzie's result upside down: Lower international trade costs foster dispersion in the country opening to trade. The reason for opposite results is the fact that trade costs do not affect the strength of the dispersion force when it derives from congestion costs. Finally, Monfort and Nicolini (2000) extend the original Krugman model to two countries and four regions confirming the essence of Paluzie's (2001) result: International trade liberalization between countries leads to more agglomeration within each country.

All these contributions are based on the Dixit–Stiglitz–Krugman model of monopolistic competition, which reduces the interactions between firms by neglecting their strategic behavior and assuming constant markup pricing due to CES demand. Notwithstanding such simplifications, results are essentially derived from cumbersome numerical simulations that end up beclouding the comparative static analysis. Against this background, the aim of the present paper is to supplement the existing literature in three respects. First, we use a different model of monopolistic competition that can be solved analytically, which in turn allows us to go far beyond existing studies in terms of comparative statics results. Second, our model also allows us to introduce variable mark-ups, thus accounting explicitly for the pro-competitive effects that interregional and international integration may trigger. Third, our quasi-linear specification allows for a simple aggregate welfare analysis, which is usually especially problematic and cumbersome in models featuring mobile agents (Charlot et al., 2006). On all three counts, our model leads to a more careful assessment of the welfare implications of various types of economic integration in the presence of goods and factor mobility.

The model of monopolistic competition we use has been devised by Ottaviano et al. (2002) to obtain closed form solutions in the original core-periphery model of Krugman (1991). In Section 2, we extend it to a richer spatial setting by borrowing some of the defining assumptions of the existing contributions discussed above. In particular, in the wake of Monfort and Nicolini (2000), we consider two countries each made of two regions. Countries and regions are distinguished from each other by differences in both *shipping costs* and *factor mobility*. Specifically, goods are assumed to be mobile between both countries and regions, whereas factors move only between regions within the same country. Moreover, trade is hampered by 'transport' costs between regions and by 'trade' costs between countries. Albeit particular and simple, this framework is sufficient to study how changing transport and/or trade costs affect the distribution of activities within countries and how the resulting economic geography of countries influences the pattern of international trade as well as national and global welfare.

As in Krugman (1991), production takes place in two sectors, a perfectly competitive sector and a monopolistically competitive one. The former employs only unskilled labor, which is immobile both between and within countries, whereas the latter employs only skilled labor, which is immobile between countries but mobile within them. Two remarks on these assumptions are in order. First, although international labor mobility between EU countries is basically free under the Rome Treaty, labor generally remains highly immobile (Faini, 1999). Second, the relative immobility of unskilled with respect to skilled workers fits well empirical evidence (Greenwood, 1997). We hence view our assumptions as largely reflecting the current situation in the EU, which is our main point of interest.[1]

The fundamental difference between our framework and those deriving from Krugman (1991) is that monopolistically competitive firms face variable rather than constant demand elasticity. This allows us to highlight two *direct competition effects*: (i) Local prices decrease with the number of local producers, in accordance with the theory of industrial organization; and (ii) lower transport and/or trade costs lead to lower prices, as suggested in location theory. Both effects are due to falling local markups ('pro-competitive effect') whereas they would be fixed with a constant demand elasticity. Thus, even though our monopolistic competition model still abstracts from direct strategic interactions between individual firms, it captures most of the main features of oligopolistic competition through markups that vary with the number of firms and the level of trade barriers. As recently argued by Winters and Chang (2000) as well as Chang and Winters (2002), such effects seem to be crucial for measuring the impact and welfare consequences of trade liberalization.

Section 3 solves for the equilibrium distribution of skilled workers and firms. Our key positive result is that lower intranational transport costs foster regional agglomeration when international trade costs are high enough, whereas lower international trade costs promote regional dispersion when intranational transport costs are high enough. This result qualifies the existing literature surveyed above. In particular, as already pointed out, both extensions of the original core-periphery model of Krugman (1991) by Monfort and Nicolini (2000) and Paluzie (2001) imply that international trade liberalization between countries leads to more agglomeration within each country. Since our model shares with theirs its basic structure and, in particular, their focus on immobile demand as the source of dispersion forces, the contrast reveals the importance of allowing for variable markups. When this is the case, the agglomeration of competing firms reduces their market power, thus imposing a downward pressure on markups. This pro-competitive effect, which is absent in their models, acts as an additional dispersion force. Our findings agree with some of the conclusions obtained by Head and Mayer (2004, p. 2632) in their survey of the empirics of agglomeration and trade: "These results point to the empirical relevance of agglomeration forces operating through forward linkages, but these forces are likely to stay very localized, *unable to generate core-periphery patterns in Europe at a large geographical level* at least as long as labor remains so sensitive to migration costs" (emphasis in the original).

Further gains from building on Ottaviano et al. (2002) are reaped in the next three sections, where we perform a detailed analysis of the welfare impacts of international (Section 4) and intranational (Section 5) integration stressing the incentives for countries to coordinate their transport policies (Section 6). Three results stand out. First, as in Brander and Krugman (1983), there can be 'excessive trade' even though trade makes a wider variety of products available to consumers. Specifically, deeper integration decreases welfare when trade costs are high. By contrast, it increases welfare when trade costs have fallen below some threshold. Additionally, the range of trade costs for which trade liberalization raises welfare depends on the internal geography and the quality of transportation infrastructure of the trading partners. Second, each country has always an

[1]We disregard the analysis of immigration from outside the two countries in our model. Though potentially very interesting, this topic is beyond the scope of this paper.

incentive to reduce its own interregional transport costs. However, such reduction is always harmful to the other country and constitutes, therefore, a *beggar-thy-neighbor policy*. The reason is that, by improving its own transportation infrastructure, a country makes its domestic market more competitive and, therefore, reduces the operating profits of foreign firms as well as the wages they pay to their workers. Hence, there is a *negative pecuniary transport externality* that materializes through the channel of internal trade. Third, as a consequence, *both countries may end up being trapped into a prisoner's dilemma*. This calls for the international coordination of national transport policies as envisaged by the Rome Treaty (Articles 3 and 71): "A common policy in the sphere of transport [...] to or from the territory of a Member State or passing across the territory of one or more Member States". It also calls for the coordination of transport policies with trade, competition, and regional policies during the process of economic integration. Some concluding remarks are contained in Section 7.

2. The model

The economy consists of two countries, labeled i (or j) $= H(ome)$ or $F(oreign)$, each having two regions labeled r (or s) $= 1, 2$. When needed, variables associated with each country and each region will be subscripted accordingly. Because of the symmetry assumption made precise below, there is no need to name differently the regions belonging to country H or F.

There are two production factors, skilled and unskilled labor; we denote by L (resp., by A) the mass of skilled (resp., of unskilled) workers in each country. Because international trade is essentially characterized by two-way trade in similar goods among similar nations, especially within the EU, we abstract from comparative advantage of both the Ricardian and Heckscher–Ohlin types. We therefore assume that both countries have access to the same technology, whereas their relative factor endowments L/A are identical.

Each individual works and consumes in the region she is established in. Unskilled workers are immobile and evenly split between regions so that each region accommodates a mass $A/2$ of them. In the wake of Krugman (1991), 'immobile labor' A is usually interpreted as a proxy for all non-tradable services, amenities and factors such as land (Baldwin et al., 2003). Accordingly, our symmetric assumption is made to prevent any region from having a priori some locational advantage in terms of market size.

Skilled workers are *mobile within* but *immobile between countries*; we denote by $\lambda_i \in [0, 1]$ their share in region 1 of country $i = H, F$. This means that the mass of skilled workers living in country i is constant, but that its interregional distribution is endogenously determined in equilibrium.

2.1. Preferences

Each consumer is endowed with one unit of labor, which she supplies inelastically, and has quasi-linear preferences over a homogeneous and a differentiated consumption good.[2] The subutility over the (endogenously determined) total mass N of varieties of the

[2]We do not view the use of quasi-linear preferences as a major handicap of our model. Indeed, as recently shown by Dinopoulos et al. (2006, p. 22), "quasi-linear preferences behave reasonably well in general-equilibrium [trade] settings".

differentiated good is quadratic, as in Ottaviano et al. (2002). An individual solves the following consumption problem:

$$\max_{q(v),\forall v\in[0,N]} \quad \alpha\int_0^N q(v)\,\mathrm{d}v - \frac{\beta-\gamma}{2}\int_0^N [q(v)]^2\,\mathrm{d}v - \frac{\gamma}{2}\left[\int_0^N q(v)\,\mathrm{d}v\right]^2 + q_0$$
$$\text{s.t.} \quad \int_0^N p(v)q(v)\,\mathrm{d}v + q_0 = y + \overline{q}_0,$$

where $\alpha > 0$, $\beta > \gamma > 0$ are parameters; $p(v)$ is the consumer price of variety v and y is the consumer's income, which depends on her skilled/unskilled status. In this expression, α measures the intensity of preferences for the differentiated product with respect to the numéraire, whereas the condition $\beta > \gamma$ implies that workers have a preference for variety. Because it is reasonable to have individuals consuming both goods at the market outcome, which as a by-product eliminates the income effects in our quasi-linear specification (Vives, 1999, p. 76), we assume that each worker has in addition to her wage a sufficiently large endowment $\overline{q}_0 > 0$ of the numéraire.

