International trade and internal geography revisited

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Abstract

Trade liberalization and trade policy obviously affect the internal distribution of economic activities within a liberalizing country. We show that the impact of decreasing international trade costs on the regional distribution of economic activities crucially depends on the value of transport costs internal to the country. Trade liberalization in developing countries with poor internal infrastructures and small volumes of interregional trade is likely to increase regional disparities, while developed countries with good internal infrastructures and large volumes of interregional trade are likely to experience redispersion. We argue that the way transport and trade costs are modeled might have a crucial impact on the results obtained.

Résumé

La libéralisation du commerce et la politique commerciale affectent manifestement la répartition interne de l'activité économique d'un pays. Nous montrons que l'impact d'une baisse des coûts d'échange sur la répartition régionale de l'activité économique dépend de manière cruciale de la valeur des coûts de transport à l'intérieur du pays. Tandis qu'une libéralisation dans les pays en voie de développement, caractérisés par de mauvaises infrastructures et de faibles volumes d'échanges interrégionaux, est susceptible d'accroître les inégalités régionales, cette même libéralisation dans les pays développés est susceptible de mener à une redispersion de l'activité. Nous montrons que la manière dont nous modélisons les coûts de transport et d'échange pourrait significativement influencer les résultats obtenus.

Keywords : trade liberalization, trade costs, agglomeration

JEL Classification : D11, F12, L13, R12

1. Introduction

It is obvious that world economic activity is unevenly distributed around the globe. At a large spatial scale, the most striking manifestation is to be found in the North-South dualism opposing the developed and the developing world (Fujita and Thisse [11]). At a much smaller spatial scale, the internal distribution of economic activity *within countries* is also highly uneven. Most countries are made up of *core regions*, characterized by high "economic density" and a large share in both GDP and employment, as well as of *peripheral regions* which contribute only marginally to both GDP and employment. This phenomenon seems to be universal in the sense that it affects more or less all countries *independently of their level of technological, social and economic development*. The São Paulo region in southeast Brazil is as much an economic core of the developing world as are the Ile-de-France and Tokyo MA for the developed world. The really striking difference between the developed and the developing world is that the overall level of regional inequalities seems to be even larger in developing countries than in industrialized ones. The most visible manifestation of those regional imbalances are urban giants like Mexico City and Bangkok, that dot the developing world since several decades. Although it is extremely difficult to weight the economic costs and benefits of those unequal regional patterns, we need to understand how they form in the first place and how changes in economic key parameters as well as in policy possibly affect those imbalances.

Since the seminal paper by Krugman [15] and its subsequent refinements (refer to Fujita and Krugman [8], Puga [27] and Fujita et al. [9]), it is well known that decreasing transport and trade costs *within a country* are susceptible to increase the spatial concentration of economic activity. [1] While this result fits well the trend observed in developed countries since the Industrial Revolution, it fits less well that of developing

[1] As recently shown by Ottaviano et al. [25], those conclusions remain valid in an alternative modeling framework with different specifications for consumer preferences and transport technology. Therefore, the main result of the core-periphery model, namely that economic agglomeration arises for sufficiently low values of trade costs, seems to be robust with respect to alternative modeling choices, at least in a two region setting.

countries in which, *despite usually high values of interregional trade costs, huge urban agglomerations and regional concentrations of economic activity have emerged*. How come? As recently shown by Behrens [4], interregional trade is not necessary for an uneven distribution of economic activities to arise. Despite *high levels of internal trade costs, a process of agglomeration can trigger in a country as the ratio of mobile to immobile factors of production increases*. This finding concurs with Bairoch [1], who argues that population growth and increasing pressure on limited amounts of arable land have released large numbers of workers from the yoke of immobility and have redirected them towards the growing urban areas. While these *internal causes* might partly explain the core-periphery structure of several developing countries, *external causes* must also be accounted for. Yet there is, to the best of our knowledge, no clear consensus on which forces are susceptible to play an important role nor on how they work for or against regional imbalances. A major exception, that has attracted a lot of attention from both development economists and international trade theorists, is the potential role of *international trade policy*.

That international trade and trade policies have a significant impact on the *international distribution* of economic activity is hardly debatable. Those aspects are emphasized in new trade theory, in which it is argued that factor mobility and self-reinforcing forward and backward linkages can lead to regional specialization as well as to significant and persistent differences in economic development and real wages (see Krugman and Venables [18], Venables [30] and Puga and Venables [28]). While factor mobility (essentially in the form of capital) increased between developed countries and from developed to certain developing countries, factor mobility between developing countries and from developing to developed countries usually remains quite low. This is most clearly seen from the figures provided by Wong [33] (p. 18), which show that developing countries' share in world FDI never exceeded 7% during the period 1971-1990. We argue in this paper that, even in the absence of international factor mobility, *international trade and trade policies have a significant impact on the internal geography of a country, as soon as production factors are at least mobile within that country*. There is a huge literature on whether international trade liberalization leads to economic growth and long-run income convergence between countries (refer, e.g., to McCulloch et al. [20]). There is nearly no literature, and especially no consensus, on whether international trade liberalization leads to stronger agglomeration of economic activities within a given country or whether we can observe a gradual dispersion as the country progressively opens up to trade. Five major exceptions are the papers by Krugman and Livas [17], Montfort and Nicolini [21], Crozet and Koenig-Soubeyran [7], Paluzie [26] and Montfort and van Ypersele [22]. Those papers develop general equilibrium models that analyze how trade liberalization (given by a progressive decrease in international trade costs) possibly affect the spatial structure within a country. While Krugman and Livas [17] "predict" internal dispersion of economic activities due to a progressive trade liberalization, the other papers "predict" an increase in regional disparities within countries. [2] This divergence in results, obtained within otherwise quite similar Dixit-Stiglitz-Iceberg modeling frameworks, is probably due to a difference in the modeling of dispersion forces. While Krugman and Livas [17] focus on urban rents/commuting costs, the other papers retain the more traditional assumption of a partially immobile population. [3]

We believe it is important to mention right away that, no matter the dispersion forces used, the results established in the current literature *do not depend on the relative values of international to interregional trade costs*. As we argue in this paper, the conclusions derived in a Dixit-Stiglitz-Iceberg framework might crucially hinge on the fact that, under such a specification, *decreasing international trade costs do not modify the share of interregional trade costs in consumer prices*. Yet, decreasing international trade costs exacerbate price competition within countries, which *can significantly increase the share of interregional trade costs in final consumer prices*.

[2] Both Montfort and Nicolini [21] and Montfort and van Ypersele [22] develop models with two countries and four regions. They show that international trade liberalization affects the internal geography within countries and that those internal geographies are interdependent. Hence, there is *spatial correlation* in the sense that countries' internal structures influence each other mutually. Whether this correlation is positive or negative seems to depend on the chosen modeling framework.

[3] See also Fujita et al. [9] (Chapter 18) for a simpler approach in terms of a pure congestion externality.

Hence, it becomes relatively more expensive to ship goods within the country, which can actually lead to a reversal of the conclusions established in the aforementionned papers *once international trade costs are sufficiently low*.

We develop in this paper a linear three region general equilibrium model based on Ottaviano et al. [25] and Behrens [4]. We show that *the relative level of international to interregional trade costs, the share of the domestic industry in the world industry and the composition of trade* are all crucial in explaining the impact of trade liberalization on the internal geography of the liberalizing country. Trade liberalization in countries characterized by high values of interregional trade costs and small volumes of interregional trade usually leads to regional divergence, while that same liberalization in countries with low values of interregional trade costs and large volumes of interregional trade usually leads to regional convergence. Those results could partly help clarifying the debate on whether trade liberalization leads to regional convergence or not. They could also explain why trade liberalization does not seem to lead to regional convergence in developing countries, while several developed countries like Great Britain seem to experience a gradual redispersion of economic activities.

