

Essays on Economic Geography and Migration

by

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Abstract

The thesis consists of three chapters. The first one ("International Convergence and Local Divergence") and the third one ("Trade and Migration: a U-shaped Transition in Eastern Europe") are economic-geography models that study the relation between international trade openness and the location of productive factors, with the subsequent implications for welfare and convergence. The second chapter ("Skill-Upgrading and the Saving of Immigrants") develops a dynamic model of saving and human-capital accumulation with two types of skills in order to explain how unskilled migration may increase the amount of funds devoted to financing higher education among natives.

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Chapter 1

International Convergence and Local Divergence

Summary 1 *This paper presents an East-West endogenous-growth model that reproduces recent stylized facts applicable to the trade liberalization process of many developing countries: convergence with the rest of the world, higher internal divergence, increasing spatial concentration of economic activity and higher growth rates. We claim that the ongoing reduction of manufacturing trade costs may generate a net inflow of global demand towards the industrialized cores of developing countries. This will induce a reallocation of labor from traditional to modern sectors. In turn, such a sectoral shift may enlarge the catch-up (imitation) potential of developing countries and raise global growth rates, due to Grossman and Helpman's complementarity between imitative and innovative activities. Although advanced economies may become relatively worse off, the effect on growth rates may allow them to gain in absolute terms.*

1.1 Introduction

China's gradual liberalization over the last decades is leading to a rapid process of catchup with more advanced economies. However, internal divergence has been rising, with the coastal areas benefitting much more than the more inland provinces. This experience has not been limited to China. Though growth in Mexico has been somewhat more disappointing, its catchup with

the rest of the world has been paralleled by increasing divergence between the more advanced and the less advanced states of the country.

This paper explores the impact of a developing country's higher trade openness on convergence, not just with the rest of the world, but also within the liberalizing country. In addition to addressing these questions of relative development, it also analyzes its effect on global long-run growth. This is important: although the rest of the world may become relatively worse off, in absolute terms it may end up gaining due to the impact of higher trade openness on growth rates.

Our modelling tool is an East-West framework with an exogenous division within the eastern (and poorest) country. The East consists of an industrialized Core — which can potentially host both manufactures and a research sector devoted to imitating western patents — and a Periphery doomed to host just primary sectors under perfect competition. We assume that international-trade barriers for our homogeneous (primary) good do not decay at the same pace as those of manufactures, as if biased technological change was affecting differently the transaction costs of both sectors.¹ Since the western aggregate income is larger, an increase in manufacturing trade openness induces a net inflow of demand for eastern varieties, which raises the relative wage of the Core with respect to the West. Simultaneously, the relative wage of the Core with respect to the Periphery also rises, since primary goods remain barely as attractive to foreign consumers as before. Then, these widening income differentials within the East give rise to Periphery-Core migrations, which also enhances peripheral wages and favors East-West convergence. However, wages in the Core do not necessarily decay with migration, since some of the immigrants will become researchers, enlarging the eastern imitation potential and the fraction of world manufactures produced in the Core, which channels an even higher world demand towards the latter location.

As for its effects on growth, the agglomeration of labor in the Core turns out to be beneficial for global growth rates. In our framework imitation and innovation are complementary activities, which implies that a higher eastern catch-up potential spurs innovation in the West. The last effect holds because stronger imitation will reduce western wages and subsequently

¹For an empirical study that confirms this tendency, linked to the recent breakthrough of telecommunications, see Rauch (1999).

increase the value of a patent, raising the natural incentives to innovate. Taking all this into account, any restriction to Periphery-Core migration proves to be harmful in terms of steady-state growth, but not necessarily in terms of regional cohesion, since a higher catch-up potential in the Core may boost internal divergence patterns in the East.

The participation of China in the world trade and investment systems involves not only crucial consequences for the internal disparities within that country, but also for the international relocation of significant labor-intensive industries, which often shift from more developed towards less developed countries. For example, as illustrated by Woo (2003), “in mid-2003, the electronic and electrical firms in Penang, Malaysia, employed 17 percent fewer workers than in 2000”. Meanwhile, Mexico’s economic liberalization and trade integration in NAFTA has also been related to (internal) regional divergence and the threat of a “giant sucking sound” posed for some segments of the US economy. Well known empirical work has already estimated a significant effect of international trade openness on higher growth and increasing regional inequality for these countries (see e.g. Wei (1993), Rodriguez-Pose and Sanchez-Reaza (2002)).

However, the study of the connections between trade openness, growth and regional inequality in developing countries had remained at a largely statistical level up to very recent times (see, e.g., Jian, Sachs and Warner (1996); Ying (1999); Kanbur and Zhang (2001); Fujita and Hu (2001); Huang, Kuo and Kao (2003)). Just a few papers have tried to introduce some specific economic modelling into the debate on the sources of inequality. We will briefly examine the explanations proposed Feenstra and Hanson (1997), Giannetti (2002) and Hu (2002). Moreover, since our framework is derived from the Grossman and Helpman (1991) model, our main innovation, compared to them, consists of explicitly incorporating trade costs in the model. We also portray a dual economy within the East, which allows us to modify the steady-state growth rate as trade shocks affect differently our two eastern regions and induce migratory flows towards the areas where imitation takes place.

Focusing on the case of Mexico, Feenstra and Hanson (1997) link rising wage inequality to the foreign capital inflows that followed NAFTA, positively correlated with the demand for skilled labor. Our model does not rely on FDI as the usual suspect behind regional divergence, since our main driving force is a fall in manufacturing trade costs, which shifts world demand towards the small economies once they are sufficiently opened to international trade. On the other

hand, Giannetti (2002) develops an East-West endogenous-growth model inspired by similar EU stylized facts (international convergence accompanied by divergence within countries). However, gradual increases in trade openness are not the main driving force of the mechanism. Instead, strong regional disparities originate from international knowledge-spillovers, which determine regional comparative advantage and subsequent productive specialization. Finally, Hu (2002) is also an economic geography model, inspired by the case of China, but it does not model explicitly the Western economy and neither does it consider growth effects. The only difference in his model between the Coastal and the Interior region is a differential access to the Western market, without further institutional distinctions. The presence of vertical linkages and rural-urban migration also lead to agglomeration in the Coast as international trade costs fall. Nevertheless, our imitation-potential mechanism is absent from his model, which leads him to support the traditional view on the pro-convergence effects of interregional migration.

It is important to note that our results crucially depend on the Periphery being *exogenously* a rural economy, radically differentiated from the rest of the East concerning productive capabilities. However, we argue that – at least in the case of China – such a geo-economic structure is not endogenously derived from the typical interplay of centripetal and centrifugal forces, as described by a Core-Periphery model in a market economy. Instead, they come from the deliberate decisions made by a body of political authorities, who face a trade-off between their own objectives and those of the common population. In other words, we are going to argue in favor of the *political-economy origins* of the economic backwardness of Central and Western China, as opposed to alternative economic-geography motivations, like those modeled, for example, by Hu (2002). Therefore, this paper intends to describe the mechanism by which current regional disparities are aggravated, but renounces to study the underlying rationale behind the Core’s specialization in manufactures and the peripheral specialization in the provision of energy, minerals, food or cheap labor.

There is substantial evidence favoring a political-economy explanation for China’s Core-Periphery situation. Branstetter and Feenstra (1999) view the political process in China as trading off the social benefits of increased trade and foreign direct investment, against the losses incurred by state-owned enterprises due to such liberalization. One of the most solid conclusions they reached during some discussions with firm managers was that, to some degree,

most foreign-invested enterprises compete with state-owned firms. The second conclusion is that "the Chinese government, both national and local, is acutely aware of that competition, and has taken steps to impede the ability of foreign firms to compete in the Chinese market". Accordingly, multinational executives have found related restrictions on their operations, e.g. export requirements, localization requirements, restrictions on domestic market access, requirements for technology transfer, ...Therefore, foreign-invested firms have mostly located along the coastal area "*following a line of least resistance*" (Gipouloux (1998)), i.e. FDI increases where there are fewer state-owned companies involved in industrial organization. In this respect, we reproduce a significant paragraph from his text:

"With a jolt, the opening up of the country and the dynamics of economic reform re-activated these divisions between coastal China and inland China, but they are *simply the traces of very ancient geo-economic dividing lines, still visible after having been blurred for three decades (1949-1979)*, from the Communists' takeover to the beginning of the reforms. The 14 coastal cities that were opened in 1984 correspond essentially to the chain of ports opened under diplomatic and military pressure after the Opium Wars."²

That is, there is something much deeper than a simple "home-market effect" keeping those divisions in place.³

The rest of the paper is organized as follows. Section 2 derives the properties of a generic steady state, which initially shows a given distribution of populations in West, Core and Periphery. Section 3 contains the comparative-statics exercise (in the level of international trade openness) that reproduces our stylized facts, while allowing for interregional migration within the East. Section 4 concludes.

²There have been sincere attempts from the Chinese authorities to switch from an uneven-national-priority strategy to a nation-wide implementation of FDI promotion. However, as Chunlai (1997) reports, "not only has the process of diffusion from the coastal region to the inland areas been slow, but also the outflow of skilled workers, technical personnel and capital from the inland areas to the coastal regions has been increasing. Perhaps, more important is that the coastal region has been getting more freedom in economic decision making from the central government than the inland regions".

³For a discussion on the highly distorted system of inland China's industrial relations, see e.g. Young (2000).

1.2 The model without migration

1.2.1 Environment

Overview

In our framework, Periphery-Core migration will be responsible for the scale effects that yield higher global growth rates. Our steady state will be characterized by the intersection of two curves: one of them describes the relative wage of the Core with respect to the Periphery for a given distribution of eastern population between both locations; the second one, also known as the "migration function", describes the amount of population willing to live in the Periphery for a given relative wage. Now we will derive the first of both curves, which implies solving the whole dynamic model regardless of the migration decision, which will be considered in section 3.

Endowments

As in Grossman and Helpman (1991), we consider 2 countries - East and West. One important novelty is the existence of three regions, i.e. we also include a Periphery within the East. The population of both countries is exogenously given (being L_s for the East and L_n for the West), since we do not allow for international migration. Nevertheless, there can be migrations within the East, which means that eastern people can move from Periphery to Core (and vice versa) in response to economic-opportunity variables; i.e. $L_s = L_a + L_c$, where L_a (the peripheral population) is an endogenous variable.

The availability of factors of production is different across regions, since every location has distinctive institutional features. There are three main productive factors: labor, researchers and financial capital. Labor can be employed in agriculture (in the Periphery) or in manufacturing (in the Core or the West), and researchers are exclusively located in the last two locations. Researchers in the West are used to conceive new varieties (startups), whereas researchers in the Core can only replicate the existing ones to produce them in the East at lower cost. Moreover, there is perfect occupational mobility between local manufacturing workers and researchers, in the sense that both have the same local earnings and are therefore indifferent between both occupations. The distribution of the population in the West and the Core between researchers

and manufacturing labor will be endogenously derived in the model.

A household (or individual) from location k owns a measure β_{nk} of western firms and β_{ck} of eastern firms. The source of this financial capital were the previous gross savings of the household, which were used to finance the new manufacturing startups producing in the Core ($\dot{\beta}_{ck}$) or the West ($\dot{\beta}_{nk}$). When allocating their savings to startups from different locations, consumers must take into account that firms from the West will be imitated from the Core and drawn out of the market with some probability.

Preferences

Any representative household (or individual) k , living in that location k , maximizes (in every period t) an intertemporal utility function W_t^k such as

$$W_t^k = \int_t^\infty e^{-\rho(s-t)} \log [U_s (X_s^i, A_s)] ds \quad (1.1)$$

where W_t^k reflects the discounted utility flow that household k expects to obtain from period t onwards by acquiring manufactures (grouped into the composite X) and the homogeneous agricultural good (A). On the other hand, the particular form of U_s reveals the relative weight assigned to food and manufactures in the following way:

$$U_s = X_s^\mu A_s^{1-\mu}, \text{ where } 0 < \mu < 1 \quad (1.2)$$

The composite of manufactures X_s is a Dixit-Stiglitz subutility function over the aggregate measure of varieties invented up to period s ,

$$X_s = \left[\int_0^{n(s)} x_j(s)^\alpha dj \right]^{\frac{1}{\alpha}} \quad (1.3)$$

where $0 < \alpha < 1$ is a positive measure of the substitutability between manufactures and $x_j(s)$ quantifies the household demand for variety j at time s , $\forall s \geq t$. These preferences imply that the individual appreciates the expansion of manufacturing diversity, since utility will grow as expenditure is more thinly divided among a growing number of varieties.

Technologies

In the global economy there is a continuum of industrial varieties with measure n , and $n = n_n + n_c$ (the addition of the measures from the West and the Core). This degree of product variety expands over time due to innovation. Moreover, an increase in the local measure of manufactures enlarges the stock of public knowledge and reduces future R&D costs. Grossman and Helpman's local stocks of knowledge are equal to n in the West - since all patents were originally made up there - and to n_c in the core. This implies that there are no international knowledge-spillovers.

The production function for every particular manufacture (and for the homogeneous primary good) is identical and very simple: 1 unit of labor generates 1 unit of final output. Labor is the only factor in the production of the primary good, whereas prior to the production of any manufacture it is necessary to incur a fixed cost (to invent or imitate the corresponding patent), which is financed by means of gross savings. By free entry in the innovative (and imitative) activity, such a fixed cost is at least equal to the market value of the patent. This value decreases with the local stock of public knowledge in this way:

$$v_c \leq \frac{a_m w_c}{n_c}, \text{ with equality when } \dot{n}_c > 0 \quad (1.4)$$

$$v_n \leq \frac{a w_n}{n}, \text{ with equality when } \dot{n} > 0 \quad (1.5)$$

where v_c and v_n denote the values of eastern and western patents, respectively, whereas $\frac{a_m}{n_c}$ and $\frac{a}{n}$ stand for the number of researchers needed to imitate a western patent in the Core and to create a new variety in the West. Our variables w_a , w_c and w_n denote the nominal wage in the Periphery, the Core and the West, respectively. Later we will establish some necessary and sufficient parameter restrictions so that imitation and innovation coexist, which implies that

$$w_n = \frac{n v_n}{a}; w_c = \frac{n_c v_c}{a_m} \quad (1.6)$$

Eastern researchers need to incur the previous fixed cost in order to replicate a western patent, while western researchers do it to invent one from scratch. On the other hand, we assume that our primary good is traded costlessly, whereas our parameter $\tau \geq 1$ introduces the classical

iceberg-notion of international trade costs for manufactures: it is necessary to buy τ units of that good abroad to consume 1 unit at home. That is, we introduce manufacturing trade costs between East and West, but we assume away internal trade costs within the East.⁴

1.2.2 Static optimization

Productive firms must decide which prices to quote in every period to maximize profits. On the other hand, free entry into the innovative (imitative) activity guarantees that the expected stream of profits for the startup is equal to the actual cost of innovation (imitation).

Consumers in any location not only decide how much to save, which equity to buy and which commodities to consume, but also choose their job (if they are not in the Periphery, they become either manufacturing workers or researchers) and their location of residence. The job decision is not problematic, since they will receive the local wage no matter whether they do research or not. On the contrary, as is usual in economic geography, we assume that expectations are adaptive when an eastern household chooses whether to migrate or not, i.e. they do not expect other households to move at the same time.

The function W_s^k is intertemporally maximized with respect to its ultimate arguments $(x_j(s), \forall j, \forall s \geq t; A(s) \forall s \geq t)$ at every period t , taking as given the expected temporal paths $v_n(s), v_c(s), n(s), p_j(s) \forall j$ and $p_a(s), \forall s \geq t$. As Grossman and Helpman do, this problem can be decomposed into 2 parts:

- The static allocation of a given per-household expenditure E_s^k among the primary good and all kind of manufactures, which gives rise to a demand function for each of these commodities.
- The choice of an optimal path for E_s^k , given the possibility of saving and investing in equity of eastern and western firms.

We will proceed now to describe the first of both parts.

Let's denote by E the aggregate world expenditure and by γ the proportion of E spent by people from the West, which is an endogenous variable. Considering that demand for any variety comes from both western and eastern consumers who face different c.i.f. prices, we can derive the aggregate demand for any western (x_n) and eastern manufacture (x_c), taking into account (1.2), (1.3) and our previous definition of γ as follows:

⁴Since those internal trade costs do not change, without loss of generality we can make them equal to zero.

$$x_n = \mu \cdot p_n^{-\epsilon} \cdot \left[\frac{\gamma E}{n_n p_n^{1-\epsilon} + \delta n_c p_c^{1-\epsilon}} + \frac{(1-\gamma) \delta E}{\delta n_n p_n^{1-\epsilon} + n_c p_c^{1-\epsilon}} \right] \quad (1.7)$$

$$x_c = \mu \cdot p_c^{-\epsilon} \cdot \left[\frac{\gamma \delta E}{n_n p_n^{1-\epsilon} + \delta n_c p_c^{1-\epsilon}} + \frac{(1-\gamma) E}{\delta n_n p_n^{1-\epsilon} + n_c p_c^{1-\epsilon}} \right] \quad (1.8)$$

where $\epsilon = \frac{1}{1-\alpha}$. In expressions (1.7) and (1.8), as in Martin and Ottaviano (1999), $\delta = \tau^{1-\epsilon}$ ($0 \leq \delta \leq 1$) is a measure of trade openness in the global economy with respect to manufactures.

Concerning firms, they maximize profits at any period s taking into account a demand of the type (1.7) or (1.8) and the simple production function described above. As a result, both utility and profit maximization from expressions (1.3), (1.7) and (1.8) result in a common optimal price for all industrial firms in location k , which is a constant mark-up over marginal costs:

$$p_k = \frac{w_k}{\alpha}, \text{ for } k = \text{West, Core.} \quad (1.9)$$

Then, from (1.9), per-period operating profits for any manufacturing firm in location k are

$$\pi_k = \left(\frac{1-\alpha}{\alpha} \right) w_k x_k \text{ for } k = \text{West, Core} \quad (1.10)$$

On the other hand, we assume that the wage differential between West and Core is high enough for eastern imitators to quote the unconstrained optimal mark-up. Therefore, this wide-gap assumption will only be satisfied if the original manufacturer can not undercut the eastern firm without incurring losses, i.e. iff⁵

$$\frac{w_c}{\alpha} \tau \leq w_n \quad (1.11)$$

Given that the primary sector is characterized by perfect competition and free entry, the agricultural price is equal to the peripheral wage and per-firm operating profits are zero. We assume that international transaction costs for primary products remain unaltered. So, without loss of generality, we state that these costs are just nil. Taking all this into account,

$$p_a = w_a = \frac{(1-\mu) E}{L_a} \quad (1.12)$$

⁵This assumption is useful to rule out strategic behavior in the pricing decisions of western and eastern firms.