In what follows, we need to keep track of where goods are produced and where goods are consumed. To make notation more compact, a triplet *irs* henceforth refers to varieties produced in region $r = 1, 2$ of country i and sold to region $s = 1, 2$ of the same country; whereas a triplet *ijr* refers to varieties produced in either region of country i and sold to region $r = 1, 2$ of country $j \neq i$. As said above, there is no need to mention the region of origin in country $i = H, F$ in the latter case, because all firms located in that country have the same access to each region of country $j \neq i$. For example, the triplet $H12$ would refer to varieties produced in region 1 and sold to region 2 of the same country H. The triplet $HF2$ would refer to varieties produced in either region of country H and sold to region 2 of country F.

Using this notation, it is readily verified that the demands of a consumer in region r of country i are given as follows:

- intraregional demands:
$$q_{irr}(v) = a - (b + cN)p_{irr}(v) + cP_{ir}, \tag{1}$$
- interregional demands:
$$q_{isr}(v) = a - (b + cN)p_{isr}(v) + cP_{ir}, \tag{2}$$
- international demands:
$$q_{jir}(v) = a - (b + cN)p_{jir}(v) + cP_{ir}, \tag{3}$$

where $p_{isr}(v)$ denotes the price a variety-v firm located in region s of country i charges to consumers in region r of the same country; whereas $p_{jir}(v)$ denotes the price a variety-v firm located in country j charges in region r of the other country $i \neq j$. In expressions (1)–(3),

$$a \equiv \frac{\alpha}{\beta + (N-1)\gamma}, \quad b \equiv \frac{1}{\beta + (N-1)\gamma}, \quad c \equiv \frac{\gamma}{(\beta-\gamma)[\beta + (N-1)\gamma]}$$

are positive bundles of parameters. If Λ_{ir} denotes the set of varieties produced in region r of country i, the measure of which is n_{ir} (with $n_{H1} + n_{H2} + n_{F1} + n_{F2} = N$), we have

$$P_{ir} \equiv \int_{\Lambda_{ir}} p_{irr}(v)\,\mathrm{d}v + \int_{\Lambda_{is}} p_{isr}(v)\,\mathrm{d}v + \int_{\Lambda_{jr}\cup\Lambda_{js}} p_{jir}(v)\,\mathrm{d}v \quad s \neq r \quad \text{and} \quad j \neq i \tag{4}$$

which is the average consumer price (up to the factor $1/N$) of all varieties in region r of country i.

2.2. Technology

There are two sectors in the economy. The first one supplies the homogeneous good under perfect competition using unskilled labor as the only input of a constant-returns technology. The unit input requirement is set to one by choice of units. In the second sector, monopolistically competitive firms offer a continuum of varieties of the horizontally differentiated good employing both types of labor under increasing returns to scale. We assume that firms can costlessly differentiate their products, so that there is a one-to-one correspondence between firms and varieties. Hence, N also stands for the mass of firms operating in the two countries.

Each firm in the monopolistically competitive sector incurs a fixed cost of $\phi > 0$ units of skilled labor, whereas its marginal labor requirement is normalized to zero without loss of generality.[3] Skilled labor market clearing in both regions of country $i = H, F$ for any given distribution λ_i of skilled workers then requires that

$$n_{i1} = \frac{\lambda_i L}{\phi}, \quad n_{i2} = \frac{(1-\lambda_i)L}{\phi}, \quad n \equiv n_{i1} + n_{i2} = \frac{L}{\phi}, \quad N = 2n. \tag{5}$$

Turning to the transportation technology, goods can be shipped across countries and regions at different shipping costs. As in most new trade and economic geography models, all shipments of the homogeneous good are assumed to be costless (Krugman, 1991; Fujita et al., 1999). Though restrictive, this assumption vastly simplifies the analysis without strongly affecting the main conclusions that can be derived from the model of the linear genre considered here (Picard and Zeng, 2005). The simplification comes from the fact that, by choosing the homogeneous good as the numéraire, in equilibrium the unskilled wage is equal to one everywhere.

Turning to the differentiated good, both international and interregional shipments of its varieties are costly. Since countries and regions may be connected to one another in various ways, conditioned by geography, infrastructure, and regional trade agreements, there is a fairly long list of cases to investigate in general. This is why we propose to simplify the analysis by assuming that all regions of a country have the same access to all regions of the other country: International shipments face the same unit cost $\tau > 0$ in terms of the numéraire, regardless of the regions of origin and destination.[4]

Interregional shipments may, by contrast, face different costs due to differences in local transportation infrastructure: Shipping one unit within country $i = H, F$ requires $t_i > 0$

[3]The model can easily be extended to the case in which the production of $q(v)$ units of variety v requires $m\,q(v)$ units of unskilled labor. What follows holds true provided that α is replaced by $\alpha - m$ in the demand functions.

[4]Behrens et al. (2006a) extend the present framework to the case of regional asymmetries, in which one country has a gated and one country has a landlocked region.

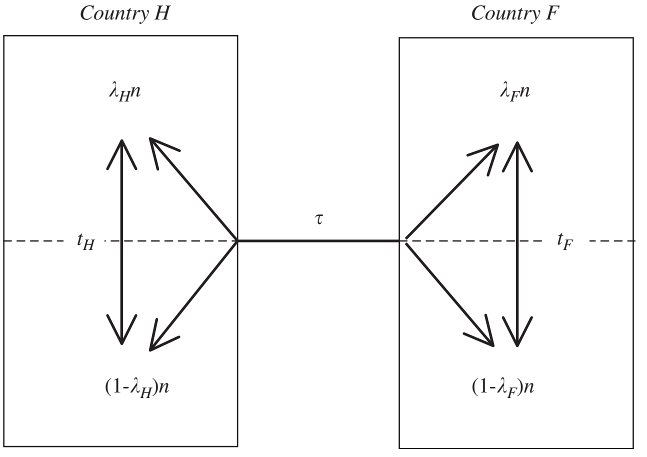

Fig. 1. Schematical representation of the space-economy.

units of the numéraire. For the ease of exposition, henceforth we refer to the international cost τ as the *trade cost* and to the interregional costs t_H and t_F as the *transport costs*. Note that since our main interest is to analyze the interactions between international trade costs and interregional transport costs, there is a priori no reason to assume that $t_H = t_F$. Our geography of transportation and trade is illustrated in Fig. 1: There is symmetry in transaction costs between pairs of regions belonging to different countries, whereas transaction costs between the two regions of the same country are country-specific.

Conceptually, the difference between trade and transportation costs is the following. The cost τ includes all impediments to trade, such as shipping costs per se, but also tariff and non-tariff barriers, different product standards, difficulty of communication, informational barriers and cultural differences. Differently, t_i stands for the sole costs of shipping the differentiated product between the two regions of the same country i. Although both of these costs have significantly decreased in recent decades, one should note that they are still far from being negligible.[5]

One final remark is in order. Because bilateral trade occurs between all EU-15 member states at a sufficiently high level of product aggregation (e.g., at the 3-digit ISIC level), as well as within each member-state, we find it relevant to focus on the case in which transport costs t_i and trade costs τ are sufficiently low for interregional and international trade to be bilateral, regardless of the distributions λ_H and λ_F of firms.[6] The formal conditions for this to hold will be established later.

2.3. Product and labor markets

We make three crucial assumptions: Product markets are *segmented*, labor markets are *local* and entry as well as exit are free. The first assumption means that each firm can set a

[5]For example, for the developed countries we have in mind, Anderson and van Wincoop (2004) provide a 'consensus estimate' of the average ad-valorem tax equivalent of total trade barriers equal to 170%. Combes and Lafourcade (2005) observe that interregional transport costs remain high, even in countries well equipped with high-quality infrastructure such as France.

[6]Note, however, that bilateral trade need not occur at more disaggregate ISIC levels, e.g. at the 6-digit level.

price specific to the region and the country in which it sells its output. Whereas there is a vast amount of empirical evidence suggesting that international markets are segmented (Haskel and Wolf, 2001), one might think of markets within free-trade areas as being more integrated in that firms would be mill pricers. While this is true to some extent, even within fairly well-integrated regional blocks, such as the EU or Canada/US, border effects remain strong (Engel and Rogers, 1996; Head and Mayer, 2000). Even more surprising, the evidence suggests that spatial price discrimination and border effects are pervasive *within* major industrialized countries (Greenhut, 1981; Wolf, 2000). In addition to largely contradicting the empirical evidence, using mill pricing would also render the formal analysis somewhat more complex without adding much to our main results.