The remainder of this paper is organized as follows. In Section 2, we lay out the basic three region model. In Section 3, we examine the case of a developing country with high values of interregional transport costs and no interregional trade. In Section 4, we turn to the polar case of a developed country with low values of interregional transport costs and bilateral interregional trade. In Section 5, we tie together the seemingly conflicting results of the literature and offer a unifying interpretation. Finally, Section 6 offers some conclusions and points towards future research directions.

2. The model

Let us briefly lay out the formal framework we use in the rest of this paper. Assume there are three "regions" labeled H, F and R respectively. Variables associated with each region will be subscripted accordingly. Regions H and F belong to the same country C, while region R corresponds to the "rest of the world" (henceforth ROW). There are two production factors in the economy: geographically mobile manufacturing workers, which produce a differentiated good under monopolistic competition and increasing returns to scale, and immobile agricultural workers, which produce a homogeneous good under constant returns to scale and perfect competition. Denote by L (resp. by L_R) the mass of mobile and by A (resp. by A_R) the mass of immobile factor in country C (resp. in the ROW). The immobile factor A is evenly split between the two regions H and F, each of which accommodates a mass $A/2$ of it. In accord with empirical observations, we assume that manufacturing workers are characterized by a low international mobility. In order to keep things as simple as possible and to remain in the spirit of international trade theory, we make the assumption that *labor is internationally immobile* (see Venables [30] and Fujita et al. [9]). Hence, both L and L_R are constant throughout the analysis. Nevertheless, workers in the manufacturing sector are mobile within country C. We denote by $\lambda \in [0, 1]$ the share of mobile factor L located in region H and we assume, without loss of generality, that there is no immobile agricultural sector in the rest of the world (i.e. $A_R = 0$). Denote finally by $N = n_H + n_F + n_R$ the mass of firms in the world economy, where n_r denotes the mass of firms located in region $r = H, F, R$.

All agents in the economy have the same quadratic utility and solve the consumption problem

$$(\mathcal{P}_Q) \begin{cases} \max_{x_0, x} \ \alpha \int_0^N x(i)\mathrm{d}i - \frac{\beta-\gamma}{2}\int_0^N x(i)^2 \mathrm{d}i - \frac{\gamma}{2}\left(\int_0^N x(i)\mathrm{d}i\right)^2 + x_0 \\ \text{s.t.} \quad \int_0^N p(i)x(i)\mathrm{d}i + x_0 = w + \bar{x}_0 \end{cases}$$

where the price of the homogenous good x_0 is taken as the numéraire, $\bar{x}_0 > 0$ is the (sufficiently large) initial endowment in good x_0 and $\alpha > 0$, $\beta > \gamma > 0$ are exogenous parameters. Let $\epsilon := \beta - \gamma$ for notational convenience. The parameter ϵ is an inverse indicator of the elasticity of substitution between any two varieties. As shown by Behrens [4], the *extended demand functions* of $(\mathcal{P}_Q)$ are given by

$$x^\star(i) = \left[a - (b + cN)p(i) + cP(i)\right]^+, \tag{1}$$

where $[f]^+$ denotes the positive part of f, where a, b and c are positive coefficients given by

$$a = \frac{\alpha}{\epsilon + N\gamma}, \quad b = \frac{1}{\epsilon + N\gamma} \quad \text{and} \quad c = \frac{\gamma}{\epsilon(\epsilon + N\gamma)} \tag{2}$$

and where

$$P(i) = \int_0^N p(j)\mathrm{d}j \tag{3}$$

is an aggregate price index of the differentiated industry.

Each firm in the differentiated industry produces a single variety under increasing returns to scale using labor only. Hence, there is a one-to-one correspondence between firms and varieties, so that n_r denotes both the mass of firms and of varieties located in region r. Without loss of generality, we assume the fixed cost ϕ is incurred in mobile labor while marginal costs are normalized to zero (see Ottaviano et al. [25]). Under those assumptions, labor market clearing implies that

$$n_H = \frac{\lambda L}{\phi}, \quad n_F = \frac{(1-\lambda)L}{\phi} \quad \text{and} \quad n_R = \frac{L_R}{\phi}. \tag{4}$$

We assume the differentiated good can be transported at no cost in the interior of each region r, while there is a unit transport cost of $\tau > 0$ (resp. a unit trade cost of $\tau_R > 0$) units of the numéraire in order to ship one unit of manufactured good between the two regions of country C (resp. between a region of country C and the ROW). We refer to τ as *internal transport costs* and to τ_R as *external trade costs*. Note that we assume that both regions can access world markets at equal costs. Hence, international trade involves no gate effects. Denote by w_r the wage rate in region r and by p_{rs} the price a firm located in region r charges in region s. In accord with empirical evidence (refer to Greenhut [12], Wolf [32] and Head and Mayer [13]), we assume that markets are *segmented* and that each firm sets a particular price in each market it sells its output in. Further, firms bear initially all transport and trade costs, even if they subsequently pass a fraction of them on to the final consumer. The profit of a firm located in region $r = H, F$ is hence given by

$$\pi_r = \left(\frac{A}{2} + \phi n_r\right) x^\star_{rr} p^\star_{rr} + \left(\frac{A}{2} + \phi n_s\right) x^\star_{rs} [p^\star_{rs} - \tau] + \phi n_R x^\star_{rR} [p^\star_{rR} - \tau_R] - \phi w_r, \quad s \neq r, \quad (5)$$

while that of a firm located in the ROW is given by

$$\pi_R = \left(\frac{A}{2} + \phi n_H\right) x^\star_{RH} [p^\star_{RH} - \tau_R] + \left(\frac{A}{2} + \phi n_F\right) x^\star_{RF} [p^\star_{RF} - \tau_R] + \phi n_R x^\star_{RR} p^\star_{RR} - \phi w_R. \quad (6)$$

As shown by Behrens [4], the profit-maximizing prices are given by

$$p^\star_{rr} = \frac{a + cP_r}{2(b + cN)} = \tfrac{1}{2}\tilde{p}_r \quad (7)$$

and

$$p^\star_{rs} = \begin{cases} \frac{1}{2}(\tilde{p}_s + \tau_{rs}) & \text{if} \quad \tau_{rs} < \tilde{p}_s \\ \tilde{p}_s & \text{if} \quad \tau_{rs} \geq \tilde{p}_s \end{cases}, \; r \neq s, \quad (8)$$

where

$$\tau_{rs} = \begin{cases} \tau & \text{if} \quad r, s = H, F, \quad r \neq s \\ \tau_R & \text{if} \quad r = H, F, \; s = R \quad \text{or} \quad r = R, \; s = H, F. \end{cases}$$

Using (4), (7) and (8), the aggregate price index (3) in region r is given by

$$P_r = n_r p^\star_{rr}(P_r) + n_s p^\star_{sr}(P_r) + n_t p^\star_{tr}(P_r), \quad s \neq r \neq t. \quad (9)$$

Note that all profit-maximizing prices depend on the price aggregate P_r of the region the firm wants to sell in, which depends itself on individual prices set by rival firms. Equilibrium prices are determined as in Ottaviano et al. [25]. Each firm sets its optimal price, taking aggregate market conditions as given, but taken together these aggregate market conditions must be consistent with firms' optimal individual prices. Hence, the equilibrium price index P_r is a fixed-point of (9). Because, as shown by Behrens [4], the expressions of the price indices (9) *depend on the structure of regional and international trade*, we have to distinguish several cases.