1.2.3 Dynamic optimization

Now we have to face the intertemporal allocation of expenditure and savings, not only to distribute consumption along the time horizon, but also to finance new startups in the West and the Core. In order to allocate expenditure and savings over time, any household k must choose (in every period s) a variation in its portfolio composition, buying or selling equity from eastern and western firms. During that process the household needs to keep in mind that (in every period s) a fraction $m = \frac{\dot{n}_e}{n_n}$ of the western measure of varieties is copied by eastern imitators, which implies that the previous owners of those firms will lose their equity.

Let π_n and π_c denote the current operating profits of any western and eastern industrial firm, respectively. At every period s , a representative household from location k owns a measure $\beta_{nk}(s)$ of western firms and $\beta_{ck}(s)$ of eastern firms. Moreover, f_{nk} stands for the proportion of gross savings devoted to buying western equity. We will explore the properties of an interior equilibrium in which new startups from both countries are financed (i.e. $0 < f_{nk} < 1$).

Our control variables are E_k (household's expenditure) and $f_{nk}(s)$, whereas the state variables are $\beta_{nk}(s)$ and $\beta_{ck}(s)$. Then, the present-value Hamiltonian faced by any household in location k at time t for the period s is the following:

$$H_k(s) = e^{-\rho(s-t)} \cdot \log E_k(s) + \Phi_{nk}(s) \left[\frac{(w_k + \beta_{nk}\pi_n + \beta_{ck}\pi_c - E_k) f_{nk}(s)}{v_n} - m\beta_{nk} \right] \quad (1.13)$$

$$+ \Phi_{ck}(s) \left[\frac{(w_k + \beta_{nk}\pi_n + \beta_{ck}\pi_c - E_k) (1 - f_{nk}(s))}{v_c} \right] \quad (1.14)$$

The first-order condition for an interior solution for $f_{nk}(s)$ is the following:

$$\frac{\Phi_{nk}(s)}{v_n(s)} = \frac{\Phi_{ck}(s)}{v_c(s)}, \quad \forall s \quad (1.15)$$

The first-order condition with respect to $E_k(s)$ yields, due to equation (1.15), that

$$e^{-\rho(s-t)} \frac{1}{E_k(s)} = \frac{\Phi_{nk}(s)}{v_n(s)} = \frac{\Phi_{ck}(s)}{v_c(s)}, \quad \forall s \quad (1.16)$$

And therefore, by differentiating and using the first-order conditions with respect to the state

variables,

$$\frac{\dot{E}}{E} = \frac{\dot{E}_c}{E_c} = \frac{\dot{E}_n}{E_n} = \frac{\dot{E}_a}{E_a} = \frac{\pi_n}{v_n} - m - \rho + \frac{\dot{v}_n}{v_n} = \frac{\pi_c}{v_c} - \rho + \frac{\dot{v}_c}{v_c} \quad (1.17)$$

The last expression shows how, in equilibrium, the profitability of western and eastern manufacturing firms must satisfy an arbitrage condition period by period.

1.2.4 Description of dynamic equilibrium without migration

System of differential equations

Now, by grouping terms, we can define $A = \frac{E}{nv_n}$ and $B = \frac{E}{n_c v_c}$. To characterize a dynamical system in A , B and $c = \frac{n}{n_c}$, we need to know first the dynamic behavior of the measures of manufacturing varieties, n_c and n . We will follow the evolution of the aggregate measure of manufactures in the core and the global economy $(\frac{\dot{n}_c}{n_c}, \frac{\dot{n}}{n})$ by looking at the labor-market-clearing conditions. These equilibrium conditions in the core and the north can be specified considering the available production function and the technology in the imitation and innovation processes:

$$L_c = a_m \frac{\dot{n}_c}{n_c} + n_c x_c \quad (1.18)$$

$$L_n = a \frac{\dot{n}}{n} + n_n x_n \quad (1.19)$$

On the other hand, the system describes the dynamics of A , B and c , but the separate evolutions of E , v_c and v_n can not be disentangled. As a consequence, Grossman and Helpman have one degree of freedom to normalize

$$E(t) = 1, \forall t \quad (1.20)$$

which implies (by equation (1.4)) that

$$A = \frac{1}{aw_n}; B = \frac{1}{a_m w_c} \quad (1.21)$$

Instead of A and B , we will be interested in the evolution of the local nominal wages w_n and w_c . Therefore, using (1.7), (1.8), (1.10), (1.17), (1.18), (1.19) and (1.21), we are ready to set up the complete system of differential equations in w_n , w_c and c (when trade openness is almost

perfect, i.e. when $\delta \rightarrow 1^-$) as follows:

$$\begin{aligned}
\frac{\dot{w}_n}{w_n} &= \left[\frac{-(1-\alpha)}{a_m} \left(\frac{w_n^{\xi-1}}{w_n^{\xi-1} + (c-1)w_c^{\xi-1}} \right) + \rho \right] + \left[\frac{L_n}{a} - \frac{\alpha(c-1)}{aw_n} \left(\frac{w_c^{\xi-1}}{w_n^{\xi-1} + (c-1)w_c^{\xi-1}} \right) \right] \\
\frac{\dot{w}_c}{w_c} &= \rho + \left[\frac{L_c}{a_m} - \frac{1}{a_m} \left(\frac{w_n^{\xi-1}}{w_n^{\xi-1} + (c-1)w_c^{\xi-1}} \right) \right] \\
\frac{\dot{c}}{c} &= \left[\frac{L_n}{a} - \frac{\alpha(c-1)}{aw_n} \left(\frac{w_c^{\xi-1}}{w_n^{\xi-1} + (c-1)w_c^{\xi-1}} \right) \right] - \left[\frac{L_c}{a_m} - \frac{\alpha}{a_m} \left(\frac{w_n^{\xi-1}}{w_n^{\xi-1} + (c-1)w_c^{\xi-1}} \right) \right]
\end{aligned} \tag{1.22}$$

We will try to provide some intuition for the previous system of differential equations. Let's begin focusing on the first equation: the first term in square brackets contains the increase in nominal wages due to expenditure. Expenditure will raise more nominal wages the higher is the discount rate (ρ). But we also have another negative term ($\frac{-(1-\alpha)}{a_m} \left(\frac{w_n^{\xi-1}}{w_n^{\xi-1} + (c-1)w_c^{\xi-1}} \right)$) next to the discount rate, and we can see that its absolute value is decreasing in $c = \frac{n}{n_c}$. That is, expenditure will make western wages grow more the higher is c , i.e. the lower is the imitation-potential of the Core. This happens because when the imitation potential is very low (c is very high), the expected life of a western patent is high and the profits offered by western firms in a given period are consequently low. This encourages people to spend (instead of saving and investing in western startups), which tends to increase nominal wages.

Let's have a look now at the second term (in square brackets) of the first equation. Its interpretation is much more straightforward: western wages will increase more the higher is innovation ($\frac{\dot{n}}{n}$), since higher innovation entails more demand for labor in the West. And innovation will be faster the more researchers (and the less manufacturing workers) you can find in the West. Since a higher imitation potential (a lower c) curtails the western demand for manufacturing workers, innovation (and wages) in the West will tend to go up the lower is c .

Therefore, in the first equation we can see that any variation in the eastern imitation potential (i.e. in c) has two opposite effects on western wages. On the one hand, as the expected life of a patent is shortened by more imitation, people receive higher annual profits and therefore save more (and spend less), reducing the growth rate of western wages. On the other hand, more imitation makes western workers shift to research (rather than manufacturing), which raises innovation and spurs future demand for labor in the West, raising the growth rate of nominal wages there.

The other two equations are easier to interpret. The second just tells us that wages in the Core will grow more the higher is ($\frac{\dot{n}_c}{n_c}$), since demand for labor will increase there. The third

equation obviously reflects that c is increasing in the speed of innovation relative to the speed of imitation.

Innovation and imitation in steady state

If we prove that there are some values c^* , w_n^* and w_c^* for which $\dot{w}_n = \dot{w}_c = \dot{c} = 0$, this will imply that there exists a steady state for our system of differential equations established in (1.22). From the second differential equation in (1.22), in our candidate to steady state

$$\frac{1}{a_m} \left(\frac{w_n^{\epsilon-1}}{w_n^{\epsilon-1} + (c-1)w_c^{\epsilon-1}} \right) = \alpha \left(\frac{L_c}{a_m} + \rho \right) \quad (1.23)$$

and from the third equation, (1.18), (1.19) and (1.23) we get that

$$g = \frac{\dot{n}}{n} = \frac{\dot{n}_c}{n_c} = (1 - \alpha) \frac{L_c}{a_m} - \alpha\rho > 0 \quad (1.24)$$

We can observe that our innovation growth rate is exclusively determined by the monopoly power, the discount rate and the imitation capacity of the Core. It may look rather odd that the global growth rate does not depend on the innovative conditions in the West. In fact, this extreme result depends on the absence of international (West-East) knowledge spillovers. Once they are allowed in Grossman and Helpman (1991)'s model, it can be shown that both countries play a role in the determination of the steady-state growth rate: what matters is that such a rate is always increasing in the imitation capacity of the Core.

Therefore, from (1.4) and (1.24),

$$\frac{\dot{v}_c}{v_c} = \frac{\dot{v}_n}{v} = -g \quad (1.25)$$

This implies that the value of every firm shrinks in steady state at a constant rate. In other words, financial capital depreciates at the rate of innovation, and it is necessary to save to make up for that depreciation period by period. Now, from equations (3.11), (1.25) and also the arbitrage condition (1.17), we are ready to obtain reduced-form equations for the profits of

any western and eastern industrial firm:

$$\pi_n = (\rho + m + g) v_n; \quad \pi_c = (\rho + g) v_c \quad (1.26)$$

It is useful, as Grossman and Helpman do, to express c as a function of m and g , where $m = \frac{\dot{n}_c}{n_n}$ is our imitation rate. Since $m = g \frac{1}{(c-1)}$, we can solve now for c :

$$c = \frac{m + g}{m} \quad (1.27)$$

As a consequence, from (1.4), (1.10), (1.19), (1.26) and (1.27), we can restate the arbitrage condition corresponding to western manufactures as follows:

$$\frac{\pi_n}{v_n} = \left(\frac{1 - \alpha}{\alpha} \right) \left[\frac{L_n}{a} - g \right] \left(\frac{m + g}{g} \right) = \rho + m + g \quad (1.28)$$

By combining (1.24) and (1.28), we can already derive a formal expression for the steady-state imitation rate m :

$$m = \left\{ \begin{array}{ll} 0, & \text{if } \frac{L_n}{a} \geq \frac{L_c}{a_m} \\ \frac{(1-\alpha) \left[\frac{L_c}{a_m} - \frac{L_n}{a} \right] \left((1-\alpha) \frac{L_c}{a_m} - \alpha \rho \right)}{\alpha \rho - (1-\alpha) \left[\frac{L_c}{a_m} - \frac{L_n}{a} \right]}, & \text{if } \frac{L_c}{a_m} \geq \frac{L_n}{a} \geq \frac{L_c}{a_m} - \frac{\alpha \rho}{1-\alpha} \\ \infty, & \text{if } \frac{L_n}{a} \leq \frac{L_c}{a_m} - \frac{\alpha \rho}{1-\alpha} \end{array} \right\} \quad (1.29)$$

As could be expected, m rises with the imitation potential of the Core relative to the western innovation capacity: $\left(\frac{L_c}{a_m} - \frac{L_n}{a} \right)$. We can already establish a first set of parameter restrictions so that the global economy exhibits a positive innovation rate and a positive measure of manufactures operate in both countries. That is, we want that $1 < c < \infty$, which requires $0 < m < \infty$ and $0 < g < \infty$. As we prove in the Appendix, this initial condition can be simply summarized as follows:

$$0 < \left[\frac{L_c}{a_m} - \frac{L_n}{a} \right] < \frac{\alpha \rho}{1 - \alpha} \quad (1.30)$$

Absolute and relative wages in steady state

Now we will see how steady-state relative wages change in response to a fall in trade costs. But there are still several endogenous variables to be determined that are crucial for our comparative

statics. Two of them are the relative wage of the Core with respect to the West ($\omega = \frac{w_c}{w_n}$) and γ . From equations (1.7), (1.8), (1.9), (1.18), (1.19) and (3.11), we can get an idea of the determinants of ω as follows:

$$\frac{x_n}{x_c} = \frac{L_n - ag}{L_c - a_m g} \frac{m}{g} = \omega^\epsilon C(\delta, L_c, \omega) \quad (1.31)$$

$$\text{where } C(\delta, L_c, \omega) = \left[\frac{\frac{\gamma}{(g/m)\omega^{\epsilon-1} + \delta} + \frac{(1-\gamma)\delta}{\delta(g/m)\omega^{\epsilon-1} + 1}}{\frac{\gamma\delta}{(g/m)\omega^{\epsilon-1} + \delta} + \frac{(1-\gamma)}{\delta(g/m)\omega^{\epsilon-1} + 1}} \right] \quad (1.32)$$

We can see from the left-hand side of (1.31) that only the supply-side fundamentals - i.e. industrial workforces in both countries and innovation and imitation long-term capacities - can modify the relative size of firms ($\frac{x_n}{x_c}$). That means that any variation in international trade openness (δ) will be exactly offset in the long run by a countervailing adjustment of ω .

Our term $C(\delta, L_c, \omega)$ is a direct measure of the home-market advantage of one of the countries to offer higher wages for similar supply-side fundamentals. The country with a higher demand capacity (i.e. the West if $\gamma > 1/2$) will be able to reward better the labor force, since less demand will be wasted paying transaction costs there. Before we explore the relative-wage consequences of a rise in δ , we need to express γ in terms of the parameters for a steady-state situation. Next lemma will be of considerable help.

Lemma 1:

In any steady state without net migratory flows, any household's expenditure is identical to that household's income period by period. Therefore, the steady-state aggregate western and eastern incomes are equal to γ and $1 - \gamma$, respectively, and there are no net savings.

Proof. See Appendix. ■

Subsequently, let's derive some formal expressions of western and eastern aggregate income. An implication of the last lemma is that a household's gross savings in steady state just cover the depreciation of previously-owned capital. Therefore, a representative household from location k will have an income

$$y_k = E_k = w_k + \rho\eta_{ck}a_m w_c + \rho\eta_{nk}a \left(\frac{g}{m+g} \right) w_n$$

where η_{ck} and η_{nk} denote the fraction of eastern and western firms, respectively, owned by that

household. From (1.12), (3.11) and our definition of γ it is possible to come out with a neat expression of this variable as a fraction between zero and one:

$$\gamma = \frac{1}{1 + \frac{\left(\frac{1-\mu}{w_n}\right) + \omega L_c + \rho \left[(1-\eta_{nn}L_n)a\left(\frac{g}{m+g}\right) + (1-\eta_{cn}L_n)a_m\omega \right]}{L_n \left[1 + \rho \left(\eta_{nn}a\left(\frac{g}{m+g}\right) + \eta_{cn}a_m\omega \right) \right]}} \quad (1.33)$$

In the denominator of (1.33), w_n is an endogenous variable that has not been fully specified yet in terms of the parameters. So, we need to obtain an expression for local absolute wages as well. Let's define first

$$Q = \frac{m}{g}\omega^{1-\epsilon} \quad (1.34)$$

Now, if we plug (1.7) into (1.19), divide numerator and denominator of the latter expression by $\left(\frac{w_n}{\alpha}\right)^{1-\epsilon}$ and rearrange, eventually we find that

$$w_n = \frac{\alpha\mu}{(L_n - ag)} \left[\frac{\gamma}{1 + \delta Q} + \frac{(1-\gamma)\delta}{\delta + Q} \right] \quad (1.35)$$

Proceeding in a similar way, we can solve for w_c from (1.18) as follows:

$$w_c = \frac{\mu}{(L_c + a_m\rho)} \left[\frac{\gamma\delta}{1 + \delta Q} + \frac{(1-\gamma)}{\delta + Q} \right] Q \quad (1.36)$$

In the next section we derive a necessary and sufficient condition for an increase in ω in response to a marginal rise in trade openness (δ).

Comparative Statics

Proposition 1:

Concerning the distribution of financial wealth, assume that

$$\eta_{nn}L_n \rightarrow 1^-; \eta_{cn}L_n \rightarrow 0^+; \eta_{cc} = \eta_{ca} = 1/L_s \quad (1.37)$$

where η_{kl} is equal to the proportion of aggregate wealth from location k owned by any household living in location l . In that case, when the imitation potential of the Core is sufficiently small, the relative wage of the Core with respect to the West (ω) rises in response to higher trade openness

if - and only if - the initial degree of trade openness is high enough, i.e. $\lim_{L_c \rightarrow a_m \frac{L_n}{a}} \left(\frac{d\omega}{d\delta} \right) > 0$
iff $\delta^2 > \frac{1-\mu}{\mu}$

Proof. See the Appendix. ■

There are two opposite effects of a reduction of international transaction costs on the relative wage ω . The first one has to do with the difference in aggregate income between East and West: a wealthier West will be likely to raise its demand for every eastern manufacture beyond the increase in aggregate eastern demand for any western good. This would result in a rise of ω (and international convergence⁶) if there were no other active forces. Let's call this the relative-size effect.

But there is still another effect. Since most of the industrial varieties are initially produced in the West, toughness of competition increases much more for the smaller market in the East (a firm suddenly faces many more competitors there as δ falls), which tends to depress ω and generate divergence. The strength of this price-index effect decreases with the initial degree of trade openness (δ), since higher values of δ imply that local price indices are almost identical to start with (i.e. the international market is almost fully open from the beginning). This means that when the initial level of trade costs is already very low, the demand flow is relatively more important, and convergence prevails.⁷

Therefore, for $\frac{d\omega}{d\delta}$ to be positive we do not only need a large differential in the size of both countries, but also a high enough initial value of δ . Under the assumptions of Proposition 1, a very high relative-size effect has been guaranteed (since the imitation capacity of the Core is infinitesimal), which makes the initial level of trade openness the only determinant of the evolution of relative wages.⁸ In this respect, this proposition may shed some light on the determinants of protectionist policies: they may be more likely to arise in small countries when the current level of trade openness is low enough.

⁶We will talk about convergence in this paper when there exists convergence in *nominal* income, instead of real income or indirect utility. The reason why we adopted such an arbitrary convention is that nominal convergence is usually the aspect detected by national accounts, given the difficulty to access good local price-indices.