The second and third assumptions imply that skilled wages are determined in each region by the zero-profit condition of the corresponding region. More precisely, the equilibrium wages of the skilled are determined by a local bidding process in which firms compete for workers by offering higher wages until no firm can profitably enter or exit the market. In what follows, we denote by w_{ir} the resulting skilled wage rate prevailing in region r of country i.

Under the foregoing assumptions, a firm located in region 1 of country H maximizes profits, given by

$$\pi_{H1} = q_{H11}\left[\frac{A}{2} + \lambda_H L\right]p_{H11} + q_{H12}\left[\frac{A}{2} + (1-\lambda_H)L\right](p_{H12} - t_H) + q_{HF1}\left[\frac{A}{2} + \lambda_F L\right](p_{HF1} - \tau) + q_{HF2}\left[\frac{A}{2} + (1-\lambda_F)L\right](p_{HF2} - \tau) - \phi w_{H1} \quad (6)$$

with respect to all four prices $p_{H11}, p_{H12}, p_{HF1}$ and p_{HF2} separately. Firms located in other regions solve symmetric maximization problems.

2.4. The market outcome

Having laid out its basic structure, we now solve the model in two steps by distinguishing between 'short-run' and 'long-run' outcomes. The present section deals with the short run when all labor is immobile and determines the market allocation for any given spatial distribution λ_H and λ_F of skilled workers. In other words, λ_H and λ_F are chosen arbitrarily at some initial values, and we find the corresponding profit-maximizing prices and zero-profit wages. In the long run, discussed in the next Section 3, skilled workers become mobile and the values of λ_H and λ_F are endogenously determined as the result of utility-maximizing migration decisions.

Maximization of the profit (6) yields the following profit-maximizing prices as a function of the price aggregate:

- intraregional prices:

$$p_{H11}(P_{H1}) = \frac{a + cP_{H1}}{2(b + cN)}, \quad (7)$$

- interregional prices:

$$p_{H12}(P_{H2}) = p_{H22}(P_{H2}) + \frac{t_H}{2}, \quad (8)$$

- international prices:

$$p_{HFr}(P_{Fr}) = p_{Frr}(P_{Fr}) + \frac{\tau}{2}, \quad r = 1, 2. \tag{9}$$

Note that the price a firm sets in a region depends on the average price of this region, which depends itself on the prices set there by all firms. Because there is a continuum of firms, each firm is negligible and chooses its optimal price, taking aggregate market conditions as given. At the same time, these aggregate market conditions must be consistent with firms' optimal pricing decisions. Hence, the (Nash) equilibrium price aggregate P^*_{H1} must satisfy the following fixed point condition:

$$P^*_{H1} = n_{H1}p_{H11}(P^*_{H1}) + n_{H2}p_{H21}(P^*_{H1}) + (n_{F1} + n_{F2})p_{FH1}(P^*_{H1}). \tag{10}$$

Similar conditions hold for the other regions. Under our assumption of bilateral trade between all countries and regions, the equilibrium price aggregate can be found by solving (10) for P^*_{H1} after using expressions (7)–(9) and recalling that $n = n_{H1} + n_{H2} = n_{F1} + n_{F2}$:

$$P^*_{H1} = \frac{2an + (b + 2cn)[(n - n_{H1})t_H + n\tau]}{2(b + cn)}. \tag{11}$$

Thus, the price aggregate decreases with the mass n_{H1} of local firms, since these firms can supply the local market at zero costs. Substituting (11) into (7) finally allows us to retrieve the equilibrium prices as follows:

- intraregional prices:

$$p^*_{H11} = \frac{2a + c[(n - n_{H1})t_H + n\tau]}{4(b + cn)}, \tag{12}$$

- interregional prices:

$$p^*_{H12} = p^*_{H22} + \frac{t_H}{2}, \tag{13}$$

- international prices:

$$p^*_{HFr} = p^*_{Frr} + \frac{\tau}{2}, \quad r = 1, 2. \tag{14}$$

As expected, each of these equilibrium prices decreases with the number of firms located in the corresponding region. Prices also depend positively on transport and trade costs, thus accounting for intranational and international competition. In what follows, we refer to these two effects as the *pro-competitive effects*. However, as lower prices and unit transport costs lead to higher commodity volumes to ship, more resources might be needed for this to happen. We refer to this as the *transport resource effect*. Finally, the equilibrium price that country-H firms set in region r of country F does not depend on the region of country j in which the firm is located; this is because all firms in country H have the same access to each region of the other country.

Substituting the equilibrium prices (12)–(14) into the demands (1)–(3) and using (11), the equilibrium consumption levels can be expressed as follows:

- intraregional demands:

$$q_{H11}^{*} = a - bp_{H11}^{*} + cn\frac{t_H}{2} + cn\frac{\tau}{2}, \quad (15)$$

- interregional demands:

$$q_{H12}^{*} = q_{H22}^{*} - (b + cN)\frac{t_H}{2}, \quad (16)$$

- international demands:

$$q_{HF1}^{*} = q_{F11}^{*} - (b + cN)\frac{\tau}{2}. \quad (17)$$

Not surprisingly, high trade costs raise the domestic demand for each national variety at the expense of varieties produced abroad. This substitution effect decreases when varieties becomes more differentiated (c decreases). Similarly, the intraregional demand for each locally produced variety increases when internal transport costs rise.

We are now equipped to determine the conditions on τ, t_H and t_F for trade to occur between any two regions at these equilibrium prices. Starting with interregional transport costs, it is easy to check that

$$\max\{t_H, t_F\} \leqslant t_{\text{trade}}(\tau) \equiv \frac{2a + cn\tau}{2(b + cn)} \quad (18)$$

must hold for interregional trade in each country to take place, regardless of the firm distributions λ_H and λ_F. Observe that a lower τ leads to a decrease in the threshold value of interregional transport costs for which there is interregional trade. Hence, *lower trade costs in the international marketplace may lead to a break down of internal trade when the regional markets of a country are poorly integrated.* This is because cheaper imported varieties will displace more expensive nationally produced ones. As to international trade costs, it is readily verified that the condition

$$\tau \leqslant \frac{2a + cn_{js}t_j}{2b + cn} \quad (19)$$

must hold for the interregional demands q_{ijr} to be positive. As can be seen from condition (19), the feasibility of international trade depends on the value of interregional transport costs and on the spatial distribution of industry *within* each country. This is because lower interregional transport costs and the agglomeration of firms exacerbate price competition in local markets, thus making penetration by outside firms more difficult. International trade occurs for all spatial distributions of the industry if and only if

$$\tau \leqslant \tau_{\text{trade}} \equiv \frac{2a}{2b + cn} \quad (20)$$

holds. Note that the value τ_{trade} does not depend on national transport costs because international trade costs are not region-specific. For the reasons mentioned in Section 2.3, we assume that both conditions (18) and (20) are always satisfied.

Turning to factor prices, the equilibrium wages of the skilled are determined by a bidding process in which all operating profits are absorbed by the wage bill. Therefore, in equilibrium the skilled wage rate in region $r = 1, 2$ of country $i = H, F$ satisfies $\pi_{ir}(w^*_{ir}) = 0$. This wage is determined by a *national component*, which depends on the distribution λ_i of firms in country i, as well as by an *export component*, which depends on the distribution λ_j of firms in the other country. This separability property will be important in the subsequent equilibrium analysis. Let us express the equilibrium wage in region r of country i as follows:

$$w^*_{ir} = \frac{D_i(\lambda_i) + E_i(\lambda_j)}{\phi}, \quad i \neq j, \tag{21}$$

where, using (5) and (6),

$$D_i(\lambda_i) = \left(\frac{A}{2} + \phi n_{ir}\right) p^*_{irr} q^*_{irr} + \left(\frac{A}{2} + \phi n_{is}\right)(p^*_{irs} - t_i) q^*_{irs},$$

$$E_i(\lambda_j) = \left(\frac{A}{2} + \phi n_{jr}\right)(p^*_{ijr} - \tau) q^*_{ijr} + \left(\frac{A}{2} + \phi n_{js}\right)(p^*_{ijs} - \tau) q^*_{ijs}$$

and where all quantities are evaluated at the equilibrium prices. The first term is the revenue from domestic sales of a firm located in country i, whereas the second term stands for its export revenue from foreign sales. Substituting these expressions back into (21) and using the equilibrium quantities finally yields

$$\begin{aligned} w^*_{ir} = & \frac{b + cN}{\phi}\left[\left(\frac{A}{2} + \phi n_{ir}\right)(p^*_{irr})^2 + \left(\frac{A}{2} + \phi n_{is}\right)(p^*_{irs} - t_i)^2\right] \\ & + \frac{b + cN}{\phi}\left[\left(\frac{A}{2} + \phi n_{jr}\right)(p^*_{ijr} - \tau)^2 + \left(\frac{A}{2} + \phi n_{js}\right)(p^*_{ijs} - \tau)^2\right]. \end{aligned} \tag{22}$$

The *market equilibrium* for any given distribution (λ_H, λ_F) of skilled labor is then defined by (5), (12)–(14) and (22) for all countries and regions.