First, we investigate the case of a *developing country* characterized by high values of internal trade costs and low volumes of interregional trade. For analytical simplicity, we assume that internal trade costs are so large that no interregional trade occurs at all. Although this is clearly a strong assumption, we believe it captures the essence of the argument we develop later on. Second, we investigate the case of a *developed country* characterized by low values of internal trade costs and large volumes of interregional trade. We assume that internal trade costs are so low that interregional trade in such a country is always bilateral. [4] Let us begin with the case of *high values of internal trade costs*.

3. Trade liberalization in developing countries

Development economists and international trade theorists have thoroughly investigated how trade policies and trade liberalization possibly affect the economic performance of developing countries. Yet, as argued by Krugman and Livas [17], the question on how those policies affect the internal geography of such countries has been largely neglected. This neglect might turn out to be mistake, because it is known that the spatial distribution of economic activities within a country can have a profound impact on growth and convergence (see Baldwin and Forslid [3], Baldwin [2] and Martin and Ottaviano [19]). In this section, we examine how international trade liberalization possibly affects the equilibrium distribution of firms in a country characterized by poor internal infrastructures and small volumes of interregional trade.

We make three assumptions on the structure of trade. First, we consider that internal transport costs τ in country C are so high that there is *no interregional trade no matter the spatial distribution of firms between regions H and F*. Second, we assume that external trade costs τ_R are sufficiently low such that the ROW sells to both regions of country C *no matter the internal distribution of firms*. Third, we assume, without loss of generality, that neither firms in region H nor firms in region F export

[4] Note that this assumption, though seemingly less strong than that of regional autarky, is not susceptible to hold for all industries in developed countries (see Behrens [4] and Behrens [5]).

their varieties to the ROW (refer to Appendix A for a justification). Under those three assumptions, expressions (7), (8) and (9) yield the equilibrium price indices

$$P_r^{\star} = \frac{a(N + n_s) + n_R(b + cN)\tau_R}{2b + c(n_r + n_R)}, \quad s \neq r. \tag{10}$$

Substituting the equilibrium price index (10) into (7) and (8) yields the equilibrium prices

$$p_{rr}^{\star} = \frac{2a + cn_R\tau_R}{2[2b + c(n_r + n_R)]}. \tag{11}$$

Note that equilibrium prices (11) are increasing with respect to external trade costs τ_R, which shows that trade liberalization (i.e. a decrease in τ_R) erodes the monopoly profits of country C firms through fiercer price competition. Note further that the impact of a modification in the mass n_R of firms in the ROW is ambiguous, because a, b and c depend on the total mass N of firms in the world economy. [5] Substituting expressions (10) and (11) into (1), the individual equilibrium demands in region r are given by

$$x_{rr}^{\star} = \frac{(b + cN)[2a + cn_R\tau_R]}{2[2b + c(n_r + n_R)]} = (b + cN)p_{rr}^{\star}. \tag{12}$$

Next, we derive the import prices of goods produced in the ROW. Using (8) and (10), the price of imports to region $r = H, F$ is given by

$$p_{Rr}^{\star} = \frac{2a + [2(b + cn_R) + cn_r]\tau_R}{2[2b + c(n_r + n_R)]} = p_{rr}^{\star} + \frac{\tau_R}{2}. \tag{13}$$

Clearly, (13) is increasing with respect to τ_R, which shows that protectionnist trade policies decrease the competitiveness of foreign firms in country C. One can further see that prices (13) are decreasing with respect to the local mass of firms n_r. Hence, the larger region imports goods cheaper from the ROW than the smaller region does (because local equilibrium prices of substitute varieties are lower). Neither of those

[5] Strictly speaking, we can investigate the impacts of a modification in n_R as long as we keep the total mass of firms N constant. As shown by Tabuchi and Thisse [29], by conveniently weighting the quadratic terms in the utility function, we can obtain parameters that are independent of industry size N.

two competition effects is directly present in the Dixit-Stiglitz-Iceberg framework. Finally, individual demands in region r for imports from the ROW are given by

$$x^{\star}_{Rr} = \frac{(b+cN)[2a-(2b+cn_r)\tau_R]}{2[2b+c(n_r+n_R)]}. \tag{14}$$

It is easy to check that by construction $x^{\star}_{HF} = x^{\star}_{FH} = 0$, because there is no interregional trade in country C. Further, since country C firms do not export, we also have $x^{\star}_{HR} = x^{\star}_{FR} = 0$.

Under which conditions on (τ, τ_R, n_R) is a trade structure with regional autarky and imports from the rest of the world sustainable? Following the same approach as in Behrens [5], one can show that

$$\tau \geq \tilde{\tau}_F(\lambda) := \frac{2a + cn_R\tau_R}{2b + c[n_H(\lambda) + n_R]} \tag{15}$$

and

$$\tau \geq \tilde{\tau}_H(\lambda) := \frac{2a + cn_R\tau_R}{2b + c[n_F(\lambda) + n_R]} \tag{16}$$

must both hold in order for firms located in region $r = H, F$ not to sell in the other region. Conditions (15) and (16) hold for all values of $\lambda \in [0,1]$ if and only if

$$\tau \geq \tau^R_a := \frac{2a + cn_R\tau_R}{2b + cn_R}. \tag{17}$$

Further, for ROW firms to profitably export to regions H and F, both

$$\tau_R \leq \frac{2a}{2b + cn_H(\lambda)} \quad \text{and} \quad \tau_R \leq \frac{2a}{2b + cn_F(\lambda)} \tag{18}$$

must hold. One can check that conditions (18) ensure that demands for imports as well as import prices net of external trade costs are non-negative for a given spatial distribution λ. Hence, firms of the ROW export to country C no matter the value of λ if and only if

$$\tau_R \leq \tilde{\tau}_R := \frac{2a}{2b + cN_C}, \tag{19}$$

where $N_C = n_H + n_F$ is the total mass of firms in country C. In the remainder of this section we assume that conditions (17) and (19) hold.

Equilibrium wages in country C are determined as in Ottaviano et al. [25] by a bargaining process in the monopolistically competitive industry, in which firms compete for workers by offering higher wages until no additional firm can profitably enter the market. Hence, there are no pure profits and all operating profits are absorbed by the wage bill. Substituting (11) – (14) into (5) and equating the resulting expression to zero, the equilibrium wage in region r is given by

$$w_r^\star = \left(\frac{A}{2} + \phi n_r\right) \frac{[2a + cn_R\tau_R]^2}{4\epsilon\phi[2b + c(n_r + n_R)]^2}. \tag{20}$$

Given the quadratic utility problem $(\mathcal{P}_Q)$, the symmetry between firms and the structure of trade, the indirect utility in region $r = H, F$ can be expressed as

$$V_r^\star = \alpha\big(n_r x_{rr}^\star + n_R x_{Rr}^\star\big) - \frac{\epsilon}{2}\big(n_r x_{rr}^{\star 2} + n_R x_{Rr}^{\star 2}\big) - \frac{\gamma}{2}\big(n_r x_{rr}^\star + n_R x_{Rr}^\star\big)^2 \\ + w_r^\star + \bar{x}_0 - n_r p_{rr}^\star x_{rr}^\star - n_R p_{Rr}^\star x_{Rr}^\star. \tag{21}$$

Substituting (11) – (14) and (20) into (21) yields, after some longer calculus

$$V_r^\star(\lambda) = \frac{b + cN}{8[2b + c(n_r + n_R)]^2}\Bigg[4\left(\frac{a}{b}\big[n_r + n_R\big] - \tau_R n_R\right) \times \\ \big[4ab + ac(n_r + n_R) + bc\tau_R n_R\big] + \left(\frac{A}{\phi} - n_r\right)(2a + cn_R\tau_R)^2 \\ - n_R\big[2a - (2b + cn_r)\tau_R\big]\big[6a + (2b + 4cn_R + cn_r)\tau_R\big]\Bigg].$$

Finally, define the indirect utility differential between region H and region F as

$$\Delta V^\star(\lambda) := V_H^\star(\lambda) - V_F^\star(\lambda), \tag{22}$$

which is of course a (continuous) function of the firm distribution λ. As usual, an equilibrium arises at $\lambda = 0$ if expression (22) is negative, an equilibrium arises at $\lambda = 1$ if this expression is positive and an interior equilibrium arises at $0 < \lambda < 1$ if this expression is equal to zero. The two fully agglomerated equilibria are always stable whenever they exist, while an interior equilibrium is stable if and only if the slope of the indirect utility differential is non-positive in a neighborhood of the equilibrium.