⁷The distributional assumptions we make in Proposition 1 are just technical (simplifying) assumptions. We can prove that it would be possible to distribute all world (financial) wealth in a strictly egalitarian way and the main result would not be affected. Furthermore, by making the Core's initial imitation capacity infinitesimal we guarantee the relative-size effect, and make the price-index effect the only relevant force in the comparative statics.

⁸We have proved that the distributional assumptions could be relaxed while preserving our main result.

But we would like to know what happens to relative incomes also out of this extreme situation, i.e. for any initial distribution of eastern population between Core and Periphery. Our next objective will be obtaining the function $\omega_c = \frac{w_c}{w_a} = f(L_a, \delta)$ that determines the labor-market-clearing relative wage in the East as a function of L_a and δ . The intersection of this curve with an exogenous migration function $\omega_c = h(L_a)$, which yields the amount of people willing to live in the Periphery as a function of the relative wage, will offer the final-steady-state values $(L_a^*(\delta), \omega_c^*(\delta))$.

1.3 The model with migration

In this model, the introduction of migratory movements is the only way to strengthen the catch-up potential of the Core and henceforth increase the steady-state growth rate. Why are innovation and imitation complementary in this model? The answer is twofold:

- Firstly, as the imitation potential rises, the demand for manufacturing labor in the West goes down and then a higher proportion of the western population is devoted to research.

- Secondly, as the imitation potential increases, the expected life of a western patent shortens, which forces western firms to offer higher profits (given the arbitrage condition) and encourages more saving and investment in new startups.

And how can we get Periphery-Core migrations in the first place? We claim that such a Periphery-Core migration will arise if the Core is initially favored by trade shocks. These results can be related, for example, to the Chinese experience: Solinger (1995) and Poncet (2006) document how - despite severe migration restrictions imposed by the government - the amount of "floating population" undertaking rural-urban migration could reach 150 million people, and they are driven mostly by economic motivations in the destination area. "Officials say that by 2020 about 60% of population will be living in cities or towns, which implies that more than 200 million new people will move from the countryside by then" (The Economist, page 29). For those people, migration obviously has a cost. But this paper tries to shed some light on the static and dynamic gains for those migrants, for the whole Chinese population and for the rest of the world. Let's now face the foundations of the migration decision.

1.3.1 Migration

In this subsection we draw partially from Faini (1996) to obtain a microfoundation for the migration function ($\omega_c = h(L_a)$).

Since we assumed away internal trade costs within the East, the price indices in both Core and Periphery will be identical. Therefore, a comparison of local real incomes reduces to a comparison of local nominal incomes. We will also assume that the utility derived from a given income in the Core is lower than that in the Periphery, which may be due to congestion effects or undesirable living conditions in an industrial location. That asymmetry will be summarized by the parameter θ ($\frac{1}{1+\frac{L_s}{\rho a_m}} \leq \theta \leq 1$).

We are going to assume some degree of heterogeneity in the eastern population with respect to their willingness to live in the Core (summarized by θ_i , where θ_i measures the willingness of individual i to live in the Core). That heterogeneity will show in a certain statistical distribution of parameter θ among the Chinese people: in particular, it will be assumed that θ follows a uniform distribution $U[\frac{1}{1+\frac{L_s}{\rho a_m}}, 1]$

Since we will not consider migration costs, the individual who is indifferent between living in the Periphery or in Core for a given ratio of incomes will be implicitly characterized by the expression

$$\bar{\theta}(w_c + \frac{1}{L_s}\rho a_m w_c) = w_a + \frac{1}{L_s}\rho a_m w_c$$

where $\frac{1}{L_s}\rho a_m w_c$ is the net financial income received by any Chinese individual, and $\bar{\theta}$ represents the willingness of the last individual to move to the Core at the current real wages. Rearranging, we can rewrite the previous expression as

$$\bar{\theta} = \frac{1 + \rho a_m \omega_c \frac{1}{L_s}}{\omega_c \left(1 + \rho a_m \omega_c \frac{1}{L_s}\right)}$$

And the amount of population living in the Core will be given, after some algebra, by

$$L_c = L_s P[\theta \geq \bar{\theta}] = \frac{1 - \frac{1 + \rho a_m \frac{\omega_c}{L_s}}{\omega_c \left(1 + \rho a_m \frac{\omega_c}{L_s}\right)}}{\frac{L_s}{L_s + \rho a_m}} = \left(1 - \frac{1}{\omega_c}\right) L_s$$

i.e. the previous expression can be rewritten as

$$\omega_c = h(L_a) = \frac{L_s}{L_a} \quad (1.38)$$

This is a decreasing and convex function in L_a , which shows the steady-state amount of eastern population willing to live in the Periphery for a given relative wage. In the next section we will spell out the intuition and details of our main results.

1.3.2 Description of dynamic equilibrium with migration

Since we want to reproduce some stylized facts, it is convenient for us to rule out any price-index effect threatening to abort East-West convergence. Therefore, trade costs should be initially low enough to turn demand flows into the main result of an incremental openness. Then, the relative-size effect will remain as the single driving force. Therefore, $\gamma > 1/2$ appears as a natural requirement that (together with $\delta \rightarrow 1^-$) could be enough to achieve international convergence in per-capita income. But let's provide first a sufficient condition for $\gamma > 1/2$ in terms of the parameters.

Lemma 2 :

Given our distributional assumptions in Proposition 1, $\lim_{\delta \rightarrow 1^-} (\gamma) > 1/2$ if $L_n > \hat{L}_n(L_c)$, where $\hat{L}_n(L_c)$ is a monotone increasing function.

Proof. See Appendix. ■

As we can see, it turns out that international differences in aggregate income amount to a difference in the size of populations. The larger is the size of L_n relative to L_c , the larger will be the innovative capacity of the West relative to the imitation potential of the East. This implies that a larger proportion of the global array of manufacturing varieties will be produced in the West, raising the western real wage relative to the eastern one.

The wide-gap assumption made explicit in (1.11) involves that $\lim_{\delta \rightarrow 1^-} (\omega) < \alpha$, from which we can also derive the following lemma.

Lemma 3:

There exists a unique upper-bound $L_c^* \geq L_c$ such that the wide-gap assumption holds together with the coexistence of a positive measure of western and eastern manufactures; i.e.

there exists a unique L_c^* such that (1.11) and (1.30) are simultaneously satisfied iff

$$a_m \frac{L_n}{a} < L_c \leq L_c^* < a_m \left[\frac{L_n}{a} + \frac{\alpha\rho}{1-\alpha} \right] \quad \forall a, a_m$$

Proof. See Appendix. ■

That is, for the Core's producers to be able to quote the unconstrained mark-up over marginal cost, it is necessary that the Core's population - which determines its imitation potential - is small enough relative to the western one: otherwise, the nominal wage in the Core would be too high and the western firms would find it profitable to undercut.

Our notion of steady state is partially characterized by the following equality:

$$\omega_c = f(L_a, \delta) = h(L_a) \quad (1.39)$$

where $\omega_c = h(L_a)$ is our migration function.

Now we will endogenously determine the curve $\omega_c = f(L_a, \delta)$. From (1.12), (1.24) and (1.36) we can obtain that

$$\lim_{\delta \rightarrow 1^-} \omega_c = \lim_{\delta \rightarrow 1^-} f(L_a, \delta) = \lim_{\delta \rightarrow 1^-} \left[\frac{L_a}{(1-\mu)} \frac{\mu \left(\frac{Q(L_a, \delta)}{1+Q(L_a, \delta)} \right)}{(L_s - L_a + a_m \rho)} \right] \quad (1.40)$$

where

$$\lim_{\delta \rightarrow 1^-} Q(L_a, \delta) = \left[\frac{(1-\alpha) \left[\frac{L_s - L_a}{a_m} - \frac{L_n}{a} \right]}{\alpha\rho - (1-\alpha) \left[\frac{L_s - L_a}{a_m} - \frac{L_n}{a} \right]} \right]^{1-\alpha} \left[\frac{\alpha(L_s - L_a + a_m \rho)}{L_n - \frac{a(1-\alpha)}{a_m} (L_s - L_a) + a\alpha\rho} \right]^\alpha \quad (1.41)$$

Here we can appreciate the two basic effects of a declining peripheral labor force ($\downarrow L_a$) on ω_c :

- First, the numerator and denominator of (1.40) directly capture the straightforward *labor-supply effect*: if new immigrants come from Periphery to Core, ω_c will tend to decrease for a given value of Q .

- Secondly, the quotient $\frac{Q(L_a, \delta)}{1+Q(L_a, \delta)}$ is decreasing in L_a because it reflects the gain in *imitation potential* of the Core after an inflow of former peripheral workers. This force tends to increase the fraction of the total measure of manufactures produced in the Core, which channels world

demand to this location and can potentially raise w_c .

The relative strength of these two effects varies along the relevant range of values of L_a : $[L_s - a_m \frac{L_n}{a}, L_s - L_c^*]$. In fact, $Q(L_a, \delta)$ acts as a positive measure of the imitation potential in the core. Moreover, additional migration reinforces much more that potential the lower $Q(L_a, \delta)$ is. In other words, once you have copied a high proportion of western varieties, it is harder for you to raise your local wage by further imitating: you have to compete - every time more toughly - with more and more producers in your own location.

In fact, since by (1.40) $f(0, \delta) = f(L_s - a_m \frac{L_n}{a}, \delta) = 0 \quad \forall \delta$ and our function f is continuous in L_a , we know for sure that $f(L_a, \delta)$ shows an inverted-U shape $\forall \delta$. That is, we can observe both an upward-sloping part of the curve - where the labor-supply effect is stronger - and a downward-sloping one, with a dominant imitation-potential effect⁹(see Figure 1).

In Figures 1 and 2 the horizontal axis measures the amount of population in the Periphery (L_a), and the vertical axis represents the relative wage of the Core with respect to the Periphery (ω_c). We can observe in Figure 1 how - due to the coexistence of a labor-supply and an imitation-potential effect with opposite effects on ω_c - the curve $f(L_a, \delta)$ has both an upward-sloping and a downward-sloping region.

In order to draw our arrows of motion, we have assumed that agents form their expectations in an *adaptive* way, as is usual in economic geography. This means that, when deciding how to allocate their financial capital, individuals take local populations as given and do not expect them to change; by the same token, when making their migratory choice, eastern individuals do not expect relative wages to vary at all (even when the economy is out of the steady state). As a result of this, we can see that the system has two stable steady states and an intermediate, saddle-path unstable one.

The first stable steady state concentrates all eastern population in the Periphery and there is no manufacturing activity at all within the East ($L_a = L_s$). It is necessary to have a critical mass of population (and researchers) in the Core to channel a sufficiently high share of world demand towards that location and raise the local wage, which will subsequently attract more population to repeat the cycle. If such a critical mass is achieved, the system will *evolve naturally* towards the second stable steady state, characterized by $\omega_c = f(L_a, \delta) = h(L_a)$ and

⁹ Provided that the whole range of values of L_a satisfies the wide-gap assumption, i.e. if $L_s - a_m \frac{L_n}{a} < L_c^*$.

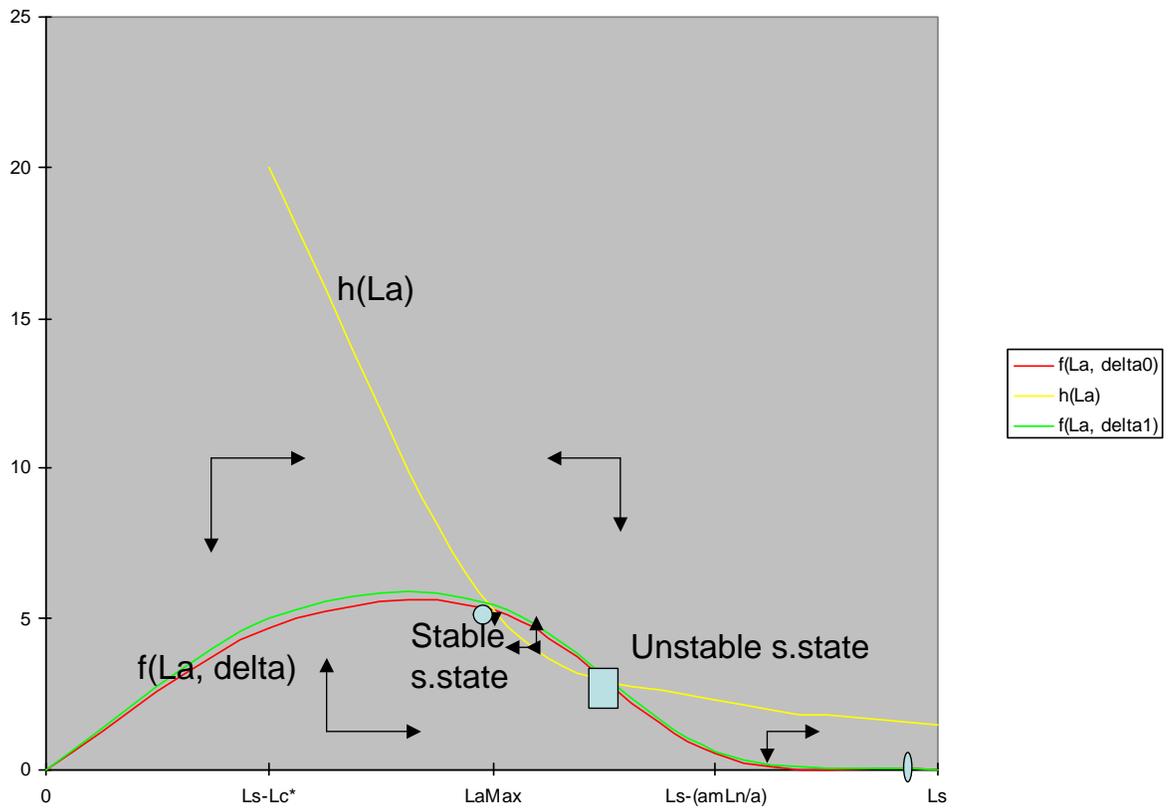


Figure 1-1: Effect of trade liberalization

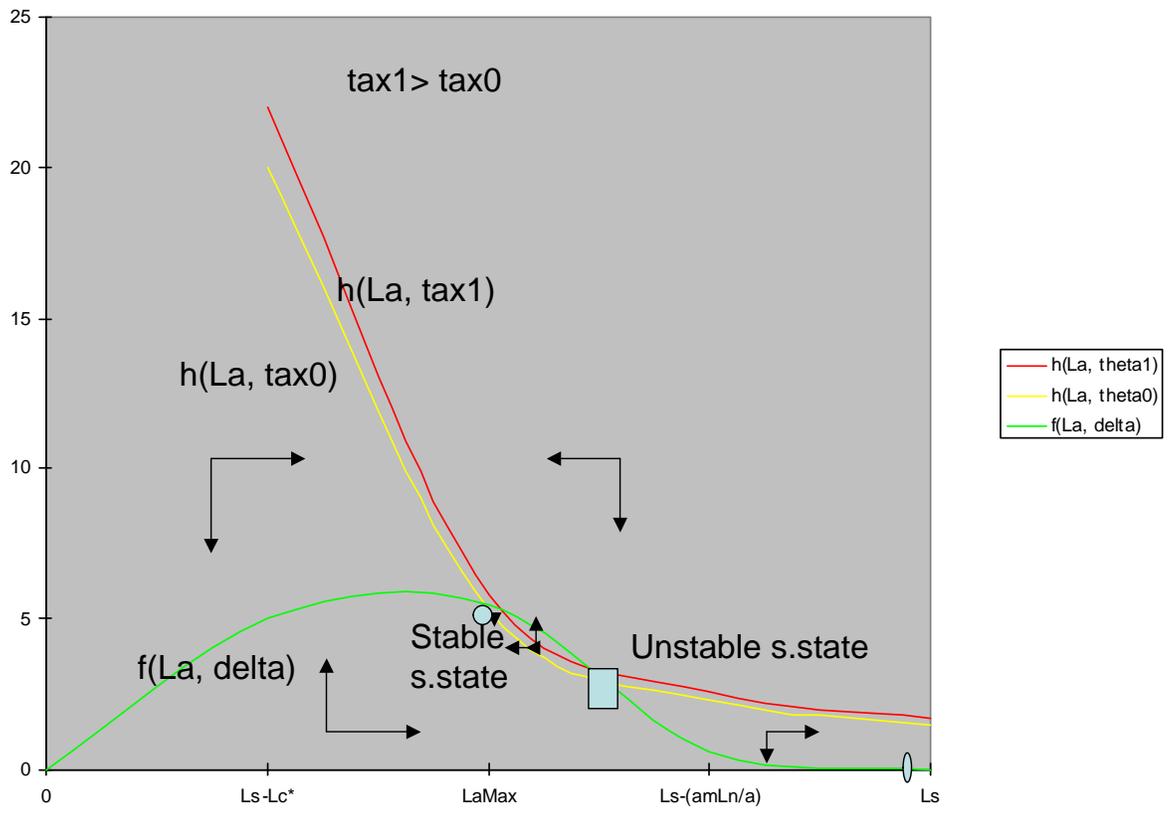


Figure 1-2: Effect of Core-Periphery redistribution

also by $\frac{\partial h}{\partial L_a} < \frac{\partial f}{\partial L_a} < 0$.

In order to replicate our stylized facts, we will assume that the economy is initially situated in the second steady state (marked with a blue circle in Figure 1) and it receives a trade shock that will shift the $f(L_a, \delta)$ -curve upwards, as represented by the transit from the red curve to the green curve in Figure 1. That is, the main characteristics of our relevant steady state are significant agglomeration effects on the Core's labor productivity and a considerable labor stickiness within the East.

1.3.3 Main results

As anticipated above, the main results we need to reproduce are international (East-West) convergence in per capita income, interregional (Core-Periphery) divergence within the East, higher concentration of labor in the Core and higher (global) growth rates. It may look counterintuitive the coexistence of potential Core-Periphery migrations and interregional divergence within the East. The reason why both phenomena coexist is that interregional divergence is obtained in terms of real income, but not in terms of utility. In the section about the derivation of migration functions, we assumed that people suffer from a congestion disutility in the Core (i.e. the marginal utility of a given income in the Core is lower than in the Periphery), and the parameter measuring congestion disutility follows a probability distribution. As more people move to the Core, the congestion disutility of the last mover becomes higher, and the ratio of Core/Periphery incomes is also higher than at the beginning.

Now we will obtain a sufficient condition for the ratio $R_{ca} = \frac{\text{per-capita income in the core}}{\text{per-capita income in periphery}}$ to increase in response to a marginal rise in δ .