3. National and global equilibria

In the long run, skilled workers within each country migrate to the region that offers them the highest utility. Hence, we first evaluate the indirect utilities of the skilled workers in regions 1 and 2 of country $i = H, F$ at the market equilibrium derived in the previous section. As shown by Ottaviano et al. (2002), the indirect utility in region r of country i is given by $V_{ir} = S_{ir} + w^*_{ir} + \overline{q}_0$, where

$$\begin{aligned} S_{ir} = & \frac{a^2 N}{2b} - a(n_{ir} p^*_{irr} + n_{is} p^*_{isr} + n p^*_{jir}) \\ & + \frac{b + cN}{2}[n_{ir}(p^*_{irr})^2 + n_{is}(p^*_{isr})^2 + n(p^*_{jir})^2] - \frac{c}{2}(n_{ir} p^*_{irr} + n_{is} p^*_{isr} + n p^*_{jir})^2 \end{aligned} \tag{23}$$

is the individual consumer surplus evaluated at the market equilibrium. The *indirect utility differential* between the two regions of country $i = H, F$ is then defined by

$$\Delta V^*_i(\lambda_i) \equiv V^*_{i1}(\lambda_i) - V^*_{i2}(\lambda_i) \tag{24}$$

which depends only upon the distribution λ_i in country i. This property stems from the fact that, as shown by (21), the equilibrium wage w^*_{ir} prevailing in region r of country i is given by the sum of two terms, $D_i(\lambda_i)$ and $E_i(\lambda_j)$, which are, respectively, independent of λ_j and of λ_i.

As a result, $E_i(\lambda_j)$ cancels out in the indirect utility differential ΔV_i^*, which becomes a function of the domestic distribution λ_i only. In other words, the spatial allocation of mobile activities within a country is not affected by the degree of agglomeration in the other country. However, we will see below that the level of welfare prevailing in a country depends on the internal geography of its trading partner as this directly affects equilibrium prices.

A *national equilibrium* is such that, in each country, no skilled worker has an incentive to change location, conditional upon the fact that the product markets clear at the equilibrium prices (12)–(14), while labor markets clear at the equilibrium wages (22). Formally, a national equilibrium arises at $\lambda_i \in (0,1)$ when $\Delta V_i^*(\lambda_i) = 0$, or at $\lambda_i = 0$ if $\Delta V_i^*(0) \leqslant 0$, or at $\lambda_i = 1$ if $\Delta V_i^*(1) \geqslant 0$. An interior equilibrium is *stable* if and only if the slope of the indirect utility differential (24) is negative in a neighborhood of the equilibrium, whereas the two agglomerated equilibria are always stable whenever they exist.

After substituting (5), (12)–(14) and (22) into (24), some cumbersome but standard calculations yield

$$\Delta V_i^*(\lambda_i) = \frac{n(b+2cn)t_i}{4\phi(b+cn)^2}\left(\lambda_i - \frac{1}{2}\right)(-\varepsilon_1 t_i + \varepsilon_2 + \varepsilon_3 \tau), \tag{25}$$

where

$$\varepsilon_1 \equiv 5c^2n^2\phi + 12bcn + 2c^2nA + 6b^2\phi + 2bcA > 0,$$
$$\varepsilon_2 \equiv 4a\phi(3b+4cn) > 0, \quad \varepsilon_3 \equiv 2cn\phi(2b+3cn) > 0$$

are bundles of parameters that are independent of transport and trade costs.

It follows immediately from (25) that $\lambda_i = \frac{1}{2}$ is always an equilibrium within each country. Since the indirect utility differential is linear with respect to λ_i, the stability of this equilibrium depends on the sign of $-\varepsilon_1 t_i + \varepsilon_2 + \varepsilon_3 \tau$. When this expression is negative, dispersion is the unique stable national equilibrium in country *i*; by contrast, when it is positive, the dispersed equilibrium is unstable so that the agglomeration of skilled workers of country *i* is the only stable equilibrium. This implies that *the economic geography of a country depends on its transport costs as well as on trade costs*, *but not on the transport costs of the other country*. This result depends on the following two assumptions. The first key-assumption is that all firms in a country have the same access to the regional markets of the other country. The second key-assumption is that international markets are segmented. Assuming that national markets are integrated (i.e., firms must charge the same mill price to all their customers living in the same country) would not affect the foregoing separability property. However, the geography of country *i* would depend on transport costs in country *j* if the international markets were integrated. As mentioned in the foregoing, there is little empirical evidence supporting such a pricing policy, especially at the international level (Engel and Rogers, 1996; Head and Mayer, 2000; Haskel and Wolf, 2001).

As the indirect utility differential in each country depends only upon its internal distribution of economic activities, a *global equilibrium* consists of two independent national equilibria (one for each country). As argued previously, agglomeration is a national equilibrium in country *i* if and only if $-\varepsilon_1 t_i + \varepsilon_2 + \varepsilon_3 \tau \geqslant 0$, which means that

$$t_i \leqslant \frac{\varepsilon_2 + \varepsilon_3 \tau}{\varepsilon_1} \tag{26}$$

or, alternatively,

$$\tau \geqslant \frac{\varepsilon_1 t_i + \varepsilon_2}{\varepsilon_3} \tag{27}$$

are necessary and sufficient conditions for agglomeration in country i to be a stable national equilibrium. This result may be summarized as follows.

Proposition 1 (*national equilibrium*). *Agglomeration is a stable national equilibrium in country i if and only if*

$$t_i \leqslant t^*(\tau) \equiv \frac{2\phi[2a(3b+4cn)+2cn\phi(2b+3cn)\tau]}{5c^2n^2\phi+6b\phi(b+2cn)+2cA(b+cn)}$$

or, equivalently, if and only if

$$\tau \geqslant \tau^*(t_i) \equiv \frac{[5c^2n^2\phi+6b\phi(b+2cn)+2cA(b+cn)]t_i - 4a\phi(3b+4cn)}{2cn\phi(2b+3cn)}.$$

The two inequalities identified in Proposition 1 are 'dual' to the extent that each yields a necessary and sufficient condition to be imposed on transport or on trade costs for agglomeration to arise in a country, each condition depending on the other parameter.[7]

The following comments are in order. First, because ε_1 is positive, *for a given τ agglomeration within country i is more likely to be a stable national equilibrium when the transport costs in this country are low*. Everything else being equal, more intranational competition leads domestic firms to cluster because they have a larger market (recall that the spatial distribution of consumers within each country is endogenous), which in turn makes the penetration by the foreign firms more difficult. This concurs with the main result of economic geography in which agglomeration arises when trading across places becomes less expensive (Krugman, 1991; Fujita et al., 1999). The novelty is that here the occurrence of agglomeration is lowered, namely $t^*(\tau)$ decreases, as trade costs keep falling. Hence, among other things, Proposition 1 shows how international trade impediments may affect the internal economic geography of countries involved in the integration process.

Second, ε_3 being positive, *for a given t_i such that $\tau^*(t_i) > 0$, agglomeration within a country is more likely to be a stable equilibrium when trade costs are high*. Everything else equal, domestic firms react to more international competition by relaxing intranational competition through dispersion. Then, liberalizing trade would foster dispersion within each country, thus providing a rationale for the empirical results of Ades and Glaeser (1995) mentioned in the Introduction. Our finding also agrees with recent work by Brülhart and Traeger (2005), who show that the 'topographical dispersion' of manufacturing activities has increased within the EU member-states in recent years.

As $\tau^*(t_i)$ increases with t_i, it also follows from Proposition 1 that the country with the lower transport costs is agglomerated for a larger range of trade costs. This result suggests that *lowering transport costs inside a country involved in a process of international integration could well trigger more regional imbalance within this country*, unless the global economy has reached a fairly high level of integration.

Last, because $\varepsilon_2 > 0$, (25) implies that *country i exhibits agglomeration when both t_i and τ are sufficiently low*. Observe also that ε_2 increases with a whereas ε_1 and ε_3 are independent

[7] Observe that, for both the agglomerated and dispersed configurations to arise as a spatial equilibrium, it must be that $\tau^*(t_i) < \tau_{\text{trade}}$ and $t^*(\tau) < t_{\text{trade}}(\tau)$.