In order to investigate the impact of an international trade liberalization on the internal geography of country C, we evaluate the sign of the derivative of the indirect utility differential (22) at the symmetric equilibrium $\lambda = 1/2$. Some long calculations show that

$$\frac{\partial(\Delta V^\star)}{\partial\lambda}\bigg|_{\lambda=1/2} \leq 0 \quad \Leftrightarrow \quad 2cn_R\tau_R\left[\left(A_b - A\right) + \frac{5}{2}\phi n_R - \frac{\phi}{2c}\left(4b + cN_C + 2cn_R\right)\right] + 4a\left[\left(A_b - A\right) + \frac{5}{2}\phi n_R\right] \leq 0, \quad (23)$$

where

$$A_b := \frac{12b\phi + cN_C\phi}{4c} \quad (24)$$

is the *break-point of the closed economy under regional autarky*. If (23) does not hold, the symmetric configuration is unstable and, as shown by Behrens [4], either full or partial agglomeration of firms in one of the two regions is a stable spatial equilibrium. It is of interest to note that if country C is closed (which corresponds to $n_R = 0$), the sign of the derivative at the symmetric equilibrium depends on the sign of $A_b - A$ as shown by Behrens [4]. Some closer inspection of condition (23) reveals that there are three possible cases, summarized in the following proposition.

Proposition 3.1 (TRADE LIBERALIZATION AND AGGLOMERATION)

Consider a country with high internal transport costs $\tau \geq \tau_a^R$ so that there is no interregional trade. If

$$(A_b - A) + \frac{5}{2}\phi n_R \leq 0$$

then dispersion is the only stable equilibrium with international trade for all values of τ_R. If

$$(A_b - A) + \frac{5}{2}\phi n_R - \frac{\phi}{2c}[4b + cN_C + 2cn_R] \geq 0$$

then (full or partial) agglomeration is a stable equilibrium with international trade for all values of τ_R. If

$$(A_b - A) + \frac{5}{2}\phi n_R \geq 0 \quad \text{and} \quad (A_b - A) + \frac{5}{2}\phi n_R - \frac{\phi}{2c}[4b + cN_C + 2cn_R] \leq 0$$

then there exists a unique value

$$\tau_R^\star = \frac{2a}{n_R} \frac{2(A_b - A) + 5\phi n_R}{\phi[4b + cN_C + 2cn_R] - 2c(A_b - A) + 5c\phi n_R} > 0$$

such that (full or partial) agglomeration is a stable equilibrium for all $\tau_R \leq \tau_R^\star$ while dispersion is the only stable equilibrium for all $\tau_R > \tau_R^\star$.

PROOF. Since τ_R is positive, the first two cases are obvious since they imply that expression (23) is either always positive or always negative. In those cases the nature of the spatial equilibrium is the same for all values of external trade costs τ_R and implies either dispersion or (full or partial) agglomeration of economic activities. Case three is also obvious since the equation $c_1\tau_R + c2 = 0$ with $\tau_R \geq 0$ is linear and has a unique solution if $c_1 \leq 0$ and $c_2 \geq 0$. Note finally that the case $c_1 \geq 0$ and $c_2 \leq 0$ is impossible and can hence be ruled out. □

Proposition 3.1 shows that *if dispersion is an equilibrium under autarky and if the dispersion forces are not too strong, the international opening to trade leads to (full or partial) agglomeration of economic activities within the liberalizing country*. Some straightforward analysis shows that $\tau_R^\star$ is decreasing with respect to c, which implies that *stronger product differentiation leads to symmetry breaking for higher values of external trade costs*. Those results are in accord with the ones established in an alternative Dixit-Stiglitz-Iceberg setting (see Montfort and Nicolini [21], Crozet and Koenig-Soubeyran [7] and Montfort and van Ypersele [22]). As one can see, the condition for dispersion

$$(A_b - A) + \frac{5}{2}\phi n_R \leq 0 \tag{25}$$

is more likely to hold if the mass of immobile factor in country C is large when compared to the mass of firms in the rest of the world and if the degree of scale economies ϕ is not too large. Condition (25) can be interpreted as a *relative-size effect*.

If A is large so that $A_b - A < 0$, dispersion prevails if the economy is closed (refer to Behrens [4]). Since the second term in expression (25) is positive, we see that the opening of the economy to international trade (hence $n_R > 0$) weakens the centrifugal force created by the immobile population. As stated by Montfort and Nicolini [21], *"openness to trade works against convergence as the international integration process exacerbates the agglomeration forces at work within countries"*. In the presence of international trade, dispersion no longer weakens price competition sufficiently since *local price competition is strengthened by foreign competitors*. Hence, the centripetal forces generated by the large market are stronger, which explains why agglomeration is more likely to arise. Turning to he condition

$$(A_b - A) + \frac{5}{2}\phi n_R - \frac{\phi}{2c}[4b + cN_C + 2cn_R] \geq 0,$$

we see that it is more likely to hold if N_C is small and if scale economies ϕ are significant. Hence, trade liberalization is more likely to lead to regional disparities in autarkic countries when those countries are *small when compared to the rest of the world* and when their industries exhibit significant scale economies.

In this section, we have shown that international trade liberalization is likely to increase the regional disparities in developing countries characterized by poor internal infrastructures. This result is in accordance with the ones usually obtained in the literature but opposes those of Krugman and Livas [17]. We explain later in Section 5 more thoroughly how all those seemingly different results might fit together. But let us first turn next to the analysis of the impacts of international trade liberalization on the internal geography of developped countries.

4. Trade liberalization in developped countries

In the preceeding section, we assumed that developping countries are characterized by high values of internal transport costs and no interregional trade. In this section, we focus on the polar case of a developped country characterized by low values of internal transport costs and bilateral interregional trade. Assume hence that τ is sufficiently small so that firms in country C always serve both regions *no matter* *the internal distribution of economic activity*. We also assume again, without loss of generality, that firms in country C do not sell to the ROW, while the rest of the world sells to both region H and region F (refer to Appendix A for a justification). Under those assumptions on the structure of trade, expressions (7), (8) and (9) yield the equilibrium price index

$$P_r^\star = \frac{aN + (b + cN)\left[n_s\tau + n_R\tau_R\right]}{2b + cN} \tag{26}$$

in region $r = H, F$ and

$$P_R^\star = \frac{a(N + Nc)}{2b + cn_R} \tag{27}$$

in the ROW. As one can see from expression (26), the price indices in regions H and F depend on a weighted average $\bar{\tau}_r = n_s\tau + n_R\tau_R + n_r 0$ of trade costs (recall that we assume that intraregional trade costs are zero). Hence *intraregional, interregional and international trade costs all influence the level of prices in each region*. Under which conditions on (τ, τ_R, n_R) is a trade structure with bilateral interregional trade and imports from the ROW sustainable? Using the same approach as in Behrens [5], the condition

$$\tau < \min_{r=H,F}\left\{\frac{a + cP_r^\star}{b + cN}\right\}$$

must hold. Some calculus shows that there is bilateral interregional trade between regions H and F for all values $\lambda \in [0, 1]$ if and only if

$$\tau < \tau_{trade}^R := \frac{2a}{2b + c(N_C + n_R)} + \frac{cn_R\tau_R}{2b + c(N_C + n_R)}. \tag{28}$$