Proposition 2:

Let $R_{ca} = \frac{Y_c/(L_s-L_a)}{Y_a/L_a}$ be the core-periphery relative per-capita income. If in the original steady state the following conditions are satisfied: a) $L_n > \hat{L}_n(L_s)$; b) $\frac{a_m L_n}{a} < L_c < L_c^*$; c) $\delta \rightarrow 1^-$; then :

$$\frac{dR_{ca}}{d\delta} > 0; \quad \frac{d\omega_c}{d\delta} > 0; \quad \frac{dg}{d\delta} > 0; \quad \frac{dL_a}{d\delta} < 0$$

Proof. See Appendix. ■

With a sudden rise in δ , the dominance of the relative-size effect - when we are close to full openness - weakens the home-market advantage of the West. The subsequent rise in

ω_c attracts a net migratory flow from Periphery to Core and increases our eastern imitation potential. Hence, the decrease in c caused by migrations channels more world demand towards eastern manufactures and exerts an upward pressure on the labor costs in the Core. This force countervails the labor-supply effect, which usually happens when industrial competition within the core is soft enough and eastern labor force is sufficiently sticky.

Given the significant agglomeration effects on labor productivity detected in the EU by Ciccone (2002) and in China by Au and Henderson (2006), accepting that $\frac{\partial f}{\partial L_a} < 0$ (i.e. that we are on the downward-sloping part of the function $f(L_a, \delta)$) does not look counterfactual. Neither does the extreme (interregional) stickiness of labor in many European and Asian countries (see Bentolila (1997); Fujita and Hu (2001)).

Let's try to face now the East-West convergence issue in a similar fashion.

Proposition 3:

If in our initial steady state $a_m \frac{L_n}{a} \leq L_c \leq L_c^*$, $L_n > \hat{L}_n(L_s)$ and $\delta \rightarrow 1^-$, then necessarily $\frac{dR_{ns}}{d\delta} < 0$, where R_{ns} is the relative per-capita income of the West with respect to the East.

Proof. See Appendix. ■

There are three forces involved in the comparative-statics evolution of relative East-West per-capita income, two of which exactly offset each other. These 2 opposite forces, whose joint effect is nil, can be described as follows:

- First, the net inflow of workers to the core enhances the innovation rate and, consequently, also the demand for labor in the West, which tends to raise w_n .

- At the same time, although the global economy innovates faster, a higher imitation potential raises the proportion of eastern manufactures. Hence, a lower proportion of total financial wealth owned by the West exactly makes up for the higher demand for researchers in that country. Therefore, the only effect capable of modifying γ comes from the aggregate demand for the manufactures produced in the West. This aggregate demand goes down in terms of our numeraire, since the western home-market advantage becomes weaker.

Corollary:

If in our initial steady state $a_m \frac{L_n}{a} \leq L_c \leq L_c^* < a_m \left[\frac{L_n}{a} + \frac{\alpha\rho}{1-\alpha} \right]$, $L_n > \hat{L}_n(L_s)$ and $\delta \rightarrow 1^-$,

then, in our comparative-statics exercise

$$\frac{dR_{ca}}{d\delta} > 0; \frac{d\omega_c}{d\delta} > 0; \frac{dg}{d\delta} > 0; \frac{dL_a}{d\delta} < 0; \frac{d\gamma}{d\delta} < 0; \frac{d\omega_c}{d\delta} > 0 \text{ and } \frac{d\omega_a}{d\delta} > 0 \text{ (where } \omega_a = \frac{w_a}{w_n} \text{)} .$$

Proof. Straightforward from (1.12), (3.11) and the last 2 propositions. ■

It is remarkable that - in our framework - a decrease in international trade costs could be *potentially Pareto-improving*. This is true because both eastern locations unambiguously gain in terms of steady-state indirect utility; and although the western per-capita (nominal) income falls, that effect could be offset by the higher growth rate for a low enough discount rate (ρ).

Furthermore, Figure 2 shows how an intensification of a Core-Periphery income-redistribution policy within the East could reduce peripheral wages, wages in the Core (due to the foregone agglomeration effects) and the growth rate of the global economy¹⁰ (for an analytical derivation of this result, see the Appendix). Nevertheless, structural changes in the Periphery - even if financed with transfers - could also enlarge the scale effects within the East and yield both convergence within China and higher global growth rates. However, this model does not lend itself to the study of public investment (there are no public goods) and structural change, so we can not assess quantitatively the relative virtue of promoting migration versus restructuring in the Periphery.¹¹

1.4 Conclusions

We have studied an East-West endogenous growth model where exogenous institutional features play a major role: they determine the relative incidence of a biased shock in trade openness on two distinct eastern regions. Within our eastern country, we have considered a perfectly-

¹⁰Therefore, the *Hukou* system may be having deleterious economic effects over China and even over the rest of the world, although its implementation could make sense from a political-economy point of view (see Solinger (1995)).

¹¹De la Fuente (2004) creates a framework to study the optimal central-planner allocation of public investment among regions, for a given degree of income redistribution that can not be extended. When calibrated for the case of Spain, he finds that the allocation of public investment has probably been too redistributive. His model is essentially static and does not consider pecuniary externalities across locations or induced modifications in the local populations, as we do. If his model considered all these effects - according to our framework - we presume that the case for redistribution through public investment in Spain would be even weaker (we can not forget that this conclusion depends on the maintenance of a given interregional solidarity through income-redistribution programmes).

competitive market structure for the Periphery together with some sources of agglomeration economies in the Core. As a result, we have reproduced our stylized facts, i.e. the coexistence of per-capita income convergence between countries and divergence within the same countries. The existence of scale effects generates a trade-off between Core-Periphery convergence and global steady-state growth. But not necessarily a trade-off between long-run growth rates and East-West convergence.

Our model has potentially interesting implications for the role of interregional transfers. In particular, we conclude that, no matter how generous interregional transfers are, if they do not help transform peripheral productive structures they can not prevent an asymmetric exposure to trade shocks. If transfers also refrained migratory flows, they could reduce the core-periphery gap, though only by lowering all easterners' labor income and the growth rate of the global economy.

On the other hand, if transfers were useful to industrialize the Periphery the scale-effects would be larger. In fact, this seems to be the recent choice of the Chinese authorities, aiming to reconcile higher growth and Core-Periphery convergence by means of the setup of new economic infrastructure in the latter location. This looks like an argument to advocate structural changes in the Periphery as opposed to direct transfers to household consumption. But, in order to elaborate on this, we need to do some welfare analysis requiring transitional dynamics and an explicit formulation of both migratory costs and structural-change costs, since we need a different framework to assess the relative virtue of promoting migration versus structural change in the Periphery. This is an interesting avenue for future research.

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1.6 Appendix

1.6.1 Steady-state fraction of manufacturing varieties in the Core

By (1.22), (1.26) and our definition of steady state,

$$\left[1 + \frac{1 - \alpha}{\alpha} \frac{c}{(c - 1)}\right] \left[\frac{L_n}{a} - \left((1 - \alpha) \frac{L_c}{a_m} - \alpha\rho\right)\right] - \left[(1 - \alpha) \frac{L_c}{a_m} - \alpha\rho\right] \frac{1}{(c - 1)} = \rho + \frac{L_n}{a} \quad (1.42)$$

Finally, solving for c in (1.42) we can get that

$$c^* = \frac{\alpha\rho}{(1-\alpha)\left[\frac{L_c}{a_m} - \frac{L_n}{a}\right]} \quad (1.43)$$

The trivial fact that $n \geq n_c$, i.e. $c \geq 1$, imposes our restriction (1.30) on the value of the parameters.

1.6.2 Income-redistribution policy between Core and Periphery

We are going to introduce a proportional income tax accompanied by a lump-sum rebate for the Chinese population. As will be shown, this form of Core-Periphery redistribution will reduce the willingness of Chinese population to live in the Core. Now we can characterize the willingness of the last individual to move to the Core ($\bar{\theta}$) as follows:

$$\bar{\theta} \left[w_c \left(1 + \rho a_m \frac{1}{L_s} \right) (1 - \Gamma) + G \right] = \left(w_a + \rho a_m w_c \frac{1}{L_s} \right) (1 - \Gamma) + G \quad (1.44)$$

where Γ measures the proportional income tax and G the corresponding lump-sum rebate.

The balanced-budget condition that links the values of τ and G can be expressed as

$$L_s G = \Gamma [w_c \rho a_m + w_c L_c + w_a L_a]$$

Solving for G and replacing the value of G in (1.44), we can obtain an expression for $\bar{\theta}$ such as

$$\bar{\theta} = \frac{L_s (1 - \Gamma) + (\rho a_m + \Gamma L_c) \omega_c}{\omega_c [L_s (1 - \Gamma) + \rho a_m + \Gamma L_c]}$$

It is finally easy to check that

$$\lim_{\tau \rightarrow 0} \frac{d\bar{\theta}}{d\Gamma} > 0 \text{ iff } \omega_c > 1$$

i.e. within the relevant range of values for ω_c , higher taxation implies an upward shift of the curve $h(L_a)$ and a lower steady-state population in the Core.

1.6.3 Proof of Proposition 1

Proof. Let's rewrite the second part of expression (1.31) as follows:

$$C(\delta, L_c, \omega) = \frac{\gamma(m\omega^{1-\epsilon} + \delta g) + (1-\gamma)\delta(\delta m\omega^{1-\epsilon} + g)}{\gamma\delta(m\omega^{1-\epsilon} + \delta g) + (1-\gamma)(\delta m\omega^{1-\epsilon} + g)} \quad (1.45)$$

After a marginal increase in δ , the right-hand side of (1.31) has to remain constant, because nothing is altered in the left-hand side of the equality. Therefore,

$$\lim_{L_c \rightarrow a_m \frac{L_n}{a}^+} \frac{(dC/d\delta)}{C} = - \lim_{L_c \rightarrow a_m \frac{L_n}{a}^+} \frac{\epsilon \frac{d\omega}{d\delta}}{\omega} \quad (1.46)$$

Then, if we take logs of (1.45) and compute the total derivative, we can get that

$$\begin{aligned} \frac{(dC/d\delta)}{C} &= \frac{(\gamma\delta^2 - (1-\gamma))}{\delta[1-\gamma(1-\delta^2)]} \\ &- \frac{\frac{d\omega}{d\delta} \left[Q(\epsilon - 1)(\delta^2 - (\gamma + (1-\gamma)\delta^2)(1-\gamma(1-\delta^2))) + \frac{d\gamma}{d\omega}\delta(1-\delta^2) \right]}{\delta[1-\gamma(1-\delta^2)]} \end{aligned} \quad (1.47)$$

From (1.46) and (1.47),

$$\frac{d\omega}{d\delta} = \frac{\omega(\gamma\delta^2 - (1-\gamma))}{\epsilon\delta(1-\gamma(1-\delta^2)) + (\epsilon-1)Q[\delta^2 - (\gamma + (1-\gamma)\delta^2)(1-\gamma(1-\delta^2))] + \frac{d\gamma}{d\omega}\delta\omega(1-\delta^2)} \quad (1.48)$$

In order to determine the sign of $\lim_{L_c \rightarrow a_m \frac{L_n}{a}^+} \frac{d\omega}{d\delta}$, it is useful to know the limit-value of ω when $L_c \rightarrow a_m \frac{L_n}{a}^+$. From (1.31),

$$\lim_{L_c \rightarrow a_m \frac{L_n}{a}^+} \frac{L_n - ag}{L_c - a_m g} \frac{m}{g} = \left[\lim_{L_c \rightarrow a_m \frac{L_n}{a}^+} \omega^\epsilon \right] \left[\lim_{L_c \rightarrow a_m \frac{L_n}{a}^+} C(\delta, L_c, \omega) \right] \quad (1.49)$$

Our parameter restriction (1.30) guarantees that $g > 0$ and then, from (1.29), (1.45) and (1.49), $0 = \left[\lim_{L_c \rightarrow a_m \frac{L_n}{a}^+} \omega^\epsilon \right] \left[\frac{\delta}{1-\gamma(1-\delta^2)} \right]$. As we can infer from (1.33), $0 < \frac{\delta}{1-\gamma(1-\delta^2)} < \infty$ provided that $\delta > 0$. Then, as a consequence,

$$\lim_{L_c \rightarrow a_m \frac{L_n}{a}^+} \omega = 0^+ \quad (1.50)$$

Moreover, since we can easily check that $\lim_{L_c \rightarrow a_m \frac{L_n}{a} +} \left(\frac{d\gamma}{d\omega} \right)$ is finite, from (??), (1.34) and (1.50) it is possible to conclude that $\lim_{L_c \rightarrow a_m \frac{L_n}{a} +} \left(\frac{d\gamma}{d\omega} \right) \omega = \lim_{L_c \rightarrow a_m \frac{L_n}{a} +} (Q) = 0$, and therefore, by (1.48),

$$\lim_{L_c \rightarrow a_m \frac{L_n}{a} +} \frac{\frac{d\omega}{d\delta}}{\omega} = \frac{\gamma\delta^2 - (1 - \gamma)}{\delta(1 - \gamma(1 - \delta^2))} \quad (1.51)$$

Since the denominator of (1.51) is positive,

$$\lim_{L_c \rightarrow a_m \frac{L_n}{a} +} \left(\frac{d\omega}{d\delta} \right) > 0 \text{ iff } \gamma\delta^2 > (1 - \gamma) \quad (1.52)$$

Next, from (1.33) and (1.35) we can obtain that

$$\lim_{L_c \rightarrow a_m \frac{L_n}{a} +} \frac{(1 - \mu)}{w_n} = \frac{(1 - \mu)}{\mu} (L_n + a\rho) \quad (1.53)$$

Now, if we plug (1.53) into (1.33), we can restate condition (1.52) only in terms of the parameters:

$$\lim_{L_c \rightarrow a_m \frac{L_n}{a} +} \left(\frac{d\omega}{d\delta} \right) > 0 \text{ iff } \eta_{nn} > \frac{1}{\mu(1 + \delta^2)} \left[\frac{(1 - \mu(1 + \delta^2))}{a\rho} + \frac{1}{L_n} \right] \quad (1.54)$$

Finally, taking into account our assumptions in (1.37),

$$\lim_{L_c \rightarrow a_m \frac{L_n}{a} +} \left(\frac{d\omega}{d\delta} \right) > 0 \text{ iff } \delta^2 > \frac{1 - \mu}{\mu}$$

■

1.6.4 Proof of Proposition 2

Proof. From our definition of R_{ca} , our distributional assumptions (1.37) and Lemma 1 we can derive that in any steady state

$$R_{ca} = \frac{\omega_c [(L_s - L_a) + \rho a_m (1 - \eta_{ca} L_a)]}{(1 + \rho \eta_{ca} a_m \omega_c) (L_s - L_a)} \quad (1.55)$$

From (1.39), any marginal variation in δ must yield the following migratory reaction between steady states:

$$\lim_{\delta \rightarrow 1^-} \frac{dL_a}{d\delta} = \lim_{\delta \rightarrow 1^-} \left[\frac{\frac{\partial f}{\partial \delta}}{\left(\frac{\partial h}{\partial L_a} - \frac{\partial f}{\partial L_a} \right)} \right] \quad (1.56)$$

The assumptions of the proposition guarantee that the denominator in (1.56) is negative. As to the numerator, from (1.31) and (1.45) we can obtain that

$$\lim_{\delta \rightarrow 1^-} \frac{\partial f}{\partial \delta} = \frac{L_a}{(1-\mu)} \frac{\mu}{(L_s - L_a)} \left[\frac{(2\gamma - 1)Q + \frac{\partial Q}{\partial \delta}}{(1+Q)^2} \right] \quad (1.57)$$

and

$$\lim_{\delta \rightarrow 1^-} \frac{\partial Q}{\partial \delta} = - \left(\frac{m}{g} \right) (\in -1) \left[\lim_{\delta \rightarrow 1^-} \omega^{-\in} \right] \left[\lim_{\delta \rightarrow 1^-} \frac{\partial \omega}{\partial \delta} \right] \quad (1.58)$$

Now, from (1.31) and (1.45) we can conclude that

$$\omega = C^{-\frac{1}{\in}}(\delta, L_a, \omega) \cdot \left[\lim_{\delta \rightarrow 1^-} \omega \right] \quad \forall \delta, \text{ since } \lim_{\delta \rightarrow 1^-} C(\delta, L_a, \omega) = 1 \quad (1.59)$$

After some computations, we can additionally get from Lemma 3 and (1.45) that

$$\lim_{\delta \rightarrow 1^-} \frac{\partial C}{\partial \delta} = 1 - 2\gamma < 0 \quad (1.60)$$

Finally, expressions (1.59) and (1.60) imply that

$$\lim_{\delta \rightarrow 1^-} \frac{\partial \omega}{\partial \delta} = \left[\lim_{\delta \rightarrow 1^-} \omega^{-\in} \right] \cdot \frac{(2\gamma - 1)}{\in} > 0 \quad (1.61)$$

If we now go backwards, plugging (1.61) into (1.58) and then (1.58) into (1.57), our final result after rearranging is that $\lim_{\delta \rightarrow 1^-} \frac{\partial f}{\partial \delta} = \frac{L_a}{(1-\mu)} \frac{\mu}{(L_s - L_a)} \cdot \lim_{\delta \rightarrow 1^-} \left[\frac{\left(\frac{m}{g} \right) (2\gamma - 1) \omega^{1-\in}}{(1+Q)^2 \in} \right] > 0$. This positive sign means, by (1.56), that $\frac{dL_a}{d\delta} < 0$. And hence, from (3.11), $\frac{dg}{d\delta} > 0$. Since

$$\frac{dR_{ca}}{d\delta} = \frac{\partial R_{ca}}{\partial \omega_c} \frac{\partial \omega_c}{\partial \delta} + \left[\frac{\partial R_{ca}}{\partial \omega_c} \frac{\partial \omega_c}{\partial L_a} + \frac{\partial R_{ca}}{\partial L_a} \right] \cdot \frac{dL_a}{d\delta} \quad (1.62)$$

we must obtain now the expressions for $\frac{\partial R_{ca}}{\partial \omega_c}$ and $\frac{\partial R_{ca}}{\partial L_a}$ to clarify unambiguously which is the sign of (1.62). Then, from (1.37) and (1.55),

$$\frac{\partial R_{ca}}{\partial \omega_c} = \left[1 + \frac{\rho a_m (1 - \eta_{ca} L_a)}{(L_s - L_a)} \right] \cdot \frac{1}{(1 + \eta_{ca} a_m \rho \omega_c)^2} \quad (1.63)$$

$$\frac{\partial R_{ca}}{\partial L_a} = \frac{\rho a_m (1 - \eta_{ca} L_a)}{(L_s - L_a)^2} \cdot \frac{\omega_c}{(1 + \eta_{ca} a_m \rho \omega_c)} \quad (1.64)$$

If we consider simultaneously (1.62) and (1.63), we can easily observe that

$$\lim_{\delta \rightarrow 1^-} \frac{dR_{ca}}{d\delta} > \lim_{\delta \rightarrow 1^-} \frac{dL_a}{d\delta} \left[\frac{\partial R_{ca}}{\partial \omega_c} \frac{\partial \omega_c}{\partial L_a} + \frac{\partial R_{ca}}{\partial L_a} \right]$$

which means that $\lim_{\delta \rightarrow 1^-} \frac{dR_{ca}}{d\delta} > 0$ if $\frac{dh}{dL_a} < \lim_{\delta \rightarrow 1^-} \left(\frac{\partial f}{\partial L_a} \right)$. Finally, if we focus on the evolution of ω_c , its total derivative can be proved to be positive provided that $\gamma > 1/2$ and $\frac{dh}{dL_a} < \left(\frac{\partial f}{\partial L_a} \right)$, since

$$\frac{d\omega_c}{d\delta} = \frac{\partial f}{\partial \delta} \cdot \left[\frac{\frac{dh}{\partial L_a}}{\left(\frac{\partial h}{\partial L_a} - \frac{\partial f}{\partial L_a} \right)} \right] \quad (1.65)$$

■

1.6.5 Proof of Proposition 3

Proof. Since L_n and L_s are invariant in our model, from Lemma 1 we can infer that $\frac{dR_{ns}}{d\delta} < 0$ iff $\frac{d\gamma}{d\delta} < 0$.