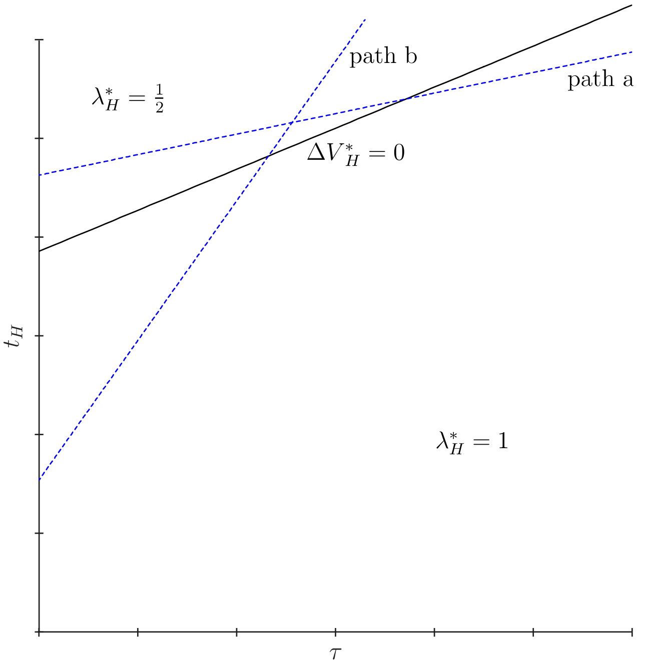

Fig. 2. Example of evolution of spatial equilibria in (τ, t_H)-space.

of a (the relative value of the differentiated product). This means that agglomeration is more likely to occur when the intensity of preferences for the differentiated product is strong enough.

Finally, it remains to investigate the impact of a simultaneous reduction in transport and trade costs. Assuming first the case of a joint and equiproportionate decrease of t_i and τ, we have

$$\mathrm{d}(-\varepsilon_1 t_i + \varepsilon_2 + \varepsilon_3 \tau) = -\varepsilon_1 \,\mathrm{d}t_i + \varepsilon_3 \,\mathrm{d}\tau = (-\varepsilon_1 + \varepsilon_3)\,\mathrm{d}\tau.$$

Because $-\varepsilon_1 + \varepsilon_3 < 0$, we thus see that an equiproportionate decrease in both (international) trade and (national) transport costs increases the likelihood of an agglomerated outcome in each country. However, Fig. 2 shows that the impacts of a non-equiproportionate decrease in transport and trade costs on the internal spatial structure of the two countries are a priori ambiguous. When trade costs fall faster than transport costs, firms may disperse within countries (path (a) in Fig. 2), whereas when transport costs fall faster than trade costs, firms may agglomerate (path (b) in Fig. 2).[8] Stated differently, *the relative speed of interregional and international integration matters a great deal for the countries' internal structure*.

For the foregoing discussion to be relevant, both agglomeration and dispersion must arise as equilibrium outcomes in each country. We show in Appendix A that a sufficient

[8] The parameter values underlying Fig. 2 are chosen as follows: $\alpha = \beta = 1$, $\gamma = \frac{1}{2}$, $A = 25$, $L = 6.5$, and $\phi = \frac{1}{2}$. Note, however, that the qualitative features of Fig. 2 are unaffected by parameter choice since ε_1, ε_2 and ε_3 are unambiguously signed.

condition for this to happen is that the mass of unskilled workers exceeds some threshold larger than three times the mass of skilled workers. This reflects the idea that immobile activities represent the larger share of the economy.

4. Trade costs and welfare

Our framework allows for a precise study of the welfare impacts of the various parameters expressing the freeness of trade across regions and countries. For simplicity, in analyzing such impacts, we neglect both the proceeds that governments obtain through tariffs on imports and the infrastructure costs they incur to make interregional transportation cheaper. Notice, however, that assuming that reductions in trade and/or transport costs require the use of resources would reinforce our results.

Individual utilities being quasi-linear, the sum of consumer and producer surplus (which is absorbed by the skilled wages) provides "an appropriate" measure of welfare in each country $i = H, F$:

$$W_i(\lambda_i, \lambda_j) = \lambda_i L[S_{i1}(\lambda_i) + w_{i1}(\lambda_i, \lambda_j)] + (1 - \lambda_i)L[S_{i2}(\lambda_i) + w_{i2}(\lambda_i, \lambda_j)] + \frac{A}{2}[S_{i1}(\lambda_i) + S_{i2}(\lambda_i) + 2],$$

where S_{ir}, as defined by (23), is the consumer surplus in region $r = 1, 2$ of country $i = H, F$ (recall that unskilled wages are equal to unity by choice of numéraire). Note that the effect of a decrease in trade costs on welfare is a priori ambiguous. On the one hand, decreasing trade costs imply a decline in equilibrium prices (see (12)), thus raising consumers' surplus. On the other hand, lower equilibrium prices decrease operating profits and, hence, wages (see (22)).

Consider first the short-run case of fixed distributions (λ_H, λ_F). To gain insights into the relationship between trade costs and welfare, we differentiate W_i with respect to τ, which yields

$$\frac{\partial W_i}{\partial \tau} = \frac{b + 2cn}{16(b + cn)}(-\kappa_1 t_i - \kappa_2 t_j + \kappa_3 \tau - \kappa_4),$$

where

$$\kappa_1(\lambda_i) \equiv 2(b + cn)[4cn^2\phi\lambda_i(1 - \lambda_i) + cnA] > 0,$$
$$\kappa_2(\lambda_j) \equiv 4cn^2(b + cn)\phi\lambda_j(1 - \lambda_j) + cnA(2b + cn) > 0,$$
$$\kappa_3 \equiv 2(6b^2 + 8bcn + 3c^2n^2)(\phi n + A) > 0,$$
$$\kappa_4 \equiv 2a(3b + 2cn)(n\phi + A) > 0.$$

Therefore, we have

$$\frac{\partial W_i}{\partial \tau} \gtreqqless 0 \quad \text{if and only if} \quad \tau \gtreqqless \hat{\tau}_i(\lambda_i, \lambda_j) \equiv \frac{\kappa_1(\lambda_i)t_i + \kappa_2(\lambda_j)t_j + \kappa_4}{\kappa_3},$$

where $\hat{\tau}_i(\lambda_i, \lambda_j) < \tau_{\text{trade}}$ for all admissible values of λ_i and t_i.

Without loss of generality, we may assume that $t_H \leqslant t_F$ so that $\hat{\tau}_H(\lambda_H, \lambda_F) \leqslant \hat{\tau}_F(\lambda_H, \lambda_F)$ for all national equilibria (see Appendix B). When τ starts decreasing from τ_{trade}, our results then show that *lowering trade costs makes each country worse off when these costs are sufficiently high*, i.e. when $\tau > \hat{\tau}_F(\lambda_H, \lambda_F)$. This is because the pro-competitive effect associated with more international integration is dominated by the increase in resources needed to support higher exports and imports. Indeed, the loss in individual welfare due to the replacement of domestic varieties by varieties produced abroad is large when trade costs are high (see (15) and (17)). As τ falls below $\widehat{\tau}_F(\lambda_H, \lambda_F)$, there is a first reversal in that welfare starts increasing in country F (the less integrated country) whereas it keeps decreasing in H (the more integrated country). For country F, the level of trade costs is now sufficiently low for the pro-competitive effect to become predominant. Finally, when τ is sufficiently low (i.e., when $\tau < \widehat{\tau}_H(\lambda_H, \lambda_F)$), welfare levels rise in both countries when trade costs decrease further. More generally, these results show that integrating two economies leads to a ∪-shaped relationship between national welfare and trade costs, with welfare being lowest in each country for some intermediate degree of international integration. *Stated differently, the benefits of integration come after its costs*, which may explain why it is difficult to agree on integration in the first place.

To sum-up, we have

Proposition 2 (*trade costs and welfare*). *Assume fixed distributions* (λ_H, λ_F). *When trade costs gradually decrease, the global economy goes through three phases*: (i) *The level of welfare in each country decreases*; (ii) *the less integrated country enjoys a welfare improvement, whereas the welfare of the more integrated country keeps falling*; *and* (iii) *both countries are better off*.

It is worth stressing that the decrease in welfare for high levels of trade costs stems from the fact that firms absorb shipping costs so that there is too much trade going on in equilibrium. This is reminiscent of the inefficiency of 'reciprocal dumping' pointed out by Brander and Krugman (1983) for the Cournot duopoly model: Lower trade costs may reduce welfare when they remain sufficiently high, because the transport resource effect due to dumping offsets the gains from tougher competition. However, as these costs fall further, less resources are used for transportation and the benefits of consuming more at lower prices take over. Here, the same line of reasoning applies due to freight absorption as the equilibrium prices (12)–(14) make clear.