Of course, in case the economy is closed (i.e. in case $n_R = 0$), condition (28) boils down to $\tau < \tau_{trade} := 2a/(2b + cN_C)$ as established by Ottaviano et al. [25]. Note also that if $\tau_R = 0$ and $n_R > 0$, $\tau < \tau_{trade}$ must hold. Hence, *if the rest of the world can access country C at low costs, bilateral interregional trade in country C can only occur if internal transport costs are strictly smaller than in case of a closed economy*. This result shows that if there are imports from the ROW, internal transport costs must be sufficiently low for domestic firms to operate in both regions. In case internal transport costs are too high, interregional trade breaks down since consumers switch from locally imported to internationally imported varieties. We believe this aspect could explaining why many developing countries are characterized by low volumes of interregional trade but comparatively high volumes of imports from the ROW.

Condition (28) ensures that regions H and F of country C always trade with each other. We still need to explicit the conditions that ensure that consumers in region H and in region F have a positive demand for imports from the ROW. This is the case if and only if

$$\tau_R \leq \tau_H^R(\lambda) := \frac{2a + c(1-\lambda)N_C\tau}{2b + cN_C}, \tag{29}$$

and

$$\tau_R \leq \tau_F^R(\lambda) := \frac{2a + c\lambda N_C\tau}{2b + cN_C}. \tag{30}$$

simultaneously hold for all $\lambda \in [0,1]$. Some straightforward calculus yields

$$\tau_R \leq \frac{2a}{2b + cN_C} = \tilde{\tau}_R, \tag{31}$$

which is simply condition (19) as established in Section 3.

In the remainder of this section, we assume that conditions (28) and (31) hold. Using (26) with (7) and (8), the equilibrium prices a firm located in region $r = H, F$ charges in its markets are given by

$$p_{rr}^{\star} = \frac{1}{2}\frac{2a + c\big[n_s\tau + n_R\tau_R\big]}{2b + cN}, \quad r \neq s \tag{32}$$

and

$$p_{rs}^{\star} = p_{ss}^{\star} + \frac{\tau}{2}, \quad r \neq s. \tag{33}$$

A similar development shows that the equilibrium prices of firms in R selling in region $r = H, F$ are given by

$$p_{Rr}^{\star} = p_{rr}^{\star} + \frac{\tau_R}{2}. \tag{34}$$

Note that

$$0 < \frac{\partial p^{\star}_{Rr}}{\partial \tau} < \frac{\partial p^{\star}_{rs}}{\partial \tau} < 1,$$

which shows that the trade cost pass-through of country C firms is larger than for firms in the rest of the world. Further, the pass-through is incomplete and any decrease in τ twists the terms of trade in favor of country C firms. Those results are in accordance with empirical results by Winters and Chang [31], who have shown that Spain's accession to the EU in 1986 had similar effects with respect to non-EU countries like the US or Japan. Because we are interested in the internal geography of country C only, prices $p^{\star}_{RR}$ pertaining to the world market are of no interest. [6] Using (26) and (32) – (33) with (1), we get the intraregional demands

$$x^{\star}_{rr} = \frac{(b + cN)\left[2a + c[n_s \tau + n_R \tau_R]\right]}{2(2b + cN)} = (b + cN) p^{\star}_{rr} \tag{35}$$

as well as the interregional demands

$$x^{\star}_{rs} = \frac{(b + cN)\left[2a + c[n_r \tau + n_R \tau_R] - (2b + cN)\tau\right]}{2(2b + cN)} = x^{\star}_{ss} - \frac{\tau}{2\epsilon}. \tag{36}$$

Further, demands for imports from the ROW to region $r = H, F$ are given by

$$x^{\star}_{Rr} = \frac{(b + cN)\left[2a + c[n_s \tau + n_R \tau_R] - (2b + cN)\tau_R\right]}{2(2b + cN)} = x^{\star}_{rr} - \frac{\tau_R}{2\epsilon}. \tag{37}$$

Using (5) and the zero-profit condition, as in Section 3, the equilibrium wage in region $r = H, F$ is given by

$$w^{\star}_r = \frac{1}{\phi}\left[\left(\frac{A}{2} + \phi n_r\right) x^{\star}_{rr} p^{\star}_{rr} + \left(\frac{A}{2} + \phi n_s\right) x^{\star}_{rs} [p^{\star}_{rs} - \tau]\right]. \tag{38}$$

Note that (38) does not include any revenues from export activities, because we assume that firms in country C do not export to the ROW. Given the quadratic utility problem $(\mathcal{P}_Q)$, the symmetry between firms and the structure of trade, the indirect utility in region $r = H, F$ is given by

[6] This amounts to making a kind of "small country" assumption.

$$V_r^\star = \alpha\big(n_r x_{rr}^\star + n_s x_{sr}^\star + n_R x_{Rr}^\star\big) - \frac{\epsilon}{2}\big(n_r x_{rr}^{\star 2} + n_s x_{sr}^{\star 2} + n_R x_{Rr}^{\star 2}\big)$$
$$- \frac{\gamma}{2}\big(n_r x_{rr}^\star + n_s x_{sr}^\star + n_R x_{Rr}^\star\big)^2 + w_r^\star + \phi_0$$
$$- n_r p_{rr}^\star x_{rr}^\star - n_s p_{sr}^\star x_{sr}^\star - n_R p_{Rr}^\star x_{Rr}^\star. \quad (39)$$

The indirect utility differential is again given by (22). Or course, the conditions for an equilibrium and its stability remain the same as before. Substituting expressions (32) to (38) into (39), the indirect utility in region r can be expressed as

$$V_r^\star(\lambda) = \frac{a(b+cN)}{b}\left(Np_{rr}^\star - n_s\frac{\tau}{2} - n_R\frac{\tau_R}{2}\right) - \frac{b+cN}{2}\Bigg[n_r p_{rr}^{\star 2}$$
$$+ n_s\left(p_{rr}^\star - \frac{\tau}{2}\right)^2 + n_R\left(p_{rr}^\star - \frac{\tau_R}{2}\right)^2\Bigg] - \frac{c(b+cN)}{2b}\left(Np_{rr}^\star - n_s\frac{\tau}{2} - n_R\frac{\tau_R}{2}\right)^2$$
$$+ \frac{b+cN}{\phi}\left[\left(\frac{A}{2} + \phi n_r\right)p_{rr}^{\star 2} + \left(\frac{A}{2} + \phi n_s\right)\left(p_{ss}^\star - \frac{\tau}{2}\right)^2\right]$$
$$- (b+cN)\left[n_r p_{rr}^{\star 2} - n_s\left(p_{rr}^\star - \frac{\tau}{2}\right)\left(p_{rr}^\star + \frac{\tau}{2}\right) - n_R\left(p_{rr}^\star - \frac{\tau_R}{2}\right)\left(p_{rr}^\star + \frac{\tau_R}{2}\right)\right].$$

Some tedious calculations yield

$$\Delta V^\star(\lambda) = \frac{(b+cN)\tau N_C}{8\phi[2b+cN]^2}(2\lambda - 1)\big[C_1\tau_R + C_2 + C_3\tau\big], \quad (40)$$

where C_1, C_2 and C_3 are constants given by

$$C_1 = 2n_R c\phi(3cN + 4b) > 0, \quad C_2 = 4a\phi(6b + 4cN) > 0$$

and

$$C_3 = \phi N_c c^2 N - 12\phi b^2 - 3\phi c^2 N^2 - 2Ac^2 N - 4bAc - 12\phi bcN.$$

As in Ottaviano et al. [25], the indirect utility differential is a linear function of λ, so that either dispersion or full agglomeration are the only spatial equilibria. As one can see from expression (40), $\lambda = 1/2$ is always a spatial equilibrium which can be stable or unstable, depending on the sign of $C_1\tau_R + C_2 + C_3\tau$. If $C_1\tau_R + C_2 + C_3\tau > 0$, full agglomeration of all firms in one of the two regions is the only stable equilibrium, while dispersion is the only stable equilibrium otherwise. Since C_1 is unambigously positive, we have the following fundamental result.