The easiest way to compute $\frac{d\gamma}{d\delta}$ is by considering expressions (1.35) and (1.37). Let

$$D(L_c, L_n) = \left[L_n + \rho a \left(\frac{g}{m + g} \right) \right] \quad (1.66)$$

From (1.24), (1.29), (1.37) and (1.73), $\gamma = w_n \left[L_n + a \left[\rho - \frac{1}{(\in-1)} \left(\frac{L_c}{a_m} - \frac{L_n}{a} \right) \right] \right]$, and by taking logs and differentiating

$$\lim_{\delta \rightarrow 1^-} \frac{d\gamma}{d\delta} \frac{1}{\gamma} = \frac{-a_m \left(\frac{dL_a}{d\delta} \right)}{a_m \in (L_n - ag)} - \lim_{\delta \rightarrow 1^-} \frac{\left[\frac{dQ}{d\delta} + (2\gamma - 1) Q \right]}{(1 + Q)} + \frac{dD}{d\delta} \frac{1}{D} \quad (1.67)$$

It is easy to show that, precisely,

$$\frac{dD}{d\delta} \frac{1}{D} = \frac{a_m \left(\frac{dL_a}{d\delta} \right)}{a_m \in (L_n - ag)} \quad (1.68)$$

and therefore, by (1.58), (1.61), (1.67) and (1.68),

$$\lim_{\delta \rightarrow 1^-} \frac{d\gamma}{d\delta} \frac{1}{\gamma} = - \lim_{\delta \rightarrow 1^-} \frac{\left[\frac{\partial Q}{\partial L_a} \frac{dL_a}{d\delta} + \frac{(2\gamma-1)Q}{\epsilon} \right]}{(1+Q)} < 0 \quad (1.69)$$

Apart from the assumptions of this proposition, expressions (1.41) and (1.69) ensure that $\lim_{\delta \rightarrow 1^-} \frac{d\gamma}{d\delta} < 0$. ■

1.6.6 Proof of Lemma 1

Proof. Let $\eta_{nk} = \frac{\beta_{nk}}{n_n}$ and $\eta_{ck} = \frac{\beta_{ck}}{n_c}$ be the proportion of eastern and western equity, respectively, owned by a representative household living in location k , where β_{nk} and β_{ck} are the absolute measures of western and eastern firms owned by that household. Then, the amount of gross savings for any household living in k can be expressed as follows:

$$(Gross\ Savings)_k = GS_k = w_k + \eta_{ck} n_c \pi_c + \eta_{nk} n_n \pi_n - E_k \quad (1.70)$$

We know that in our steady state $\frac{\dot{\eta}_{jk}}{\eta_{jk}} = \frac{\dot{\beta}_{jk}}{\beta_{jk}} - g = 0$, i.e. $\frac{\dot{\beta}_{jk}}{\beta_{jk}} = g \forall j = \text{West, core}; \forall k = \text{West, core, periphery}$. Therefore,

$$\frac{\dot{\beta}_{nk}}{\beta_{nk}} = \frac{GS_k f_{nk}}{v_n \beta_{nk}} - m = \frac{\dot{\beta}_{ck}}{\beta_{ck}} = \frac{GS_k (1 - f_{nk})}{v_c \beta_{ck}} = g \quad (1.71)$$

where f_{nk} is the proportion of total gross savings devoted to the purchase of western equity. Then, from (1.71), (1.4) and (1.28), we can easily solve for GS_k :

$$GS_k = (m + g) \eta_{nk} a \left(\frac{g}{m + g} \right) w_n + g \eta_{ck} a_m w_c \quad (1.72)$$

On the other hand, it is easy to see from (1.4) and (1.25) that the instantaneous variation in the value of previously-owned assets, considering also the effect of imitation, is the following:

$$\frac{\partial V_k}{\partial t} = -(m+g)\eta_{nk}a\left(\frac{g}{m+g}\right)w_n - g\eta_{ck}a_m w_c$$

where V_k is the value of previously-owned assets by a household in location k . Since, by (1.72) and the last equation, $(Net\ Savings)_k = GS_k + \frac{\partial V_k}{\partial t} = 0 \forall t$ in any steady state, any household's wealth is kept constant along the balanced growth path, i.e.

$$y_k = E_k = w_k + \rho\eta_{ck}a_m w_c + \rho\eta_{nk}a\left(\frac{g}{m+g}\right)w_n \quad (1.73)$$

where y_k is household k 's income, $\forall k = \text{West, Core, Periphery}$ in steady state. ■

1.6.7 Proof of Lemma 2

Proof. From (1.33) we can check that

$$\lim_{\delta \rightarrow 1^-} \gamma > 1/2 \text{ iff } (1 - \mu) < \lim_{\delta \rightarrow 1^-} \left[w_n \left(L_n + a\rho \left(\frac{g}{m+g} \right) \right) - w_c (L_c + a_m \rho) \right] \quad (1.74)$$

As we can conclude after inspecting expressions (1.24), (1.29), (1.35) and (1.36), condition $\lim_{\delta \rightarrow 1^-} \gamma > 1/2$ can only be satisfied iff (1.74) holds. Now we just have to look for a sufficient condition that guarantees (1.74). From our definition of Q in expression (1.34), condition (1.74) can be restated as follows:

$$\frac{(1 - \alpha) \left[\frac{L_c}{a_m} - \frac{L_n}{a} \right]}{\alpha\rho - (1 - \alpha) \left[\frac{L_c}{a_m} - \frac{L_n}{a} \right]} \cdot \left[\frac{\alpha(L_c + a_m\rho)}{L_n - ag} \right]^{\epsilon-1} < P^\epsilon \quad (1.75)$$

By the assumptions established in this lemma, necessarily $P^\epsilon > 0$. Let's now define the function

$$H(L_c, L_n) = \frac{(1 - \alpha) \left[\frac{L_c}{a_m} - \frac{L_n}{a} \right]}{\alpha\rho - (1 - \alpha) \left[\frac{L_c}{a_m} - \frac{L_n}{a} \right]} \cdot \left[\frac{\alpha(L_c + a_m\rho)}{L_n - ag} \right]^{\epsilon-1} - P^\epsilon \quad (1.76)$$

It is easy to see that $\frac{\partial H}{\partial L_c} \geq 0$ and $\frac{\partial H}{\partial L_n} \leq 0 \forall L_c, L_n$. Therefore, a sufficient condition for (1.74) follows from any situation in which $H(L_c, L_n) < 0$. We want to search for a relation between

the initial values of L_c and L_n that ensures that $H(L_s, L_n) < 0$ and hence that $\lim_{\delta \rightarrow 1^-} \gamma > 1/2$. For any initial value of L_c that satisfies (1.24) and (1.30), we can determine that, from (1.76),

$$H(L_c, \frac{aL_c}{a_m}) = -P^\epsilon < 0 \text{ and } H(L_c, a \left[\frac{L_c}{a_m} - \frac{\alpha\rho}{1-\alpha} \right]) > 0 \quad (1.77)$$

Since the equality $H(L_c, L_n) = 0$ contains an implicit function $\hat{L}_n(L_c)$ for which $\frac{\partial L_n}{\partial L_s} = -\frac{\partial Q/\partial L_s}{\partial Q/\partial L_n} > 0 \forall L_c, L_n$, then $\hat{L}_n(L_c)$ is an increasing function in L_c . Since $H(L_s, L_n)$ is a monotone and continuous function in L_n , from (1.77) we can apply Bolzano's theorem to state that

$$\exists \text{ a unique function } \hat{L}_n(L_c) \text{ such that } H(L_c, \hat{L}_n(L_c)) = 0 \forall L_c \quad (1.78)$$

Finally, from the sign of the partial derivatives above, we can say with certainty that $\forall L_c$, if $L_n > \hat{L}_n(L_c)$ then $H(L_c, L_n) < 0$, which means that $Q < P$ and hence that $\lim_{\delta \rightarrow 1^-} \gamma > 1/2$.

■

1.6.8 Proof of Lemma 3.

Proof. From (1.11) we can express the wide-gap assumption when $\delta \rightarrow 1^-$ as

$$\frac{\left(L_n - \frac{(1-\alpha)L_c}{a_m} + \alpha\rho \right)}{\alpha(L_c + a_m\rho)} \cdot \left[\frac{(1-\alpha) \left[\frac{L_c}{a_m} - \frac{L_n}{a} \right]}{\alpha\rho - (1-\alpha) \left[\frac{L_c}{a_m} - \frac{L_n}{a} \right]} \right] \leq \alpha^\epsilon \quad (1.79)$$

Rearranging and rewriting (1.79) with an equality, we get the following quadratic equation in L_c :

$$\left[\frac{L_c}{a_m} - \frac{L_n}{a} \right] = \frac{\frac{\alpha\rho}{(1-\alpha)}}{\left(1 + \frac{\left(L_n - a \frac{(1-\alpha)}{a_m} + \alpha\rho \right)}{\alpha \frac{2-\alpha}{1-\alpha} (L_c + a_m\rho)} \right)} \quad (1.80)$$

Since, from condition (1.30), $L_c > 0$ and $L_n > \frac{a}{a_m} L_c - \frac{\alpha\rho}{(1-\alpha)}$, we can conclude that the denominator of the right-hand side of (1.80) is bigger than 1. This means that at least one root L_{c1}^* of (1.80) satisfies for sure the inequality $a_m \frac{L_n}{a} < L_{c1}^* < a_m \left[\frac{L_n}{a} + \frac{\alpha\rho}{1-\alpha} \right]$, because the right-hand side is positive and smaller than $\frac{\alpha\rho}{1-\alpha}$. Now we have to make sure that L_{c1}^* is a unique root within the interval $(a_m \frac{L_n}{a}, a_m \left[\frac{L_n}{a} + \frac{\alpha\rho}{1-\alpha} \right])$.

If we formally restate (1.79) we can obtain the following inequality:

$$Z(L_c) = EL_c^2 + FL_c + G \leq 0 \quad (1.81)$$

where

$$E = \frac{a_m \alpha^{\frac{2-\alpha}{1-\alpha}} - a(1-\alpha)}{a_m^2} \quad (1.82)$$

$$F = \frac{L_n \left(\frac{2-\alpha}{1-\alpha} - \alpha^{\frac{2-\alpha}{1-\alpha}} \frac{a_m}{a} \right) + \alpha \rho \left[a + \alpha^{\frac{1}{1-\alpha}} a_m \left(2 - \frac{1}{1-\alpha} \right) \right]}{a_m}$$

$$G = - \left[\frac{L_n}{a} \left[\alpha \rho \left(a + \alpha^{\frac{1}{1-\alpha}} a_m \right) + L_n \right] + \alpha^{\frac{3-2\alpha}{1-\alpha}} \cdot \frac{1}{1-\alpha} a_m \rho^2 \right]$$

We can see that, in principle, the signs of E and F are undetermined but that of G is clearly negative, which implies that $Z(0) < 0$. Let's explore now the implications of the 2 possibilities concerning the sign of E :

-If $E > 0$ then, since $Z(0) < 0$, $Z(L_c)$ is necessarily a quadratic function with one positive and one negative root. Therefore, we know for sure that there is a unique L_{c1}^* such that $Z(L_{c1}^*) = 0$ and $a_m \frac{L_n}{a} < L_{c1}^* < a_m \left[\frac{L_n}{a} + \frac{\alpha \rho}{1-\alpha} \right]$. Given that this curve cuts the horizontal axis from below, conditions (1.81) and (1.30) will be satisfied.

-If $E < 0$, $Z(L_c)$ will be now a concave function with at least one positive root L_{c1}^* , but in principle it could have another one within our particular interval $\left[a_m \frac{L_n}{a}, a_m \left[\frac{L_n}{a} + \frac{\alpha \rho}{1-\alpha} \right] \right]$. In order to reject this latter possibility, it will be enough to show that $Z(a_m \frac{L_n}{a}) < 0$ and $Z(a_m \left[\frac{L_n}{a} + \frac{\alpha \rho}{1-\alpha} \right]) > 0$, which would imply that the other root is out of our interval.

It is possible to check that

$$\begin{aligned} Z\left(a_m \frac{L_n}{a}\right) &= -\frac{(\in - 1)^{\in + 2}}{\in^{\in + 1}} \cdot \rho a_m \cdot \left(\frac{L_n}{a} + \rho\right) < 0 \\ Z\left(a_m \left[\frac{L_n}{a} + \frac{\alpha \rho}{1-\alpha}\right]\right) &= \left(\frac{\in - 1}{\in}\right) \rho L_n (\in^2 + \in - 2) > 0 \end{aligned}$$

Again, since this curve intersects the horizontal axis from below, if $E < 0$ the wide-gap case is compatible with positive measures of manufactures in both countries iff $a_m \frac{L_n}{a} < L_c \leq L_c^* < a_m \left[\frac{L_n}{a} + \frac{\alpha \rho}{1-\alpha} \right]$.

To summarize, if $\delta \rightarrow 1^-$, $\forall a_m$ and a , $\forall \alpha \in (0, 1)$, \exists a unique L_c^* such that both (1.11) and (1.30) hold iff $a_m \frac{L_n}{a} < L_c \leq L_c^* < a_m \left[\frac{L_n}{a} + \frac{\alpha \rho}{1-\alpha} \right]$, where L_c^* is the smallest positive root

of equation (1.80). ■

Chapter 2

Skill-Upgrading and the Saving of Immigrants

Summary 2 *This note derives positive implications about the effect of immigration on labor income and the skill composition of the labor force in receiving economies. The novel mechanism through which immigration affects labor-market outcomes is the availability of new loanable funds for human-capital investment, which results in endogenous skill upgrading. Given their higher training costs in the host economy, immigrants usually do not acquire advanced academic skills, and they accordingly skip the financial costs of education at the college level. As a result, they self-select as net lenders, which reduces the equilibrium interest rates and facilitates the upgrading mostly of new generations of natives. Consequently, the aggregate labor income of natives increases with immigration.*

2.1 Introduction

Both legal and illegal immigration from LDCs conform a reality acquiring unprecedented dimensions today in many developed countries. Accordingly, there has been a substantial deal of controversy as to whether the average native worker gains or loses from the new migratory flows. Two recent empirical exercises that obtain quite opposite conclusions are Borjas (2003) and Ottaviano and Peri (2006). The main reason why the second of these papers estimates a net average gain, unlike the first one, is the multiplicity of channels by which immigrants affect

labor market outcomes. Apart from the downward pressure on native wages, Ottaviano and Peri's structural model allows for a consideration of between-worker complementarity and the entry of new firms in response to higher profitability.

Our purpose in this paper is exploring an alternative channel by which the immigration surplus could be enlarged. Unskilled immigrants are often accused of draining funds from the welfare systems of recipient countries, while they contribute very little with direct taxes given their low upgrading prospects. Here we explore a novel mechanism by which they could offset - at least partially - that effect as net suppliers of loanable funds. We show how immigrants - even when they are permanent - face cultural barriers that increase their training costs; this fact makes them work during most of their life-cycle, without a formal acquisition of academic training at the college level. Moreover, after skipping these academic financial costs, an altruistic motive leads them to carry their savings forward into the future in order to bequeath to their children, which raises the amount of loanable funds available in the financial system. This increase in loanable funds lowers interest rates, thus providing young cohorts of natives with savings to finance their educational expenses. These favorable financial conditions lower the ability requirement for those who try to become skilled, who are mostly native, which raises the skill composition in the host economy.

In order to make our results as sharp as possible, we explore the limit case in which the (labor-market) complementarity between skilled and unskilled labor is totally switched off. In spite of that, we find that an immigration surplus continues to exist, even if both labor categories are perfectly substitutable. Therefore, although wages hardly vary with immigration, the skill-upgrading of natives leads to an immigration surplus. This result runs counter to Borjas (1994)'s statement that 'an immigration surplus arises *only when native wages fall* as a result of immigration'.

We want to emphasize that - given their higher training costs and the intergenerational persistence of that situation - certain ethnic groups of immigrants are likely to remain stuck in their relative position of inferiority with respect to earnings and upgrading. However, *precisely because of that stickiness* - and since they will probably work during most of their life cycle - they can provide natives with better wage prospects, even in the absence of wage-premium rises due to skill complementarities. Therefore, the frequent complaint about the relatively

poor performance of some immigrants in the labor market may not always be justified, since the main reason for their relative economic backwardness - i.e. their higher training costs - is also the key to some natives' gain from immigration.

2.2 Related Literature

2.2.1 Theoretical Contributions

There is a long history of attempts to account for the dynamics of the economic performance of immigrants relative to natives. Along the whole series of theoretical and empirical efforts to understand the issue, there has been a common interest in the savings rate, frequently considered the key to migrants' capacity to accumulate wealth and increasingly approach the economic performance of the native-born. Initially, migrants' apparent success to approach - and even eventually outperform - their native counterparts was justified with self-selection arguments: the migratory decision was only undertaken by a very specific range of the foreign-born population, and therefore the human-capital and demographic characteristics of migrants and natives were not homogeneous.