Our analysis provides additional contributions to Brander and Krugman's about the impact of trade integration on welfare. First, when Brander and Krugman (1983, Section 3) consider free entry, their analysis reveals that the integration process raises unambiguously the level of welfare in each country. However, they do not consider the impact of integration on factor prices, so that only the consumer surplus is taken into account in their welfare analysis.

Second, in our model the impact of trade integration on national welfare depends also on the quality of transportation infrastructure within countries since $\widehat{\tau}_i$ depends positively on t_i and t_j. Hence, the range of trade costs for which trade integration is welfare-reducing shrinks when trade agreements concern countries having a low quality of domestic transportation infrastructure. Interestingly, *exports from the low transport cost country increase more than the rise of its imports*, which might provide an economic rationale, from the viewpoint of the old member-states, for the recent enlargement of the EU.

Third, the internal geography of trading partners matters in the relationship between trade integration and welfare. Indeed, Proposition 2 rests on the assumption that both distributions λ_H and λ_F are unaffected by the fall in trade costs. However, we know from Proposition 1 that lowering trade costs fosters the dispersion of activities within each country. Thus, we may expect either λ_H, or λ_F, or both, to decrease from 1 to $\frac{1}{2}$. In this case, the absolute value of both $\kappa_1(\lambda_i)$ and $\kappa_2(\lambda_j)$ increases, thus implying that both $\widehat{\tau}_H$ and $\widehat{\tau}_F$ rise. In other words, by changing the internal geography of each country, a steady decrease of trade costs leads to a shrinking of the domain over which more economic integration appears to be harmful to each country. This result also suggests that the welfare loss due to international integration is less likely when the national economies exhibit a dispersed spatial pattern, thus providing a rationale for the EU's regional development policies within the different member-states.

5. Transport costs and welfare

Consider now a gradual decrease in transport costs in country i. As the welfare impact may vary across countries, it is useful to distinguish between the *national* and the *global effects* of lower t_i.

5.1. National welfare

Some tedious, but standard, calculations show that, regardless of the equilibrium configuration in either country, we have

$$\frac{\partial W_i}{\partial t_i} < 0, \quad i = H, F.$$

Hence, *the welfare of country i always increases when its transport costs are lowered*. This is because the transport resource effect is always more than offset by the pro-competitive effect triggered by the lower unit transport cost: The domestic firms increase their market shares at the expense of foreign firms (see (15) and (17)).

Consider now the impact on country $j \neq i$. Because a decrease in t_i, by exacerbating price competition in country i, affects adversely the export prices of the firms located in country $j \neq i$ and because this effect is the only one that impacts on the welfare of this country, we immediately have

$$\frac{\partial W_j}{\partial t_i} > 0, \ i = H, F \quad \text{and} \quad j \neq i.$$

In words, we see that a country is always worse off when the other country improves the quality of its transportation infrastructure, thus showing that such an improvement is equivalent to a beggar-thy-neighbor policy. Put differently, we have something like a "fortress effect" in that *accessing the increasingly integrated national market becomes more and more difficult*. Such a finding might explain the negative empirical relationship between domestic transport infrastructure investment and foreign income obtained by Bougheas et al. (2003) from data on 16 European countries over the period 1987–1995.

A first conclusion therefore emerges: *Each country has an incentive to decrease its transport costs but this affects adversely the other country*. The reason is rent shifting which leads to a potential conflict of interests between countries.

5.2. Global welfare

The analysis of the impact of a change in t_i on global welfare is more convoluted as the total effect varies with the internal geography of the trading partners. For simplicity, we restrict ourselves to two special, but relevant, cases in which the transport cost t_i varies whereas t_j is kept constant, the resulting effect being evaluated when both costs are equal.

Let

$$\Omega_i(\lambda_i, \lambda_j) \equiv \frac{\partial W_i}{\partial t_i} + \frac{\partial W_j}{\partial t_i} \quad \text{with } j \neq i \tag{28}$$

so that the evolution of $W_i + W_j$ is given by the sign of $\Omega_i(\lambda_i, \lambda_j)$. When $\Omega_i(\lambda_i, \lambda_j) < 0$ (resp., $\Omega_i(\lambda_i, \lambda_j) > 0$), the global welfare rises (resp., falls) when transport costs in country i decrease. Setting $t_H = t_F = t$ in (28), we now show that the sign of $\Omega_i(\lambda_i, \lambda_j)$ varies with the value of t and, therefore, with the internal geography of countries H and F. As $t_H = t_F$, only two spatial patterns may arise in equilibrium, namely the two economies are dispersed ($\lambda_H = \lambda_F = \frac{1}{2}$) or agglomerated ($\lambda_H = \lambda_F = 1$). In other words, as shown by Proposition 1, we must distinguish the cases where $t > t^*(\tau)$ and $t < t^*(\tau)$.

Consider first the case in which $t > t^*(\tau)$, that is, dispersion prevails in either country. We then have

$$\Omega_i(\tfrac{1}{2}, \tfrac{1}{2}) = \frac{n(L + A)(b + cn)}{16(2b + cn)^2}(\delta_1 t - \delta_2 - \delta_3 \tau),$$

where $\delta_1 > 0$, $\delta_2 > 0$ and $\delta_3 > 0$ are bundles of parameters that are independent of transport and trade costs.[9] Let

$$\widetilde{t}_d(\tau) \equiv \frac{\delta_2 + \delta_3 \tau}{\delta_1} > 0$$

be the solution to $\delta_1 t - \delta_2 - \delta_3 \tau = 0$ with respect to t. It is then straightforward that $\Omega_i(\frac{1}{2}, \frac{1}{2}) > 0$ (resp., $\Omega_i(\frac{1}{2}, \frac{1}{2}) < 0$) if and only if $t > \widetilde{t}_d$ (resp., $t < \widetilde{t}_d$). In Appendix C, we show that $\widetilde{t}_d(\tau) > t^*(\tau)$ if and only if trade costs take fairly large values but these are such that dispersion still prevails in both countries. In this case, *global welfare decreases as long as $t > \widetilde{t}_d$ and increases when $\widetilde{t}_d > t > t^*(\tau)$*. By contrast, when trade costs take fairly small values, we have $\widetilde{t}_d(\tau) < t^*(\tau)$. Consequently, we always have $t > \widetilde{t}_d(\tau)$ so that *decreasing transport costs within a country is always inefficient.*

We now come to the case in which $t < t^*(\tau)$ so that agglomeration prevails in the two national economies. The analysis is similar to the one above but the results are more clear-cut. Specifically, we prove in Appendix D that $\Omega_i(1, 1)$ is always positive. Hence, *when the two countries are agglomerated, any reduction of transport costs by one country is always beneficial to this country and to the global economy.*

Our analysis may then be summarized as follows.

Proposition 3. *When dispersion prevails in both countries ($t > t^*(\tau)$), a unilateral decrease of transport costs by one country, evaluated at equal transport costs in both countries, is socially undesirable as long as $t > \widetilde{t}_d(\tau) > t^*(\tau)$ but becomes desirable when $t^*(\tau) < t < \widetilde{t}_d(\tau)$. When agglomeration prevails in both countries ($t < t^*(\tau)$), such a decrease is always socially desirable.*

[9] We have: $\delta_1 \equiv 12b^2 + 20bcn + 9c^2n^2$, $\delta_2 \equiv 4a(3b + 2cn)$ and $\delta_3 \equiv 2cn(4b + 3cn)$.

6. Is there a need to coordinate transport policies?

As varying trade and national transport costs have different impacts on welfare (see Propositions 2 and 3), the following question suggests itself: *should national and international transport policies be coordinated*? As in the foregoing, we assume that t_i varies unilaterally whereas t_j is kept constant, the resulting effect being evaluated when both costs are equal ($t_H = t_F = t$).

Our setting being symmetric, we have

$$\left.\frac{\partial W_j}{\partial t_i}\right|_{t_i=t_j} = \left.\frac{\partial W_i}{\partial t_j}\right|_{t_i=t_j} \quad \text{with } j \neq i. \tag{29}$$

Thus, substituting (29) into (28) shows that

$$\Omega_i(\lambda_i, \lambda_j) = \left.\frac{\partial W_i}{\partial t_i}\right|_{t_i=t_j} + \left.\frac{\partial W_i}{\partial t_j}\right|_{t_i=t_j} \quad \text{with } j \neq i$$

also measures the impact on the welfare of country i of a simultaneous and identical variation of t_i and t_j. We know that each country has an incentive to improve its welfare by decreasing its own transport costs. However, when both countries simultaneously decrease their transport costs, we may reinterpret the results of Proposition 3 as follows.