Proposition 4.1 (TRADE LIBERALIZATION AND DISPERSION)

Consider a country with low internal transport costs $\tau < \tau^R_{trade}$*, so that interregional trade is always bilateral. Assume that the value of external trade costs decreases. Then dispersion of economic activities within the country can be sustained as an equilibrium for a larger range of parameter values.*

PROOF. Since $C_1 > 0$, we see that dispersion is more likely as the level of international trade costs τ_R decreases. □

Note that, on the one hand, our results with interregional trade, obtained in a quadratic utility framework, are opposed to those established in a Dixit-Stiglitz-Iceberg framework (see Montfort and Nicolini [21], Crozet and Koenig-Soubeyran [7] and Montfort and van Ypersele [22]). This is somewhat surprising because, as shown by Ottaviano et al. [25] as well as by Fujita and Thisse [11], the *two modeling approaches usually yield the same qualitative results*. Note also that, on the other hand, our results confirm those of Krugman and Livas [17], despite the fact that those authors use different dispersion forces. Further, our results obtained in section 3 conform to those established by Montfort and Nicolini [21], Crozet and Koenig-Soubeyran [7] and Montfort and van Ypersele [22]. How come? In the next section, we offer a first attempt at tying together those seemingly contradictory results.

5. Does the way trade costs are modeled matter?

As shown in sections 3 and 4, trade liberalization is susceptible to have different impacts on the internal geography of liberalizing countries, *depending crucially on their internal structure of trade*. For analytical convenience, this result has been established for two extreme cases only: the one in which firms do not sell interregionally at all and the one in which firms always sell interregionally. [7] Note that the results we obtained in the case with bilateral interregional trade are the opposite of those established in a Dixit-Stiglitz-Iceberg framework, where it is shown that trade liberalization

[7] Unfortunately, the three region setting seems to be too complicated to yield any clear analytical results in the asymmetric cases. For results under unilateral trade in a two region setting refer to Behrens [5].

leads to increasing regional divergence. How come that both models yield such different results, despite very similar underlying assumptions in terms of agglomeration and dispersion forces? Further, our results confirm those of Krugman and Livas [17], who conclude that international trade liberalization leads to regional convergence in the liberalizing country. How come that both models yield the same results, despite very different assumptions on dispersion forces? In this section, we argue that the way trade costs are modeled matters. In particular, one should distinguish between tariff and non-tariff components because their impact upon the spatial configuration of the economy is susceptible to be different, at least when there are more than two regions.

The differences (in the case of Montfort and Nicolini [21], Crozet and Koenig-Soubeyran [7] and Montfort and van Ypersele [22]) as well as the similarities (in the case of Krugman and Livas [17]) in results are most likely driven by the particular way trade costs are modeled in the Dixit-Stiglitz-Iceberg approach. [8] Recall that in this approach trade costs take Samuelsons' *multiplicative iceberg form*. This assumption, which implies that trade costs are de facto equivalent to an *ad valorem tariff*, is often made because alternative specifications of *"transportation costs can undermine the constant demand elasticity that is one of the crucial simplifying assumptions of the Dixit-Stiglitz model"* (Krugman [16]). Yet, as argued by Fujita and Thisse [11], *"such a result conflicts with research in spatial pricing theory in which demand elasticity varies with distance* [...] *although the iceberg cost is able to capture the fact that shipping is resource-consuming, such a modeling strategy implies that any increase in the mill price is accompanied with a proportional increase in transport costs, which often seems unrealistic* [...] *this is enough to cast doubt on the generality of the results derived under the iceberg assumption".* [9] We argue, in the remainder of this section,

[8] One should nevertheless keep in mind that our model differs in two respects from the Dixit-Stiglitz-Iceberg approach. First, transport costs are additive instead of multiplicative. Second, preferences are quasi-linear (with quadratic subutility) instead of Cobb-Douglas (with CES subutility). Hence, differences in results could be driven by the fact that demand elasticities vary in our approach, while they are constant under a Dixit-Stiglitz-Iceberg specification. Because trade costs and demand elasticities are strongly intertwined through firms' mark-up strategy, this issue is difficult to settle. More work is called for here.

[9] It is surprising that this issue has only attracted little attention. Indeed, it is usually

that the way transport and trade costs affect prices in both approaches could explain the differences in results.

Assume that $\tau \in (0,1)$ is the iceberg coefficient in the Dixit-Stiglitz-Iceberg model. Hence, if one unit of any variety is shipped between regions H and F, only a fraction τ of this unit arrives at its destination. Denote by p_{rr} the mill price in region $r = H, F$. The delivered price in region s is then given by

$$p_{rs} = \frac{p_{rr}}{\tau}.$$

The *share of trade costs* $(p_{rs} - p_{rr})/p_{rs}$ in delivered prices is given by $1 - \tau$, which is independent of the mill price. Hence, no matter the mill price, the share of trade costs is constant, which implies that it is *always equally profitable to ship the good between both regions*. Roughly speaking, whether mill prices increase or decrease, firms' profit margins on interregionally sold goods remain constant.

Consider now the quadratic setting with linear trade costs $\tau \geq 0$. The delivered price in region s, as given by (8), is equal to

$$p_{rs} = p_{ss} + \frac{\tau}{2}.$$

Note that if there are no transport costs, the firm sells at the "mill price" $p^{\star}_{ss}$ (and not $p^{\star}_{rr}$). Hence, in this case the share of trade costs in delivered prices is given by $(p_{rs} - p_{ss})/p_{rs}$, which finally yields

$$\frac{p_{rs} - p_{ss}}{p_{rs}} = \frac{\tau}{2p_{ss} + \tau}. \tag{41}$$

Clearly, expression (41) is *increasing as the mill price in region s decreases*. Hence, *if mill prices decrease while interregional trade costs remain constant (there is no reason*

aknowledged that iso-elastic demands are very specific. As noted by Winters and Chang [31], if demand *"is iso-elastic, the mark-up is constant, so if marginal costs are fixed, the impact effect is to pass on the whole tariff cut to consumers. Less convex (e.g. linear) demand curves generate incomplete pass-through because falling prices reduce the elasticity of demand and thus increase the optimal mark-up"*.

why both should a priori vary simultaneously), firms' profit margins on interregional buisness are gradually wiped out (this can also be seen from the evolution of delivered prices net of trade costs, given by $p^{\star}_{rs} - \tau = p^{\star}_{ss} - \tau/2$). This result is important and it is well known in international economics that it plays a fundamental role in several industries. As argued by Henderson et al. [14], quite modest changes in prices (due to increasing liberalization or rapidly changing supply and demand conditions) can completely wipe out profit margins in industries in which either prices are already relatively low or in which imported intermediate inputs account for a large share of total value added. This profit erosion may in turn prove strong enough to incite firms to relocate in order to save on trade costs, which can actually counterbalance the effect of an initial decline in those costs.