However, in the late 80's Djajic (1989) and Galor and Stark (1990) inaugurated a line of research by which *incentives in the host country* - as opposed to a self-selection derived from the migratory decision - were highlighted as the reason for the higher local saving-rates of immigrants relative to otherwise identical natives. The differential incentives faced by migrants came for a certain probability of return migration: they saved more than natives because lower future wages in the home country increased their future marginal utility of wealth, and the extra precautionary savings were useful for them to outperform comparable native-born.

The main novelty of our approach is that *it applies even to permanent residents* in the host country who will never intend to return. That is, a higher savings propensity does not need to hinge on a probability of return migration and an earnings differential between the home and the host country. In this sense, Cornelius (1990) reports that the maturation of social networks of unskilled migrants in the US is making of permanent migration a prevalent phenomenon: " the shift from a migrant population consisting mainly of highly-mobile, seasonally employed 'lone males', towards a more socially heterogeneous, year-round, *de facto permanent*

Mexican immigrant population in California accelerated in the 1980's". This tendency adds some relevance to the potential channel we identify.

2.2.2 Empirical Evidence

Concerning the empirical literature, a few old pieces of evidence seemed to capture the regularities we mentioned above about migrants' savings propensity. For example, Jones and Smith (1970) reported that the *local* (i.e. net of remittances) savings rate of migrant workers in Great Britain in 1975 was about 2% above the UK average. For France, the average local savings of foreign workers in 1970 was 50% higher than those of a French person with the same income (Granier and Marciano (1975)). Further evidence from this period is also collected in MacMillen (1982).

Nevertheless, the previous articles provide only a weak support to our argument, since they are based on data from countries where higher education is heavily subsidized by the public sector, and therefore where our basic mechanism can hardly hold. That is the reason why we have turned to the evidence from the US, where it is a common practice to apply for loans to finance educational expenses and repay those loans once the applicant owns a steady job. Our major relevant findings about the US reality can be summarized as follows:

- a) According to the 2001-2002 Current Population Survey (CPS), the workforce participation by male undocumented migrants reaches 96%, whereas only 84% of comparable native-born US citizens are members of the labor force.

- b) Immigrants conform 11% of total US population, 14% of all workers, 20% of low-wage workers and 39% of low-skilled workers. These numbers seem to roughly validate our assumption about higher training costs for migrants, and to confirm our outcome about their self-selection as low-skilled workers.

- c) Is there any evidence in support of their crucial role as net lenders in the US? Concerning this issue, we have resorted to the econometric results obtained by Carroll, Rhee and Rhee (1999). These authors use household data from the 1980 and 1990 Census of Population and Housing in the US to test whether the saving patterns of immigrants are significantly different across the country of origin, and also whether those patterns match up with the saving patterns of their home countries. They also test whether there is a general "immigration effect" at the

time of entry, taken to mean the effect on saving that is common to all immigrants, regardless of their origin and the duration of their stay in the US.

Interestingly, they find that *"all immigrants have higher saving rates than natives"*, and the "immigration effect" on the savings rate is positive and significant. But that is not the end of the story: if their basic motivation to save so much was a possibility of return migration - as in Galor and Stark (1990) or Stark (2006)'s models - they should have found that assimilation completely eliminates the extra savings. *But, however, for many countries the estimates show no sign of assimilation in savings behavior.* Even for those countries which have those signs of assimilation, "it takes 27 to 62 years to close a 5 percent saving rate gap".

Moreover, Carroll, Rhee and Rhee (1999) also report that "immigrants from Greece, Italy and Portugal had the highest savings rate, over twenty percent of income annually." And, precisely, it is noticeable that people from those countries in the sample are mostly blue-collar workers (producers and labor workers) often with only elementary educational attainment (47.5% for Greece, 67% for Italy and 74.6% for Portugal, respectively). We believe that there must be an underlying economic rationale behind the saving behavior of those ethnic groups and its impact on the host economy, and we have tried to shed some light on these issues.

2.3 The Model

2.3.1 Assumptions and general description

Immigrants are assumed to stay permanently in the host economy. They enter the host country (at the beginning of their life) without previously-accumulated human capital, and - for simplicity - the higher training costs are intergenerationally permanent, in such a way that there is no difference between newly-arrived immigrants and their children with respect to upgrading probabilities.¹

We portray a receiving country whose production function combines skilled (N_s) and unskilled industrial workers (N_u) in a perfectly-competitive environment. For simplicity, we have abstracted from the use of physical capital. Individuals supply a unit of labor inelastically

¹Alternatively, we could make every generation of immigrants become identical to natives in their second period of life, but allow for a continuous flow of immigrants in every period. Under this alternative setup, we would not expect results to change substantially.

and there is no disutility from effort. The production function faced by any productive unit is specified as follows:

$$y = (N_u^\varepsilon + \delta N_s^\varepsilon)^{\frac{1}{\varepsilon}} \quad (2.1)$$

where $\delta > 1$ is an indicator of technology bias towards skilled labor. Traditional models of immigration surplus have focused on labor-market complementarities derived from a limited degree of substitutability between skilled and unskilled labor ($0 < \varepsilon < 1$); this resulted in a net gain for the native population once unskilled wages fell and the subsequent surplus was appropriated by skilled labor (or capital). In contrast to these explanations - and in order to sharpen our point - here we will focus on a pure capital-market complementarity in which both types of labor are perfect substitutes and - consequently - their respective wages are not altered by immigration (since $\varepsilon = 1$). We will show how, even in that case, skill-upgrading is able to induce a rise in the aggregate labor income of natives.

As a result of perfect competition - and given (2.1) and our assumption on perfect substitutability ($\varepsilon = 1$) - the skill-premium is given by

$$\omega = \frac{w_s}{w_u} = \delta \quad (2.2)$$

In our model, which is based on Galor and Zeira (1993), individuals live for two periods. In the first one they must decide whether to acquire skills by investing in academic training - using the parental human-capital bequest - or to work as unskilled; in the second period they work according to their skills, consume, have a child, decide upon the child's home education and (potentially) leave a human-capital bequest.

Our particular assumption is that parents do not bequeath physical or financial capital in period two, but they can hire some qualified professors to teach their child at home and reduce his/her future training costs (at the university) in case he/she was to become skilled.² More specifically, if the child is capable enough, parents finance x hours of home teaching. Such a human-capital transfer will reduce their child's needed number of hours in college by the amount

²Altruism and bequests are not strictly necessary to make our point. Nevertheless, they are convenient to justify immigrants' decision not only to work from the beginning, but also to postpone consumption and save. An alternative would be introducing a reason to save endogenously during the first period of life, by means - for example - of a cost of rearing children during the second period.

ax , where a is a measure of the idiosyncratic ability of the child to profit from home-education.

We adopt the assumption of risk-neutrality of preferences and warm-glow altruism, in the form of parental interest in the future income enjoyed by the child. The assumption on risk neutrality is a strong one, because in that way the optimal human-capital bequest (x) is independent of parental wealth. Nevertheless, we are not interested in the dynamics of income inequality, but in a simple comparative-statics exercise between two steady states with a different proportion of migrants in the population of the host country. Under risk neutrality, there will be a unique steady state, which will facilitate our work. Let us consider the following utility function, expressed in expected terms:

$$U_t = c_t + \beta E_t W_{t+1} \tag{2.3}$$

where c_t stands for consumption (during adulthood) and $E_t W_{t+1}$ for the expected income accruing to the next generation. On the other hand, β is an indicator of parental altruism towards future generations.

During his/her educational process, any individual must hire a quantity γ of skilled professors at the university, though his own ability combined with the human capital bequest allows him to reduce that upgrading cost. Every professor works for one period. When deciding whether to upgrade skills in period one or not, young individuals make the following comparison:

$$(2 + r) \geq \delta(1 - (\gamma - ax)(1 + r)) \tag{2.4}$$

where $\gamma\delta$ is a measure of the training costs, which depend on the skilled wage - as in Rigolini (2004) - because only skilled teachers can train the unskilled labor force. The term ax represents the amount of training that the individual can skip due to the familial transmission of human capital (x) and his/her idiosyncratic ability (a).

Unskilled individuals are supposed to work in both periods and save the initial earnings for the second one, since they only consume (and bequeath) in period two. *The skilled ones borrow from the unskilled to pay for their training costs* in the first period, and then repay their debt once they receive the skilled wage in the second period. Consequently, from (2.4), a young native individual will decide to upgrade skills iff

$$a \geq \frac{1}{x} \left(\gamma + \left(\frac{(2+r) - \delta}{\delta(1+r)} \right) \right) \equiv \bar{a} \quad (2.5)$$

whereas a similar expression \bar{a}' holds for immigrants provided that we replace γ by $\gamma' \geq \gamma$.

Our assumption is that parents observe the realization of the child's ability and decide upon leaving a human-capital bequest (or not) on the basis of that realization. From (2.5), they know that the child will upgrade iff $x \geq \frac{\phi}{a}$, where

$$\phi(r) = \gamma + \left(\frac{(2+r) - \delta}{\delta(1+r)} \right) \quad (2.6)$$

and a is the observed realization of the ability random variable. Therefore, following (2.3), parents will compare the current costs and future benefits of providing a bequest, which are shown in the following inequality:

$$-\delta \frac{\phi}{a} + \beta (\delta - (2+r)) \geq 0$$

For simplicity, we have assumed that parents derive utility from their child's *gross* earnings, before their debts have been repaid. This implies that parents will bequeath exactly what their child needs to become a skilled worker, and never more. If the previous inequality is non-negative, it will be worth for them to leave a bequest due the high gross earnings of the offspring. This will happen only if the ability realization is high enough, i.e. there will be a bequest provided that

$$a \geq \alpha \equiv \frac{2+r - \delta(1 - \gamma(1+r))}{\beta(\delta - (2+r))(1+r)} \quad (2.7)$$

Therefore, it is the boundary-value for the parent (α) the only relevant cutoff for the decision-making. It is easy to check that $\frac{\partial \alpha}{\partial r} > 0$. Let us denote by α' the relevant cutoff value for immigrants, who only differ from natives because $\gamma' > \gamma$. We also assume that a is a random variable that follows a general distribution function $F(a)$, with support on $a \in [0, \infty)$, such that $F'(a) \geq 0 \forall a$.

The labor force in the model can be native or immigrant. We assume that the amount of native population is normalized to 1, whereas a measure M of immigrants are already in the economy during the first period considered. The only distinction between any native and

immigrant employee is the cost parameter $\gamma' > \gamma$, which is higher for immigrants because of the need to learn the language and similar cultural barriers.

Where do teachers come from in this economy? Since they are skilled employees, they must get the same wage as the skilled industrial workers, i.e. all members of the skilled labor force must be indifferent between teaching or working for the industry. Furthermore, there must be exactly the right amount of teachers to train next period's labor force. Therefore, if we denote the measure of teachers at time t by τ_t and the measure of skilled industrial workers at time t by N_t^s , then $\tau_t = \gamma(N_{t+1}^s + \tau_{t+1})$. Hence, in steady state,

$$N^s = (1 - \gamma)(N^s + \tau)$$

2.3.2 Existence and uniqueness of a steady-state competitive equilibrium

If we now consider an endogenous interest rate r , we can obtain the conditions required for the existence and uniqueness of a steady-state competitive equilibrium in this economy. This equilibrium can be defined as a positive interest rate and a subsequent allocation of immigrants and natives across the skilled and unskilled occupations, such that the supply of credit by the unskilled is identical to the demand by skilled industrial workers and teachers. It is straightforward to derive that the relevant equilibrium condition in steady state is

$$F(\alpha) + MF(\alpha') = \delta [(\gamma - \phi)1 - F(\alpha) + M(\gamma' - \phi')(1 - F(\alpha'))] \quad (2.8)$$

where on the left-hand side we have the supply of loanable funds by the unskilled, and on the right-hand side we can observe the aggregate expenditure on training. Taking expressions (2.6) and (2.8) into account, the previous expression boils down to the following equality:

$$\frac{\delta - (2 + r)}{1 + r} (1 - F(\alpha) + M(1 - F(\alpha'))) = F(\alpha) + MF(\alpha') \quad (2.9)$$

Studying carefully the previous equality gives rise to the following proposition on the conditions for the existence and uniqueness of a steady-state competitive equilibrium.

Proposition 3 *If $\delta(1 - \gamma') \geq 2$, then there exists a unique steady-state competitive equilibrium characterized by a positive interest rate $r^* \in (0, \delta - 2)$, with positive measures of the native and*

immigrant population both in the borrowing and the lending side of the credit market.

Proof. From expression (2.9) it is straightforward, after rearranging, to come up with the following equation of the aggregate excess demand for credit:

$$Z(r) = \frac{1}{1+r} [(\delta - (2+r))(1+M) - (\delta-1)(F(\alpha) + MF(\alpha'))] \quad (2.10)$$

where we have denoted by $Z(r)$ the difference between the aggregate demand and the aggregate supply of credit. From (2.7) we can observe that the value of r that makes $\alpha' = 0$ is

$$\underline{r} = \frac{\delta - 2 - \delta\gamma'}{1 + \delta\gamma'} \quad (2.11)$$

i.e. \underline{r} is the value of the interest rate that shuts down the supply of credit. On the other hand, the value of r that shuts down the demand for credit is precisely

$$\bar{r} = \delta - 2 \quad (2.12)$$

Now we have to prove that our equilibrium interest rate lies between both values and is also unique. It is easy to show that $Z(\underline{r}) = \frac{\delta(\delta-1)\gamma'}{1+\delta\gamma'} > 0$ and also $Z(\bar{r}) = -(\delta-1)(1+M) < 0$. Moreover, a thorough inspection reveals that $Z(r)$ is a continuous, differentiable, strictly decreasing function for all values of r . This implies, using Bolzano's theorem, that - if $\underline{r} \geq 0$, i.e. if $\delta(1-\gamma') \geq 2$ - then there exists a unique competitive equilibrium interest rate $r^* \in (0, \delta-2)$ such that $Z(r^*) = 0$. Furthermore, $\alpha(r^*) > \alpha'(r^*) > 0$, which involves that there are positive measures of the native and immigrant population on both sides of the credit market. ■

The previous proposition spells out the requirement of a relatively advantageous skilled occupation (in terms of both the skill premium and training costs) for the existence of an active demand side of the credit market. At the same time, that condition guarantees that the supply side will be active as well, since market clearing ensures that one side of the market will not shut down while the other is active. Furthermore, the equilibrium interest rate is shown to be unique, which facilitates our task of predicting the effects of immigration.

2.3.3 The availability of loanable funds

Now we are ready to derive our desired *effect of immigration on the availability of loanable funds*. This happens because, in this setting, loans are supplied by unskilled workers who receive income from their first period of life - though they can not consume until the second period - and they are demanded by the skilled labor force to finance their individual training expenses. Migration provides a higher proportion of unskilled people who supply funds, which reduces r and also the cutoff values of α and α' needed to access high-wage jobs. For the new supply of immigrants to provide a net supply of funds, they need to face higher training costs in order to enlarge the pool of lenders more than the pool of borrowers. As a result, it is possible to obtain an immigration surplus that does not depend on variations in the wage premium.

Proposition 4 *Provided that ε is close enough to 1 (perfect substitutability between unskilled and skilled labor) and $\gamma' > \gamma$, then $\frac{d\alpha}{dM} < 0$, $\frac{d\alpha'}{dM} < 0$, $\frac{dr}{dM} < 0$ and the aggregate labor income of natives increases with immigration.³*

Proof. From (2.9) we can differentiate and solve for $\frac{dr}{dM}$ to obtain that

$$\frac{dr}{dM} = \frac{(\delta - (2 + r)) - (\delta - 1)F(\alpha')}{[MF'(\alpha')\frac{d\alpha'}{dr} + F'(\alpha)\frac{d\alpha}{dr} + (1 + M)]} \quad (2.13)$$

Furthermore, we know from (2.9) that $\delta - (2 + r) = \frac{(\delta-1)(F(\alpha')M+F(\alpha))}{1+M}$. By plugging the latter expression into (2.13), we finally get

$$\frac{dr}{dM} = \frac{(\delta - 1)(F(\alpha) - F(\alpha'))}{(1 + M)[MF'(\alpha')\frac{d\alpha'}{dr} + F'(\alpha)\frac{d\alpha}{dr} + (1 + M)]} \quad (2.14)$$

We know from (2.7) that $\frac{d\alpha}{dr}, \frac{d\alpha'}{dr} > 0$ and hence the denominator of the last expression is positive. For (2.14) to be negative we also need the numerator to be smaller than zero, which requires $\alpha' > \alpha$. This last inequality holds iff

$$\gamma' > \gamma$$

³ By aggregate labor income of natives we understand the sum of the remunerations to both skilled and unskilled labor.

Then, $\frac{d\alpha}{dM} = \frac{d\alpha}{dr} \frac{dr}{dM} < 0$. Since wages are invariant - by perfect substitutability - and $\delta > (2 + r) > 1$, the aggregate labor income of natives increases. ■

Additionally, we can make some inferences about the welfare implications of immigration for different groups of natives. All generations of natives can be ex-ante better-off if the skill premium is high enough. Indeed, we know that

$$\beta E_t W_{t+1} = \beta [(1 - F(\alpha))\delta + (2 + r)F(\alpha)] = \beta [\delta - F(\alpha) (\delta - (2 + r))]$$

Since immigration reduces the interest rate, there are 2 opposite effects of immigration on the expected income of the offspring: on the one hand, it is easier for them to upgrade and get the higher wage, but if they do not, they will receive lower interest-rate payments. After some algebra, it is possible to come up with a neat conclusion about $\frac{dE_t W_{t+1}}{dM}$:

$$\frac{dE_t W_{t+1}}{dM} > 0 \text{ iff } (\delta - 1) \frac{d\alpha}{dr} F'(\alpha) (\text{share}_u) > 1 \quad (2.15)$$

where $\text{share}_u = \frac{F(\alpha')M + F(\alpha)}{1 + M}$ is the share of unskilled population over the total. Expression (2.15) means that the expected income of the offspring will rise if (and only if) the ability cutoff is substantially lowered, many people take advantage of it and the skill premium is substantial enough.

2.4 Conclusions

This note establishes a formal link between the relative training costs of migrants and their working and saving behavior, with an immediate implication with respect to the skills of natives' future generations. One of the innovative aspects of this work is the absence of any reference to return migration as a key to understanding the saving behavior of immigrants. Another one is the way we disregard any complementarity between productive factors, in order to differentiate our argument from traditional models of immigration surplus.

As a conclusion, we can emphasize that the reason for the usual complaint about the relatively poor performance of immigrants in the labor market may work as a blessing under the right circumstances, since the cause of their (relative) economic backwardness - i.e. their higher

training costs - is also the key to some natives' gain from immigration. Another intriguing implication is the fact that, even in the case of perfect substitutability between skilled and unskilled labor, natives can always be better-off in real terms provided that the skill premium is high enough.