First, when $t > \widetilde{t}_d(\tau)$, each country ends up being worse off because the negative effect inflicted by the other country is dominant. Put differently, the two countries are in a *prisoner's dilemma situation*. This result is explained by the fact that lowering simultaneously both transport costs leads domestic and foreign firms to decrease their prices. Yet, because the international price difference remains the same whereas the interregional price difference decreases, consumers substitute national varieties for foreign varieties. When transport costs are initially high, firms price in the elastic part of their demand so that the revenues earned from exports fall substantially. This in turn yields lower operating profits and, hence, lower wages. Such a result can be established only in a setup accounting for the international relationships between countries as the direct effects of improving national transport infrastructure on domestic welfare are always positive. It uncovers a case in which international cooperation in choosing a transportation policy is desirable.

Second, as in the foregoing, when $t < \widetilde{t}_d(\tau)$ both countries are better off. All of this shows that *uncoordinated transport policies may have diverging consequences on the welfare level of each country according to the initial level of the corresponding transport costs*. That coordinating transport policies is globally desirable should not come as a surprise in a setting replete with pecuniary externalities. What is surprising is the fact that both countries can be hurt by the absence of cooperation in designing their transportation policies.

In Section 3, we have seen that a decrease in trade costs fosters dispersion, whereas a decrease in transport costs promotes agglomeration. Thus, a joint decrease of all these costs has a priori an ambiguous impact on the spatial distribution of activities within each country and, therefore, on its welfare. To gain some insights, we evaluate how a joint variation of τ, t_H and t_F may affect the relationship between those costs and welfare. For given τ and t_i, we have seen that a fall in t_j decreases the revenues from export sales in country $i \neq j$ but does not affect its consumer surplus. Furthermore, when τ decreases, the consumer surplus in country i does rise due to lower prices. To determine the global effect, we set $T \equiv \tau = t_H = t_F$ and study the sign of $\partial W_i / \partial T$:

$$\text{sign}\left\{\frac{\partial W_i}{\partial T}\right\} = \text{sign}\{(-2\kappa_1 - 2\kappa_2 + \kappa_3)T - \kappa_4\},$$

where κ_1, κ_2, κ_3 and κ_4 are defined in Section 4. Since countries are now symmetric, they exhibit the same economic geography given by $\lambda_H^* = \lambda_F^* = 1$ or by $\frac{1}{2}$. It is readily verified that, whatever the equilibrium spatial configuration, $\partial W_i / \partial T < 0$ when $T < \tau_{\text{trade}}$. Hence, *improving both international and national transportation infrastructure is desirable*, at least when countries do not differ too much in terms of their transportation facilities. Furthermore, we have seen in Section 4 that the welfare of a country may be negatively affected by a decrease in trade costs. When national transport costs change in the same direction as trade costs, this negative effect may vanish. All these results suggest that *there is a case for coordinating intranational and international transport policies* within large trading blocs such as the EU.

7. Conclusions

We have presented a model that shows how changes in the transportability of commodities as well as in the mobility of factors *within* countries affect the location of economic activities, the distribution of factors, the geography of demand and, therefore, the pattern of trade as well as their respective welfare implications.

Our key positive result is that lower intranational transport costs foster regional divergence when international trade costs are high enough, whereas lower international trade costs promote regional convergence when intranational transport costs are high enough. This clearly shows that, when production factors have different degrees of mobility at different spatial scales of analysis, *international and interregional integration play important*, *yet distinct*, *roles in explaining the evolution of geography and welfare within each country*. Since EU regional policies mainly focus on financing transport infrastructure in lagging regions, our analysis suggests that such a policy may fail to deliver the expected results in terms of better regional cohesion because its impact critically depends on the degree of international integration *as well as* on the degree of national integration, both of which are likely to significantly vary across countries within the EU.

Our result that lower international trade costs promote regional convergence when intranational transport costs are high enough qualifies the existing literature surveyed in Section 1. There, we pointed out that both extensions of the original core-periphery model of Krugman (1991) by Monfort and Nicolini (2000) and Paluzie (2001) imply that international trade liberalization between countries leads to more agglomeration within each country. Since our model shares with theirs its basic structure and, in particular, their focus on immobile demand as the source of dispersion forces, the contrast may appear puzzling. This need not be the case as our setup with variable demand elasticity encapsulates pro-competitive effects, which act as an additional dispersion force and are absent in their models.

Turning to normative issues, three results stand out. First, as in Brander and Krugman (1983), when trade costs are high there can be ‘excessive trade’ even though trade makes a wider variety of products available to consumers. Second, while each country has a unilateral incentive to reduce its own interregional transport costs, such a reduction is always harmful to the other country, thus constituting a beggar-thy-neighbor policy. Third, as a consequence, *both countries may end up being trapped into a prisoner's dilemma*. This calls for the international coordination of national transport policies as envisaged by the Rome Treaty.

Finally, it is worth noting that our key positive result relies on the pro-competitive effects due to variable markups, which are absent in standard CES models such as Monfort and Nicolini (2000) and Paluzie (2001). Thus, it is not driven by the use of additive and linear transport/trade costs. This does not mean, however, that there is no need for more 'realistic' specifications of those costs. For example, Behrens et al. (2006b) introduce density economies in international transportation, which arise when shipping costs are lower on routes processing large volumes of freight, and show that these create a link between the internal economic geographies of the trading partners on top of the welfare effects highlighted in the present paper. As density economies are likely to be relevant in the case of transportation costs but much less so in the case of administrative barriers, while tariff and non-tariff barriers certainly coexist, these results suggest that future research should focus on a richer characterization of the various types of costs burdening distant transactions instead of collapsing them all into a single parameter as is usually done.

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Appendix A

Observe that, for both the agglomerated and dispersed configurations to arise as a spatial equilibrium, it must be that $\tau^*(t_i) < \tau_{\text{trade}}$ and $t^*(\tau) < t_{\text{trade}}(\tau)$. Because $\varepsilon_2 > 0$, when $\tau = 0$ the latter inequality holds provided that $-\varepsilon_1 t_{\text{trade}}(0) + \varepsilon_2 < 0$. By continuity, the two configurations will then emerge as equilibria in the vicinity of $\tau = 0$. Because the value of ε_1 rises with A, $-\varepsilon_1 t_{\text{trade}}(0) + \varepsilon_2 < 0$ holds if and only if A exceeds some threshold value that we denote $\overline{A}$, which is the unique solution to $-\varepsilon_1 t_{\text{trade}}(0) + \varepsilon_2 = 0$. In particular, some simple calculations show that $\overline{A}$ is larger than $3L$; hence, we assume throughout that $A > \bar{A} > 3L$. Note also that $t^*(\tau)$ always exceeds some positive threshold when τ is arbitrarily small, whereas $\tau^*(t_i)$ equals 0 as soon as t_i is smaller than this threshold.

Appendix B

We show here that $\hat{\tau}_F \geqslant \hat{\tau}_H$ for all equilibria when $t_F \geqslant t_H$. Recall first that

$$t_F \geqslant t_H \implies \lambda_F \leqslant \lambda_H,$$

i.e., the less integrated country is more dispersed. Since

$$\widehat{\tau}_H \equiv \frac{\kappa_1(\lambda_H)t_H + \kappa_2(\lambda_F)t_F + \kappa_4}{\kappa_3},$$
$$\widehat{\tau}_F \equiv \frac{\kappa_1(\lambda_F)t_F + \kappa_2(\lambda_H)t_H + \kappa_4}{\kappa_3},$$

we then have

$$\widehat{\tau}_F - \widehat{\tau}_H = \frac{[\kappa_1(\lambda_F) - \kappa_2(\lambda_F)]t_F - [\kappa_1(\lambda_H) - \kappa_2(\lambda_H)]t_H}{\kappa_3},$$

where

$$\kappa_1(\lambda_F) - \kappa_2(\lambda_F) = 4cn^2(b+cn)\phi\lambda_F(1-\lambda_F) + c^2n^2A,$$
$$\kappa_1(\lambda_H) - \kappa_2(\lambda_H) = 4cn^2(b+cn)\phi\lambda_H(1-\lambda_H) + c^2n^2A.$$

Because $t_F \geqslant t_H \implies \lambda_F \leqslant \lambda_H$, we obtain

$$\kappa_1(\lambda_F) - \kappa_2(\lambda_F) \geqslant \kappa_1(\lambda_H) - \kappa_2(\lambda_H) > 0$$

so that $\widehat{\tau}_F \geqslant \widehat{\tau}_H$, which establishes the result.