How do those differences possibly explain the diverging results? Consider the following hypothetical situation. Assume we are in a Dixit-Stiglitz-Iceberg world and assume further that the current equilibrium is one of complete dispersion. Clearly, in that case $p_{HH} = p_{FF}$ by symmetry. What happens precisely as external barriers to trade gradually dissolve as τ_R decreases? First, as explained by Montfort and Nicolini [21], price competition in both region H and region F gets fiercer, leading to a decrease in the equilibrium prices p_{HH} and p_{FF}. Hence, delivered prices decrease but, as argued previously, the share of trade costs in those prices remains constant. Therefore, *trade liberalization has no impact on the relative profitability of country C firms' interregional buisness*. To put it somewhat differently, there is no internal trade cost distortion. Yet, increasing price competition due to imports decreases the initial advantage firms enjoyed from being physically separated. Hence, the market size effect comes to dominate, which leads firms to agglomerate in whichever region has a small initial advantage. As explained by Montfort and Nicolini [21], trade liberalization exacerbates the agglomeration forces at work in country C.

Assume now that we are in a quadratic world with linear trade costs and that the initial equilibrium is one of complete agglomeration in, say, region H. As τ_R decreases, so do the mill prices p_{HH} and p_{FF}, for the same reasons as before. Yet, as argued previously, because mill prices decrease the share of trade costs in delivered prices increase. Hence, it becomes relatively less profitable for firms in the core to ship goods to the periphery, because their profit margins are eroded. This implies that, contrary to the previous case, there is an internal trade cost distortion. Firms in the core suffer from increased price competition due to imports and *since profit margins on interregional trade decrease this competition is even stronger in the periphery*. Because the relative dissipative effect of internal distance increases due to external competition, firms eventually find it profitable to relax competition in the core by relocating to the periphery and increasing their profit margins on local markets. Hence, we observe an externally driven redispersion of economic activities in country C, as established by Proposition 4.1.

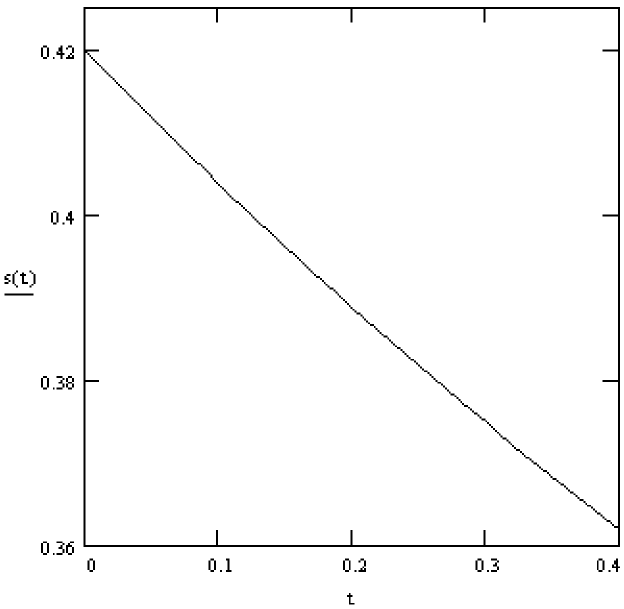

Figure 1: Share of interregional trade costs in prices as function of τ_R

Figure 1 plots the share of trade costs in interregional prices for firms located in region H as a function of external trade costs τ_R (under the assumption of a core-periphery structure with $\lambda = 1$; refer to Appendix B for parameter values). As one can see, this share *gradually rises* from approximately 36.21% to 42%. This implies that a progressive trade liberalization with the ROW decreases profitability on interregional trade by up to 5.79%. Hence, firms find it eventually profitable to relocate from the core H to the periphery F in order to capture part of those lost 5.79%. [10]

Why do the results derived in Section 3 under autarky confirm those of Montfort and Nicolini [21]? In the particular case of autarky, we have

$$p_{rs} = \tilde{p}_s \quad \text{and} \quad p_{ss} = \frac{\tilde{p}_s}{2},$$

so that the share of trade costs in interregional prices is *constant* and equal to $1/2$ (this particular value being linked to the quadratic framework). Hence, in that case, the share of trade costs in delivered prices behaves as in the Dixit-Stiglitz-Iceberg framework. International trade liberalization therefore leads to increasing regional divergence, for the same reasons as those established by Montfort and Nicolini [21], Crozet and Koenig-Soubeyran [7] and Montfort and van Ypersele [22].

As argued so far, our results fit nicely with those of the Dixit-Stiglitz-Iceberg approach once one takes into account the way international trade liberalization affects (or does not affect) the share of trade costs in delivered prices. How do our results relate to those of Krugman and Livas [17]? In their specification, Krugman and Livas [17] focus on urban issues and model dispersion forces in terms of land-rent/commuting costs. As argued before, a progressive international trade liberalization keeps unchanged the share of trade costs in delivered prices. Nevertheless, the absolute value of trade costs in the economy decreases as mill prices go down. This in turn implies that commuting costs (which remain constant) get relatively more important than interregional trade costs in the economy. Or, as recently shown by Tabuchi and Thisse [29], when *"transport costs are small (resp. large) with respect to commuting costs, the only stable equilibrium involves dispersion (resp. agglomeration)"*. Hence, as argued by Crozet and Koenig-Soubeyran [7], in such a framework a decrease in international trade costs weakens the agglomeration forces while leaving the dispersion forces largely

[10] Notice that in our example very low levels of international trade costs $\tau_R < 0.05$ lead to a breakdown of interregional trade from F to H. Hence, as shown by Behrens [5], firms in the core can no longer profitably relocate to the periphery since in that case they cut themselves completely off from the larger market in H.

untouched.

We believe our results show that conclusions on regional convergence or divergence due to international trade liberalization should be interpreted very carefully, because they are susceptible to change with the assumptions made on trade costs and dispersion forces. In particular, *it seems that decreasing trade costs can have very different impacts on the spatial distribution of economic activities, depending on whether we consider decreases in tariffs or in transport costs*. As shown previously, decreases in ad valorem tariffs favor the agglomeration of economic activities, while decreases in transport costs and non-tariff barriers favor dispersion. Those results might explain why the european integration process initially led to stronger regional divergence, because most of the european integration prior to EC-92 consisted in reductions in and abolition of tariff barriers only. It also suggests that the future eastern expansion of the EU to ten new member states should focus on both the development of infrastructures and the abolition of tariffs in order to promote regional convergence and trade.

6. Some concluding remarks

International trade liberalization and trade policy clearly affect the regional equilibrium within a liberalizing country. As shown in this paper, the precise effect of a progressive opening to international trade on the regional distribution of economic activities *depends much on the internal structure of trade*. At least two cases should be distinguished. As shown in Section 3, trade liberalization in developing countries with poor internal infrastructures can lead to regional divergence. This result is essentially driven by the fact that increasing international integration, by increasing local price competition, exacerbates the large market effect within the liberalizing country. Hence, since interregional trade costs remain large, local firms care more about market size, which triggers a process of cumulative regional divergence that leads to a core-periphery structure. The most visible results of such cumulative processes of "explosive" urban and regional growth can be found in the giant Third World metropolises. Although many authors are tempted to agree with Krugman and Livas [17] and consider that those giant cities and regional imbalances are an unintended by-product of import-substituting industrialization policies applied during the 1960's and 70's, more recent policies of trade liberalization do not seem to reverse the trend. Indeed, according to projections of the United Nations (1994), urban and regional growth is likely to contiune and 26 cities could exceed a population of 10 millions in 2025, the majority of which are located in the currently developing world (see Fujita and Thisse [11]). We believe that interregional integration *within* developing countries, by improving infrastructures and unifying local markets, is a necessary condition for subsequent international integration to lead to balanced regional development. Indeed, as shown in Section 4, trade liberalization in developed countries with good internal infrastructures can lead to regional convergence. This result is essentially driven by the fact that *a decrease in international trade costs, by decreasing equilibrium prices, leads to a relative increase in interregional trade costs*. Hence, firms are more sheltered from local competition, which can lead to redispersion of economic activities. We believe those results are fundamental to understand, especially with respect to the future eastern extension of the EU. Indeed, they suggest that an increasing integration with the EU is likely to widen the gap of regional disparities within the new member countries in case their internal trade costs are too high. Hence, integration with the EU should be accompanied by a parallel regional integration within those countries.