Chapter 3

Trade and Migration: a U-shaped Transition in Eastern Europe

Summary 5 *This paper proposes a 2-country 3-region economic geography model that can account for the most salient stylized facts experienced by Eastern European transition economies during the 1990s. In contrast to the existing literature, which has favored technological explanations, trade liberalization and factor mobility are the only driving forces. The model correctly predicts that in the first half of the decade trade liberalization led to divergence in GDP per capita, both between the West and the East and within the East. Consistent with the data, in the second half of the decade, internal labor mobility in the East reversed this process and convergence became the dominant force. The model furthermore shows that the same U-shaped pattern applies to relative industrialization of West and East, although within the East the hinterland continued to lose industry throughout the decade.*

3.1 Introduction

The decade of the 1990s in Eastern European transition economies has been characterized by a U-shaped pattern of relative development. Initially, relative income per capita between Western and Eastern Europe diverged, and from the middle of the decade onward, this pattern reversed, and Eastern Europe started to catch up with its Western counterpart. When analyzing the relative performance of different Eastern European countries, a similar pattern emerges. The

countries closest to the West initially experienced faster growth than the Hinterland, but in the second half of the decade that pattern also reversed.

The literature has typically explained these U-shaped patterns by relying on technological arguments or on the misallocation of factors of production. Boldrin and Canova (2003), for example, suggest that technological obsolescence led to an initial period of intense unemployment and reallocations after trade was liberalized. Blanchard (1996) and Blanchard and Kremer (1997) link the initial slump to microeconomic “disorganization”. The collapse of the state sector was precipitated by traditional input suppliers, who found attractive opportunities outside the state sector and broke the established productive chains.¹ Cociuba (2006) and Keller (1997) also stress the role played by technology adoption to account for the GDP trajectories of Eastern European countries. The existing literature thus puts the emphasis on the intensity of reallocations that were needed to adapt to a superior Western technology, followed by a remarkable catch-up process that was conditioned (and sometimes threatened) by redistributive public policies.

While we do not claim these explanations are erroneous in any way, in this paper we deliberately disregard issues of technological backwardness or sectoral misallocations. Instead, we propose an economic geography model, where trade liberalization and factor mobility are the only driving forces. The model consists of 2 countries (West and East) and three regions (one region in West, and a Border and Hinterland in the East). To make the results as sharp as possible, West and East have identical technologies and endowments. Agriculture is perfectly competitive, and industry is monopolistically competitive. Although workers are perfectly mobile between sectors, there is no labor mobility between East and West. As for labor mobility within the East, part of the policy experiment consists in understanding how the migratory liberalization between Border and Hinterland affects relative economic performance. Trade in industrial goods is subject to transport costs, which are higher between Hinterland and West than between Border and West. As in Krugman and Venables (1995), industrial firms use intermediate goods, which gives rise to forward and backward linkages.

¹According to Blanchard and Kremer (1997), international trade was - if at all - beneficial to stabilize those economies, since it provided them with abundant new input suppliers, capable of replacing the previously destroyed economic relationships. Here our paper suggests that an immediate exposure to international trade might have been damaging to CEE countries in the short run.

This simple setup, which abstracts from technology and endowment differences, is sufficient to account for the main stylized facts. Before describing the results in some more detail, we need to be more specific about the timing and the extent of the two driving forces, trade liberalization and factor mobility. The focus of our analysis is the decade of the 1990s. The European Union had already liberalized much of trade with Eastern Europe in the very early 90s. Later in the decade, labor mobility within Eastern Europe, which traditionally had been virtually illegal, was liberalized. We can therefore conclude that trade liberalization predated migration within the East. One could of course wonder why we do not analyze labor mobility between East and West as well. However, with the exception of ethnic Germans, migration between East and West only took off in earnest at the turn of the century, so it cannot account for the reversal in the U-shaped pattern around the middle of the decade.

The first result is that trade liberalization between West and East leads to divergence in GDP per capita, both between West and East and between Border and Hinterland. The positive performance of West can be explained by a Home-Market effect. As trade costs drop, firms shift towards the larger market. This same phenomenon gives rise to the relative deindustrialization of East in favor of West. Proximity to the larger market has benefits though, given the crucial access to the bulk of consumption goods and intermediate inputs. This explains the divergence between Border and Hinterland, in favor of the region closest to the West.

The second result is that the introduction of labor mobility within East leads to convergence in GDP per capita, not just between Border and Hinterland (which is obvious), but also between West and East. As soon as migrations are allowed, population moves from Hinterland to Border. This allows for a stronger Home-Market effect in East. As a result, Border attracts new firms,² and income per capita in East starts to catch up with that of West. Within East, income differences between Border and Hinterland go down, but in terms of industrialization, Border continues to gain relative to Hinterland.

It is important to realize that trade liberalization alone would not be able to account for the upward part of the U-shaped pattern between West and East and between Border and

² Although in our model there is no capital, we can assimilate the flow of firms from West to Border - following the migratory reform - with the abundant FDI received by eastern countries. That FDI experienced a substantial acceleration in the second half of the decade: according to the EBRD, 85% of the FDI received by the area came after 1993 (see Marinov (2003)).

Hinterland³. Allowing for labor mobility is therefore what drives the revival of East. However, it is sufficient for labor mobility to be introduced within East for income per capita to converge between East and West. Of course, permitting labor mobility between East and West would only reinforce our results.

Our model can be viewed of a generalization of Krugman and Venables (1995). They showed how in a 2-region model the early stages of trade liberalization could bring about lower real wages and deindustrialization in smaller markets. The difference with our 3-region model is that we can analyze both the relative performance of East and West and Border and Hinterland. In other words, we can say something about the internal geography of East. This approach has other potential applications. For example, one may be interested in understanding how trade liberalization affects the internal geography of China. To address this issue, clearly a 3-region model, such as the one we propose, is needed.⁴

Our work is also related to Puga and Venables (1997), with the qualification that we explore asymmetric country sizes. That practice is also undertaken by Forslid (2004), although his model does not permit the study of labor mobility, and the absence of vertical linkages prevents a detailed welfare analysis. Finally, Venables (2000) presents a similar three-location framework as we do, but he focuses on the internal geography of a developing country that is hardly industrialized for intermediate levels of trade costs. Our starting point is different: for all levels of trade costs, both West and East are industrialized.⁵

To the best of our knowledge, there are very few papers dealing explicitly with trade liberalization and the internal geography and welfare of Eastern European countries. One of them is Crozet and Koenig-Soubeyran (2002). They extend Krugman (1991) by including a third

³It is true that, in a setting with two symmetric countries, Puga (1999) predicts that trade alone would generate a final East-West convergence stage. Nevertheless, the existence of an internal trade barrier within the East gives rise to an asymmetry in the size of the markets, which prevents convergence unless migration is introduced. In any case, we can understand the introduction of free migration as a way to accelerate the upcoming of convergence (both East-West and Border-Hinterland) as trade barriers melt away.

⁴Another interesting point is exploring the normative implications of free internal labor mobility. Unfortunately, our conclusions - though interesting - are very dependent on our parameterization and difficult to generalize.

⁵Brakman and Garretsen (1993) and Ross (2001) are two interesting applications of economic-geography models to the understanding of internal disparities in the unified Germany. Nevertheless, they do not introduce a third location (the larger EU) as a significant element to explain those evolutions. They just portray a lowering of internal trade barriers between both German regions. Their models - as Krugman (1991) and Forslid and Ottaviano (1999) - , link the mass of manufacturing varieties to the stock of mobile labor, which prevents a study of global industrialization / deindustrialization.

location (the EU) and allowing for a differential regional access to the EU market within the CEECs. They analyze in depth the different forces shaping the prevalence of the Border over the Hinterland, although their model cannot study deindustrialization at the national level, and does not reproduce the external and internal patterns of convergence.

Another paper of interest is Damijan and Kostevc (2002), who study the role played by FDI to accelerate the arrival of an interregional-convergence stage within Eastern Europe. The role played by FDI in their model resembles the one played here by internal migration. Nevertheless, in their setting the Hinterland - understood as the region where the state capital locates - is larger than the Border and benefits from the absorption of manufacturing activity in the early stages of trade openness. That is just the opposite to what Crozet and Koenig (2002) and our model predict.

The rest of the paper is organized as follows. Section 2 describes the stylized facts we aim to explain, and justifies the main assumptions underlying our policy experiment. Section 3 presents the analytical framework. Section 4 uses numerical experiments to study the effect of trade liberalization and migration. Section 5 concludes.

3.2 Policy changes and stylized facts

3.2.1 Policy changes

We start by discussing the two main policy changes we focus on: increased trade openness between West and East, and internal labor mobility within East. Justifying their relative timing, with trade liberalization predating labor mobility, is important for our policy experiments.

East-West trade liberalization

The route towards East-West trade liberalization started quite early in countries like Yugoslavia or Romania. In particular, the European Community signed an initial Generalized System of Preferences with Romania in 1974, and an agreement on manufacturing trade was reached in 1980. However, the most comprehensive Generalized Systems of Preferences (GSP) were approved by the EU and individual CEE countries at the beginning of the 1990s, from 1990 to 1992. The EU granted GSP status first to Hungary and Poland (1990), then to Bulgaria

and former Czechoslovakia (1991), and subsequently to Estonia, Latvia and Lithuania (1992). In short, *"the features found in the trading pattern of CEECs suggest that the export share towards EU-15 was, in the first half of the 1990s, relatively high partly because reduction in trade barriers had already taken place."* (De Benedictis, De Santis and Vicarelli (2005)).

Migratory liberalization within East, but not between East and West

According to Kaczmarczyk and Okolski (2005), during the communist era migration in Eastern Europe was negligible. This does not only apply to migration between countries, but also within countries. Rural-to-urban mobility was also greatly delayed and generally low. In contrast to Western European nations, in many Eastern countries the process of industrialization took place in the absence of massive urbanization.

It was during the 1990s when substantial policy reforms were enacted to liberalize labor flows across Eastern European countries. For example, in 1993 the Czech Republic established a liberal migration policy which turned the country into the home to tens of thousands of migrants from Europe and Asia during the decade (Drbohlav, 2005). In 1993 Russia abolished the internal passport and allowed for freedom of movement (Heleniak, 2002).

To understand the magnitude of the phenomenon, in 1989 fewer than 3 million visitors entered Poland from the Soviet Union, but their number more than doubled the next year and continued to grow to more than 14 million in the peak year 1997. Although these numbers talk about visitors, a survey conducted in Ukraine and Poland in 1995 suggests that many of the so-called visitors worked illegally during their stays in Poland, mostly as petty traders. They were encouraged by the economic crisis in the former Soviet Union, and by the easy access to Eastern Europe.

This last point is important. The results of a survey on the borders of Poland with Belarus, Ukraine and Russia reveal that Poland was not perceived by respondents to be the destination country, but rather as a good place to "learn about migration", before infiltrating the grey economic zones of Western Europe. According to Iglicka (2001a), migration from Russia stopped in Poland, because of the much more difficult access to Western European countries. Iglicka (2001b) argued that

"Migration pressure from the East induced by the collapse of the system, combined with the

*restrictive migration policy of Western Europe towards former USSR countries, were conducive to the formation of the Central European buffer zone. Poland is probably the best example of a buffer zone country.”*⁶

The only exception to restricted migration between East and West concerns ethnic Germans. Between 1989 and 1999 an estimated 678,000 ethnic Germans moved to the homeland. Although there were non-ethnic German foreign nationals moving, their net migration experienced a sharp decline around 1992, to the extent that net migration in the mid nineties was close to zero.

Of course by the turn of the century this situation changed, and migratory flows between East and West increased significantly. However, our paper’s focus is limited to the 1990s. For that particular decade, assuming labor mobility within the East, but no labor mobility between East and West seems adequate.

3.2.2 Main stylized facts

We now give an overview of the main stylized facts we aim to account for in our theoretical model.

U-shaped pattern of relative income per capita between East and West.

Figure 1 shows income per capita of East relative to West.⁷ As can be seen divergence in the first half of the decade was followed by a slight convergence starting around the middle of the decade.

U-shaped pattern of relative income per capita within East

A similar U-shaped pattern shows up when analyzing the income per capita of Hinterland relative to Border. This can be seen in Figure 2, where we consider the Czech Republic, Hungary, Poland and Slovenia as the Border, and the rest of Eastern countries included in our previous footnote as the Hinterland.

⁶Poland, the Czech Republic or Hungary will be an example of a Border country in the model we will present later.

⁷Data come from the Groningen Growth and Development Center. West has been defined as EU-15, and East as Albania, Armenia, Azerbaijan, Belarus, Bosnia, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia, Serbia, Slovak Republic, Slovenia, Tajikistan, Turkmenistan and Ukraine.

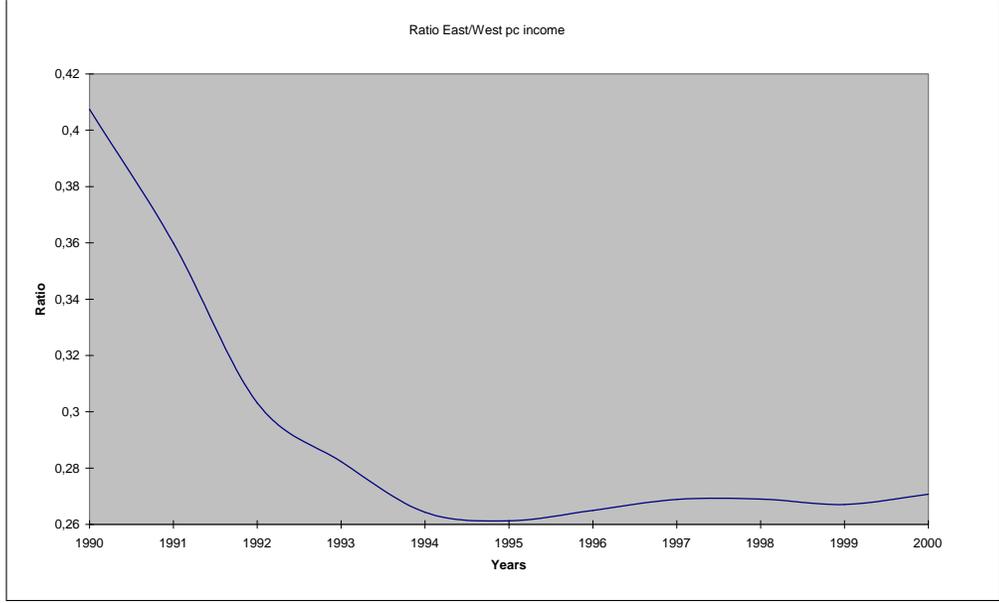


Figure 3-1: U-shaped pattern of East-West relative development.



Figure 3-2: U-shaped pattern of Hinterland-Border relative development.

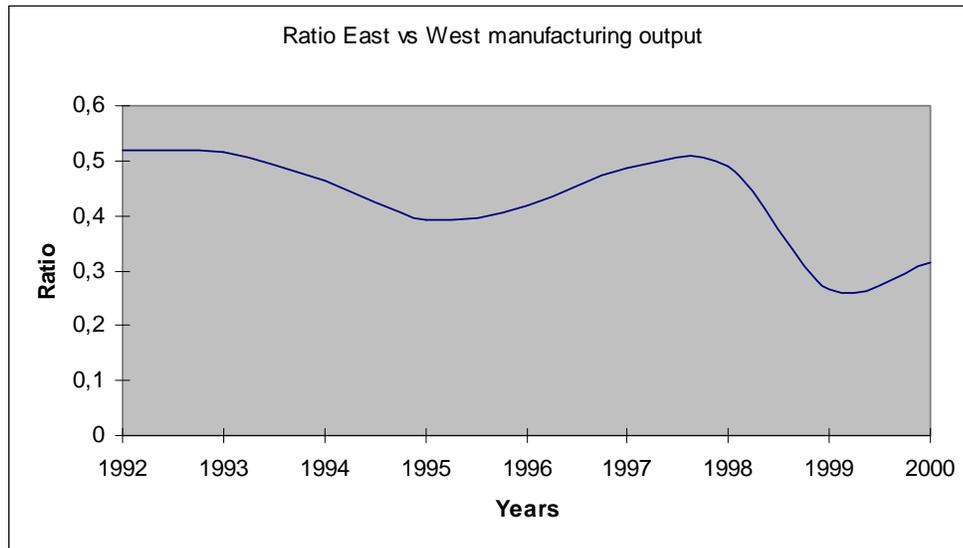


Figure 3-3: Ratio East / West manufacturing output

Pattern of industrialization between East and West

In Figure 3 we plot the ratio of Eastern to Western manufacturing production during the period 1992-2000. The reason why the U-shaped pattern is broken in the last 2 years of the decade is the negative impact of the 1999 financial crisis on the Eastern manufacturing outcome, which obscures the relative recovery that was taking place since 1995.⁸

Continued deindustrialization of Hinterland

Since we have manufacturing data just for a couple of Hinterland countries, we provide below (in Figure 4) the joint evolution the share of manufacturing output for Romania and Estonia.

⁸Data are collected from the wiiw Industrial Database for Eastern Europe (Wien) and the Groningen Growth and Development Center. We include the Czech Republic, Hungary and Poland as the Border, whereas we only have access to Romania and Estonia as the Hinterland.

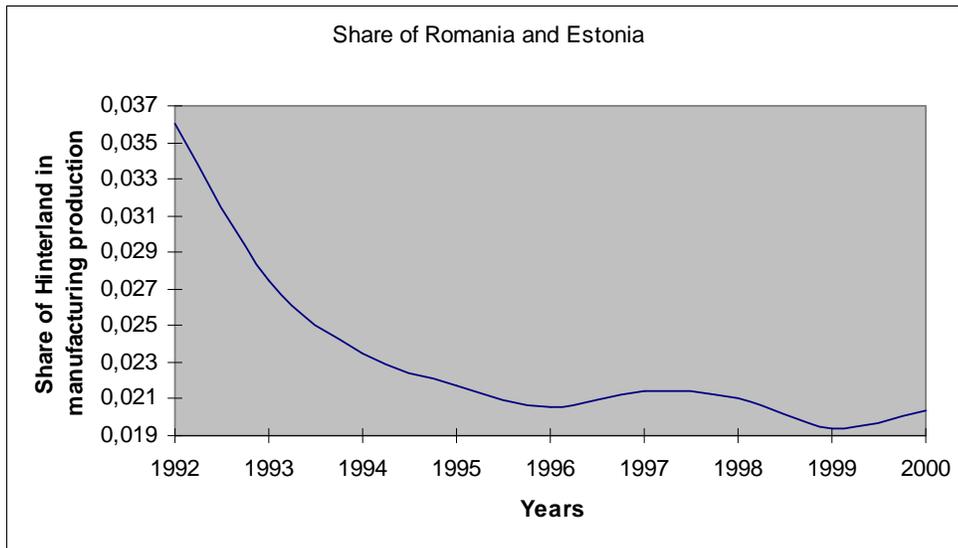


Figure 3-4: Continuous deindustrialization of Hinterland.