Appendix C

To determine the sign of $\Omega_i(\frac{1}{2},\frac{1}{2})$, we have to rank $\widetilde{t}_d$ and t^*. Set $\Delta_d \equiv \widetilde{t}_d - t^*$. As $\widetilde{t}_d$ is independent of A whereas t^* is a decreasing function of A, Δ_d is an increasing function of A. To determine the sign of Δ_d, we evaluate Δ_d at the lowest admissible value of A, which is given by the threshold $\overline{A}$ identified in Appendix A. It is then readily verified that $\Delta_d(\overline{A}) > 0$ if and only if $\tau \in (\widetilde{\tau}, \tau_{\text{trade}})$ where

$$\widetilde{\tau} \equiv \frac{2acn(3b+4cn)}{24b^3 + 72b^2cn + 70bc^2n^2 + 21c^3n^3} < \tau_{\text{trade}}$$

in which case $\Delta_d > 0$ for all values of $A > \overline{A}$. Hence, $\Omega_i(\frac{1}{2},\frac{1}{2}) > 0$ as long as $t > \widetilde{t}_d$, thus implying that both countries are worse off when one country unilaterally cuts its own transport costs from high values. By contrast, when $t \in (t^*, \widetilde{t}_d)$, we obtain $\Omega_i(\frac{1}{2},\frac{1}{2}) < 0$ in which case the domestic country gains more than the foreign country loses.

It remains to describe what happens when $\tau < \widetilde{\tau}$, that is, when $\Delta_d(\overline{A}) \leqslant 0$. In this case, $\widetilde{A}$ exists such that $\Delta_d(A) > 0$ (resp., $\Delta_d(A) < 0$) when $A > \widetilde{A}$ (resp., $A < \widetilde{A}$), where

$$\widetilde{A} \equiv \frac{\phi}{c} \frac{9a(2b^2 + 21bcn + 13c^2n^2) + (5bc^2n^2 + 6c^3n^3)\tau}{3(2ab + 2cn) + (4cbn + 3c^2n^2)\tau} > \overline{A}.$$

When $\tau < \widetilde{\tau}$, two cases may arise when $A > \widetilde{A}$. In the former one, $\Omega_i(\frac{1}{2},\frac{1}{2}) > 0$ as long as $t > \widetilde{t}_d$ and negative otherwise. In the latter case, we always have $A < \widetilde{A}$ and $\Omega_i(\frac{1}{2},\frac{1}{2}) > 0$ because $\widetilde{t}_d < t^*$. In other words, a decrease in one country's transport costs is always globally efficient when the mass of unskilled is not too large.

Appendix D

We have to evaluate the sign of

$$\Omega_i(1,1) = \frac{n(b+2cn)A}{16(b+cn)^2}(\eta_1 t - \eta_2 - \eta_3 \tau),$$

where

$$\eta_1 \equiv 6b^2 + 8bcn + 3c^2n^2 > 0, \quad \eta_2 \equiv cn(4b+3cn) > 0, \quad \eta_3 \equiv 2a(3b+2cn) > 0.$$

Let $\widetilde{t}_a$ be the solution of $\eta_1 t - \eta_2 - \eta_3 \tau = 0$ with respect to t, namely

$$\widetilde{t}_a \equiv \frac{\eta_2 + \eta_3 \tau}{\eta_1} > 0.$$

Clearly, $\Omega_i(1,1) > 0$ (resp., $\Omega_i(1,1) < 0$) if and only if $t > \widetilde{t}_a$ (resp., $t < \widetilde{t}_a$). To rank $\widetilde{t}_a$ and $t^*(\tau)$, we set $\Delta_a \equiv \widetilde{t}_a - t^*(\tau)$. Again, $\widetilde{t}_a$ is independent of A whereas $t^*(\tau)$ is a decreasing function of A, so that Δ_a is an increasing function of A. Because $\Delta_a(\overline{A}) > 0$, Δ_a is positive for all $A > \overline{A}$, thus implying that $\Omega_i(1,1)$ is always positive.

References

Ades, A., Glaeser, E., 1995. Trade and circuses: Explaining urban giants. Quarterly Journal of Economics 110, 195–227.

Anderson, J.E., van Wincoop, E., 2004. Trade costs. Journal of Economic Literature 42, 691–751.

Baldwin, R., Forslid, R., Martin, P., Ottaviano, G.I.P., Robert-Nicoud, F., 2003. Economic Geography and Public Policy. Princeton University Press, Princeton.

Behrens, K., Gaigné, C., Ottaviano, G.I.P., Thisse, J.-F., 2006a. Is remoteness a locational disadvantage? Journal of Economic Geography 6, 347–368.

Behrens, K., Gaigné, C., Ottaviano, G.I.P., Thisse, J.-F., 2006b. How density economies in international transportation link the internal geography of trading partners. Journal of Urban Economics 60, 248–263.

Bougheas, S., Demetriades, P., Morgenroth, E., 2003. International aspects of public infrastructure investment. Canadian Journal of Economics 36, 884–910.

Brander, J., Krugman, P., 1983. A 'reciprocal dumping' model of international trade. Journal of International Economics 15, 313–321.

Brülhart, M., Traeger, R., 2005. An account of geographic concentration patterns in Europe. Regional Science and Urban Economics 35, 597–624.

Chang, W., Winters, L.A., 2002. How regional blocs affect excluded countries: The price effects of MERCOSUR. American Economic Review 92, 889–904.

Charlot, S., Gaigné, C., Robert-Nicoud, F., Thisse, J.-F., 2006. Agglomeration and welfare: The core-periphery model in the light of Bentham, Kaldor, and Rawls. Journal of Public Economics 90, 325–347.

Combes, P.-Ph., Lafourcade, M., 2005. Transport costs: Measures, determinants, and regional policy. Implications for France. Journal of Economic Geography 5, 319–349.

de la Fuente, A., Vives, X., 1995. Infrastructure and education as instruments of regional policy: Evidence from Spain. Economic Policy 20, 13–51.

Dinopoulos, E., Fujiwara, K., Shimomura, K. 2006. International trade patterns under quasi-linear preferences. Mimeo, University of Florida, available at ⟨http://bear.cba.ufl.edu/dinopoulos/Research.html⟩.

Engel, C., Rogers, J.H., 1996. How wide is the border? American Economic Review 86, 1112–1125.

Faini, R., 1999. European migrants: An endangered species. In: Baldwin, R., Cohen, D., Venables, A.J. (Eds.), Market Integration and the Global Economy. Cambridge University Press, CEPR Publications, Cambridge.

Fujita, M., Krugman, P., Venables, A.J., 1999. The Spatial Economy. Cities, Regions and International Trade. MIT Press, Cambridge, MA.

Greenhut, M.L., 1981. Spatial pricing in the United States, West Germany and Japan. Economica 48, 79–86.

Greenwood, M.L., 1997. Internal migration in developed countries. In: Rosenzweig, M.R., Stark, O. (Eds.), Handbook of Population and Family Economics. North-Holland, Amsterdam, pp. 648–719.

Haskel, J., Wolf, H., 2001. The law of one price—a case study. Scandinavian Journal of Economics 103, 545–558.

Head, K., Mayer, T., 2000. Non-Europe. The magnitude and causes of market fragmentation in the EU. Weltwirtschaftliches Archiv 136, 284–314.

Head, K., Mayer, T., 2004. The empirics of agglomeration and trade. In: Henderson, J.V., Thisse, J.-F. (Eds.), Handbook of Regional and Urban Economics, vol. 4. North-Holland, Amsterdam, pp. 2609–2669.

Krugman, P., 1991. Increasing returns and economic geography. Journal of Political Economy 99, 483–499.

Krugman, P., Livas Elizondo, R., 1996. Trade policy and the third world metropolis. Journal of Development Economics 49, 137–150.

Martin, Ph., Rogers, C.A., 1995. Industrial location and public infrastructure. Journal of International Economics 39, 335–351.

Monfort, Ph., Nicolini, R., 2000. Regional convergence and international integration. Journal of Urban Economics 48, 286–306.

Ottaviano, G.I.P., Tabuchi, T., Thisse, J.-F., 2002. Agglomeration and trade revisited. International Economic Review 43, 409–436.

Paluzie, E., 2001. Trade policies and regional inequalities. Papers in Regional Science 80, 67–85.

Picard, P., Zeng, D.-Z., 2005. Agricultural sector and industrial agglomeration. Journal of Development Economics 77, 75–106.

Quah, D.T., 1996. Empirics for economic growth and convergence. European Economic Review 40, 1353–1375.

Vives, X., 1999. Oligopoly Pricing: Old Ideas and New Tools. MIT Press, Cambridge, MA.

Winters, L.A., Chang, W., 2000. Regional integration and import prices: An empirical investigation. Journal of International Economics 51, 363–377.

Wolf, H., 2000. Intranational home bias in trade. Review of Economics and Statistics 82, 555–563.