As argued in this paper, the nature of the results is likely to hinge on the way we model trade costs. Trade liberalization is susceptible to have different impacts on liberalizing countries, depending on both the nature of trade costs and the degree of national integration. Strangely enough, those points seem to have been missed until now. We believe that, in the end, only empirical investigations will allow to discriminate between those alternative sets of results. Until this work gets done, we should be careful when chosing a modeling strategy for transport and trade costs.

Appendix A

In this appendix, we prove that our results do not dependent on the fact that firms in country C cannot export to the ROW. Using expression (27) with (8), the condition for firms in country C to profitably export to the ROW is given by

$$\tau_R \leq \frac{2a}{2b + cn_R}. \tag{42}$$

It is easy to check that (42) applies to both the autarky case of Section 3 and the bilateral trade case of Section 4. This is due to the fact that condition (42) *does not depend on the internal geography of country C* (and hence on the structure of interregional trade). Clearly, this is a strong assumption that depends on the chosen modeling framework. Indeed, we could expect that a larger agglomeration of firms gives rise to the development of infrastructures and services which *allow firms located in the larger region to access the external market more easily and at lower cost* (see, e.g., Behrens et al. [6]). [11]

The following proposition establishes that the internal geography of country C is independent of its firms' export activities. It is established for the bilateral trade case only. A strictly similar development applies to the case with regional autarky and is hence omitted.

Proposition 6.1 (INTERNAL INDEPENDENCE FROM EXPORTS)

Assume there is interregional trade in country C for all $\lambda \in [0, 1]$. Assume further that both regions H and F have the same access to world markets.

[11] Those considerations are at the heart of the theories of hubs and economies of transport density, in which it is argued that an increase in the mass of local firms decreases costs of accessing foreign markets, since demand for transport services leads to the development of trunk routes and large scale infrastructures. Clearly, those mechanisms play a crucial role in many countries. As stated by Mori and Nishikimi [23], *"On average, transport costs from Japan to a non-hub port in Southeast Asia is 22.6% higher than to a hub port in the same region"*. As shown by Crozet and Koenig-Soubeyran [7], in case regions have different external trade costs, the border region with an advantage in exporting to the ROW usually attracts a larger share of the industry.

Then the internal geography of country C is independent of whether firms in country C have an export activity or not.

PROOF. Suppose that country C can sell to the rest of the world while there is internal bilateral trade between regions H and F. One can check that the price indices (26) remain the same, while $P_R^\star$ in (27) is now given by

$$P_R^\star = \frac{aN + (b + cN)N_C\tau_R}{2b + cN}. \tag{43}$$

Due to market segmentation, all equilibrium prices, given by (32), (33) and (34) are unchanged, while world market prices satisfy

$$p_{RR}^\star = \frac{2a + cN_C\tau_R}{2(2b + cN)},$$

which implies that the prices at which country C exports to the rest of the world are given by

$$p_{HR}^\star = p_{RR}^\star + \frac{\tau_R}{2} \quad \text{and} \quad p_{FR}^\star = p_{RR}^\star + \frac{\tau_R}{2}. \tag{44}$$

Note that those export prices depend on conditions in the world market only and are independent from the internal distribution of firms in country C. As already explained, this is essentially due to the fact that firms do not gain in terms of transport costs from clustering into an agglomeration. Using (43) and (44), export demands from the rest of the world for varieties produced in country C are given by

$$x_{HR}^\star = x_{FR}^\star = \frac{(b + cN)[2a - (2b + cn_R)\tau_R]}{2(2b + cN)}, \tag{45}$$

which are non-negative if and only if condition (42) holds. All other demands remain unchanged. Naturally, as soon as country C is able to export to the rest of the world, equilibrium profits and hence wages in regions H and F rise. This is due to the fact that firms produce under increasing returns to scale and have access to an overall larger market when there are exports, which leads to decreasing average production costs and increasing profits (and hence wages). Using the zero-profit condition, the new equilibrium wages are given by

$$\tilde{w}_r^\star = \frac{1}{\phi}\Bigg[\left(\frac{A}{2}+\phi n_r\right)x_{rr}^\star p_{rr}^\star + \left(\frac{A}{2}+\phi n_s\right)x_{rs}^\star[p_{rs}^\star - \tau] + \left(A_R + \phi n_R\right)x_{rR}^\star[p_{rR}^\star - \tau_R]\Bigg]$$

in region $r = H, F$. Note that revenue on the world market (the third term) is independent of the internal firm distribution λ. Hence

$$\tilde{w}_H^\star = w_H^\star + b \quad \text{and} \quad \tilde{w}_F^\star = w_F^\star + b$$

which, since what matters in the indirect utility differential (22) is the difference $\tilde{w}_H^\star - \tilde{w}_F^\star$, establishes that this indirect utility differential is not modified. □

Proposition 6.1 proves that condition (42) may be violated while our discussion on the internal structure of country C remains valid. Hence, from now on, we simply assume that (19) holds, so that there are imports from the ROW to country C. Proposition 6.1 states the important result that *the internal geography of country C depends on the impact of the ROW on that country, but not on the impact of C on the ROW. Hence, it is the incoming component of international trade that shapes the internal geography of the country, while the outgoing component has no effect.* This result can be interpreted in terms of a "small country assumption" and does no longer hold if we assume that there are regional differences in accessing world markets (as in Crozet and Koenig-Soubeyran [7]). Those regional differences in accessing world markets cannot be explained in the modeling framework we use here. As long as we are interested in how international trade shapes the internal geography of a country, we can focus on the *incoming* component only and neglect the *outgoing* component. Hence it does not matter whether the country has only an import activity in the industry or if it also exports part of its local production.

Appendix B

In this appendix, we provide a numerical illustration of the two cases discussed in sections 3 and 4. Assume in both cases that $\alpha = \beta = 1$,$\gamma = 0.5$, $L = 5$ and $\phi = 1.2$. Let us start with the case of increasing agglomeration in a developing country. Assume that $n_R = 5$, $A = 16$, $L = 5$, $\tau = 1.2$ and $\tau_R = 0.32$. One can easily check that conditions (17) and (19) hold and that the unique stable equilibrium for those parameter values involves dispersion. Consider now a trade liberalization and assume that the external level of trade costs decreases to $\tau_R = 0.2$. The new equilibrium configuration involves full agglomeration of all firms in one of the two regions.

Turn now to the case of decreasing agglomeration in a developed country. Assume that $n_R = 5$, $A = 30$, $L = 5$, $\tau = 0.3$ and $\tau_R = 0.32$. One can easily check that conditions (28) and (31) hold and that the unique stable equilibrium for those parameter values involves full agglomeration. Consider now a trade liberalization and assume that the external level of trade costs decreases to $\tau_R = 0.2$. The new equilibrium configuration involves dispersion of firms among the two regions.

One can see that the trade liberalization from $\tau_R = 0.32$ to $\tau_R = 0.2$ has a different impact in both cases. The justifications are provided by propositions 3.1 and 4.1 respectively.

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