3.3 The model

Consider a model with two countries (West and East) and three regions (one region in West, and Border and Hinterland in East). The three regions are denoted by W (West), B (Border) and H (Hinterland). There are two sectors, agriculture and industry, and two factors of production, labor and land. Both countries have identical technologies and endowments, though West is better integrated due to the absence of internal trade costs. In practice, this turns West into a larger market. The regions of East are equally large in terms of land. Whereas labor is immobile between East and West, it may or may not be mobile within East. Part of our policy experiment consists in understanding how the introduction of migratory flows between Border and Hinterland affects relative economic performance.

Trade in industrial goods is subject to transport costs, which are higher between Hinterland and West than between Border and West, because there are trade costs between Border and Hinterland. The agricultural sector is perfectly competitive, and uses land and labor as its inputs. Since the supply of land is fixed, the agricultural sector faces decreasing returns to labor. This entails agriculture endogenously takes place in all locations. The industrial sector

is monopolistically competitive. As in Krugman and Venables (1995), industrial firms use labor and intermediate goods, which gives rise to forward and backward linkages. The detailed description of the model in the following subsections is similar to Puga (1999).

3.3.1 Endowments

To make our results as sharp as possible, there is no role for traditional comparative advantage sources. The goal is to understand whether simple forces of economic geography can account for the stylized facts of Eastern European transition economies. That is, countries and regions do not differ in their access to technology or relative endowments of labor and land, but just in their locational advantage. That advantage is itself endogenous, and linked to the interplay of international and interregional trade costs, as the former decrease over time.

In particular, let us denote by K_i and m_i the stocks of land and labor in location i , respectively. The former is an invariable parameter of the model, whereas the latter will end up being endogenous, once we allow for labor mobility between Border and Hinterland within the East. In particular, we will set $K_H = K_B = 1/2$, $K_W = m_W = 1$, $m_H + m_B = 1$.

3.3.2 Industry

Trade in manufactures is subject to iceberg transport costs. Between West and Border, for one unit to arrive, τ_B units should be shipped, where $\tau_B > 1$. The internal trade cost between Border and Hinterland is T , where $T > 1$. Between West and Hinterland, Border plays the role of a 'port' through which all goods need to be shipped. This implies that trade cost between West and Hinterland, τ_H , must be equal to $\tau_B T$.

The industrial sector is monopolistically competitive. There is a continuum of manufacturing varieties whose available mass in each location is an endogenous variable. Following Dixit and Stiglitz (1977), production of a quantity $x(k)$ of any variety k requires the same fixed (α) and variable ($\beta x(k)$) quantities of the production input in any location. This combined with symmetry and increasing returns ensures that in equilibrium no variety is produced by more than one firm in more than one country.

The production input in manufacturing is a Cobb-Douglas composite of labor and an aggregate of intermediates. Following Ethier (1982), all industrial goods enter symmetrically into

the intermediate aggregate, with a constant elasticity of substitution across varieties ($\sigma > 1$). The price index of the aggregate industrial composite used by firms is region specific, and in the case of location B it is defined by

$$q_B = \left[\int_{h \in n_B} p_B^{1-\sigma}(h) dh + \int_{h' \in n_W} p_w^{1-\sigma}(h') \tau_B^{1-\sigma} dh' + \int_{h'' \in n_H} p_H^{1-\sigma}(h'') T^{1-\sigma} dh'' \right]^{\frac{1}{1-\sigma}} \quad (3.1)$$

where p_i represents the price of a locally-produced manufacturing variety in region i . We have also denoted by n_i the available mass of manufacturing varieties produced in region i . (The price indices of the other regions can be defined by analogy). Now that we have determined the price of the intermediate composite, we can write down the cost function of a manufacturing firm h located in region i that produces output $x_i(h)$:

$$C_{ih} = (\alpha + \beta x_i(h)) q_i^\mu w_i^{1-\mu} \quad (3.2)$$

where w_i stands for the local wage in region i , and μ ($0 \leq \mu \leq 1$) is the share of intermediates in firms' costs (an indicator of the strength of vertical linkages).

3.3.3 Agriculture

Agriculture is perfectly competitive. It produces a homogeneous good - which plays the role of numeraire ($p_i^A = 1 \forall i$) -, using labor and land with a constant returns to scale technology described by the production function $y_i = g(L_i^A, K_i)$. K_i is the stock of arable land available in location i and L_i^A denotes agricultural employment. In our particular case - as in Puga (1999) -, function g will be a Cobb-Douglas production function: $g(L_i^A, K_i) = L_i^{\theta} K_i^{1-\theta}$. Therefore, from the landowners' profit maximization we can obtain the following demand for agricultural labor:

$$L_i^A = K_i \left(\frac{\theta}{w_i} \right)^{\frac{1}{1-\theta}} \quad (3.3)$$

We incorporate a system of public landownership: once agricultural rents have been collected, they are perfectly taxed away and rebated to the local workers in a lump sum fashion.⁹

⁹Since in many of these countries land was privatized during the second half of the decade, we have allowed in some experiments for a land-privatization reform in parallel with the migratory reform. To that purpose, we assumed that - after that reform - land rents belonged entirely to agricultural workers, whose total income

Let us denote by m_i the total population living in location i , and by R_i the per-capita agricultural rents rebated to every local worker living in i . In particular, using (3.3) and the agricultural production function, it is easy to show that

$$R_i = \frac{\left((1 - \theta) K_i \left(\frac{\theta}{w_i} \right)^{\frac{\theta}{1-\theta}} \right)}{m_i} \quad (3.4)$$

3.3.4 Preferences

Turning to the demand side, consumers have Cobb-Douglas preferences over the agricultural good and a CES composite of industrial goods, with industrial expenditure share γ ($0 \leq \gamma \leq 1$). For simplicity, all industrial varieties produced are assumed to enter consumers' utility function with the same constant elasticity of substitution with which they enter firms' technology. This generates the following indirect utility function for workers living in location i :

$$V_i = q_i^{-\gamma} Y_i \quad (3.5)$$

where Y_i stands for the income of a representative worker in location i . That income consists of labor earnings and the rural and urban rents rebated proportionally to the local population.

3.3.5 Residential Sector

We follow Krugman and Livas Elizondo (1996) and introduce commuting costs internal to each region. This provides a source of congestion, which prevents the full agglomeration of all Eastern manufactures in the Border region. In each of the three locations, we assume the existence of a Central Business District (CBD) to which the local population must commute in order to supply their amount of effective labor. That population is distributed along a segment centered at the CBD, and every worker must allocate inelastically a unit of time between effective labor and commuting¹⁰. As can be expected, those commuting costs will be higher the further away

(agricultural wage plus land rents) was kept identical to the urban wage. As a result, the qualitative results of our simulations were not different from those presented below.

¹⁰For simplicity, we assume that both farmers and manufacturing workers need to commute to the CBD. That is believed to be innocuous for our main qualitative conclusions.

every commuter is from the CBD. In particular, a commuter living at a distance z from the CBD will supply $1 - 2\delta z$ units of time to the labor market, where δ is the parameter that measures the strength of commuting costs.

Consequently, the local stock of effective labor in i will be

$$L_i = 2 \int_0^{\frac{m_i}{2}} (1 - 2\delta z) dz = m_i (1 - \delta(m_i/2)) \quad (3.6)$$

where m_i denotes the size of the population living in location i . Since the distribution of population across CEE regions turns out to be endogenous, we will consider that $m_B + m_H = 1$ in the case of perfect labor-mobility within the East. In the case of perfect labor-mobility restrictions, we will exogenously set $m_B = m_H = 1/2$.

Moreover, the extra income that a worker can gain by living closer to the CBD will be exactly compensated by higher rent costs paid to the landowners, in such a way that all local workers enjoy the same utility level. This implies that the real urban rent $R^U(z)$ to be paid by a worker living in location i can be derived as follows:

$$R_i^U(z) = w_i(1 - 2\delta z) - w_i(1 - \delta m_i) = \delta w_i(m_i - 2z) \quad (3.7)$$

Since all urban rents are collected and proportionally rebated to the local population, we need to compute the magnitude of the urban rebate, which - from (3.7), will be equal to

$$\text{Urban Rebate} = \frac{2 \int_0^{\frac{m_i}{2}} R_i^U(z) dz}{m_i} = \delta w_i \left(\frac{m_i}{2} \right)$$

Therefore, adding up labor income and rural and urban rebates, nominal income

$$Y_i = w_i(1 - \delta \left(\frac{m_i}{2} \right)) + R_i \quad (3.8)$$

3.3.6 Labor Mobility

There is no labor mobility between West and East, but there may be labor mobility between Border and Hinterland. As is standard in the literature, migration is assumed to be myopic, acting only in response to *current* real-income differentials. Labor mobility has the effect of eliminating those real-income differences, net of commuting costs, between Border and Hinterland:

$$Y_B q_B^{-\gamma} = Y_H q_H^{-\gamma} \quad (3.9)$$

3.3.7 General Equilibrium

Individual demands coming from workers, all of which share the same elasticity of substitution σ , are calculated by using Roy's identity on expression (3.5) and summed in each region. Demands coming from individual firms, which also share the same elasticity of substitution, are calculated by using Shephard's lemma and summed in each region. As a result, total demand for a firm in region i producing variety h , $x_i(h)$, is

$$x_i(h) = \sum_{j \in \{B, H, W\}} (p_i(h))^{-\sigma} e_j q_j^{\sigma-1} T_{ij}^{1-\sigma} \quad (3.10)$$

where T_{ij} is the indicator of transport costs from i to j , and e_i is the total expenditure on manufactures in region i :

$$e_i = \gamma \left(w_i m_i \left(1 - \delta \left(\frac{m_i}{2} \right) \right) + m_i R_i \right) + \mu \int_{h \in n_i} C(h) dh \quad (3.11)$$

The first term in expression (3.11) is the value of consumer expenditure, since consumers spend a fraction γ of their income on manufactures, where consumer income is the sum of labor income and the rebate of urban and agricultural rents. The final term is intermediate demand, generated as firms spend fraction μ of their costs on manufactures.

Differentiating demand with respect to a firm's own price - after substituting expressions (3.1), (3.2) and (3.11) into (3.10) - shows that every firm faces a constant price elasticity σ in every region. All firms producing in any particular region then have the same profit - maximizing producer price, which is a constant relative mark-up over marginal cost:

$$p_i = \frac{\sigma \beta}{\sigma - 1} q_i^\mu w_i^{1-\mu} = q_i^\mu w_i^{1-\mu} \quad (3.12)$$

where we have applied the normalization $\frac{\sigma\beta}{\sigma-1} = 1$.

Even though firms set a unique price for their output regardless of whether it is sold domestically or exported, the consumer price paid per unit received is either T , τ_B or $T\tau_B$ times higher in the region where the good has to be imported. The profits of each manufacturing firm in region B are, from expressions (3.2) and (3.12),

$$\pi_B = \frac{1}{\sigma} \left[q_B^{\mu(1-\sigma)} w_B^{(1-\mu)(1-\sigma)} (q_B^{\sigma-1} e_B + q_H^{\sigma-1} e_H \Phi + q_W^{\sigma-1} e_W \Phi_I) - q_B^\mu w_B^{1-\mu} \right]$$

or, equivalently,

$$\pi_i = \frac{p_i}{\sigma} (x_i - 1) \quad (3.13)$$

where $\Phi = T^{1-\sigma}$, $\Phi_I = \tau_B^{1-\sigma}$ and we have applied the normalization $\alpha = \frac{1}{\sigma}$. This means that

$$x_i = 1 \quad (3.14)$$

is the unique level of output giving firms zero profits.

On the other hand, given (3.1) and (3.12), the price-index equation for region B can be written implicitly as follows:

$$q_B^{1-\sigma} = \left(q_B^\mu w_B^{1-\mu} \right)^{1-\sigma} n_B + \left(q_H^\mu w_H^{1-\mu} \right)^{1-\sigma} n_H \Phi + \left(q_W^\mu w_W^{1-\mu} \right)^{1-\sigma} n_w \Phi_I \quad (3.15)$$

and the same can be done with q_H and q_W .

Turning to the labor market, from (3.2) and (3.3), the labor-market clearing condition can be written as

$$(1 - \mu) \frac{C(h)_i}{w_i} n_i + K_i \left(\frac{\theta}{w_i} \right)^{\frac{1}{1-\theta}} = L_i = m_i (1 - \delta(m_i/2)) \quad (3.16)$$

The first term in the left-hand side of (3.16) is labor demand in manufacturing, obtained by application of Shephard's lemma to (3.2). The second term stands for the agricultural demand for labor, which is given by expression (3.3). If we add up both terms, the sum must be equal to the available supply of effective labor, given by (3.6).

Now we are ready to give a formal definition of a Steady State associated with a given level of τ_B :

Definition 6 A Steady State associated with a given τ_B is a vector of prices and allocations $\{p_i, w_i, q_i, x_i, R_i, Y_i, C_i, m_B, e_i, n_i; i \in \{B, H, W\}\}$ that satisfies

1. Equation (3.1): $q_B = \left[\int_{h \in n_B} p_B^{1-\sigma}(h) dh + \int_{h' \in n_W} p_w^{1-\sigma}(h') \tau_B^{1-\sigma} dh' + \int_{h' \in n_H} p_H^{1-\sigma}(h') T^{1-\sigma} dh' \right]^{\frac{1}{1-\sigma}}$
(Definition of price-index of local intermediate composite)
2. Equation (3.12): $p_i = q_i^\mu w_i^{1-\mu}$ (Profit Maximization by manufacturing firms)
3. Equation (3.10): $x_i(h) = \sum_{j \in \{B, H, W\}} (p_i(h))^{-\sigma} e_j q_j^{\sigma-1} T_{ij}^{1-\sigma}$ (Utility maximization by consumers and cost minimization by firms; the market of every manufacturing variety clears).
4. Equation (3.11): $e_i = \gamma (w_i m_i (1 - \delta(\frac{m_i}{2})) + m_i R_i) + \mu \int_{h \in n_i} C(h) dh$ (Aggregation of consumer and firm expenditure on manufactures).
5. Equation (3.4): $R_i = \frac{\left((1-\theta) K_i \left(\frac{\theta}{w_i} \right)^{\frac{\theta}{1-\theta}} \right)}{m_i}$ (Profit maximization in agriculture).
6. Equation (3.2): $C_{ih} = (\alpha + \beta x_i(h)) q_i^\mu w_i^{1-\mu}$ (Definition of the cost function for every variety).
7. Equation (3.16): $(1 - \mu) \frac{C(h)_i}{w_i} n_i + K_i \left(\frac{\theta}{w_i} \right)^{\frac{1}{1-\theta}} = m_i (1 - \delta(m_i/2))$ (Local labor market clearing).
8. $(x_i - 1)n_i = 0, x_i \leq 1, n_i \geq 0$. (Free entry / zero-profit condition for local manufacturing firms).
9. Equation (3.8): $Y_i = w_i (1 - \delta(\frac{m_i}{2})) + R_i$ (Definition of nominal income).
10. Equation (3.9): $Y_B q_B^{-\gamma} = Y_H q_H^{-\gamma}$ (Determination of relative labor supply in Border and Hinterland when labor mobility is allowed; otherwise, the relevant equation is $m_B = 1/2$).

The first nine conditions above are linked to three equations, one for each location; whereas condition 10 is only expressed by equation (3.9). Therefore, computing a steady state for every value of τ_B is a static problem with 28 equations and 28 unknowns.

It is useful to think of short-run profits as being related to the number of firms in each region by four forces: product and labor-market competition, and cost and demand linkages. A larger number of firms producing in the same region increases demand for labor, leading to higher wage costs - expression (3.16). Product market competition is also tougher in regions where more varieties are produced locally; if more varieties are available locally instead of being imported subject to trade costs then the price index of industrial goods is lower - expression (3.1) -so, for a given price and level of expenditure, local demand for each industrial good is smaller -

expression (3.10). Product and labor market competition tend to make firms located in markets with relatively many firms less profitable, encouraging exit and leading to the geographical dispersion of industry. Therefore, these two forces are sometimes called "neoclassical".

Pulling in the opposite direction there are cost and demand linkages. Cost linkages come from the lower prices that firms and consumers have to pay for manufactures in regions where there are relatively many firms - expressions (3.1), (3.2) and (3.5). Demand linkages arise as an increase in the number of demand firms and / or workers raises local expenditure on manufactures - expression (3.11). Cost and demand linkages tend to increase the short-run profitability of firms in regions with a large number of firms, and they lead to entry. When they are strong enough they can overturn product and labor-market competition, thereby making dispersed outcomes unstable and triggering industrial agglomeration.

In the long run, profits must be zero wherever there is a positive measure of firms, and there must be no firms wherever profits are negative. That adjustment takes place increasing the number of firms if profits are positive and decreasing it (for potential, if not for actual, firms) whenever they are negative.

3.4 Numerical Simulations

The goal of this section is to analyze the effect of trade liberalization and labor mobility on development, industrialization and population density. We conduct two different experiments. In both of them we look at the effects of a gradual decrease in international trade costs (τ_B), while keeping a fixed value of internal trade costs (T) between Border and Hinterland. In the first experiment there is no labor mobility of any kind, neither between East and West nor between Border and Hinterland. In the second experiment, trade liberalization is followed by the introduction of labor mobility within the East, between Border and Hinterland.

Our choice of parameter values will be identical to Puga and Venables (1997)'s with respect to $\mu = 0.55$; $\gamma = 0.5$; and $\theta = 0.8$. However, we selected $\sigma = 3$ instead of $\sigma = 4$ in order to fit better the observables¹¹. On the other hand, we had to assign some values to the new

¹¹We can justify that our model's parameterization falls in the ballpark of what is reasonable. For example, the value of σ can be induced from the average markup in the industry. A value of $\sigma = 3$ corresponds to a markup of 50%; Brakman, Garretsen and Schramm (2006) recently estimated for the EU a value of σ around

parameters in our model: $\Phi = 0.85$, $\delta = 0.05$, $K_H = K_B = 1/2$, $K_W = m_W = 1$, $m_H + m_B = 1$. The degree of internal trade openness between Border and Hinterland (Φ) is, by assumption, always bigger or equal than the degree of international trade freeness (Φ_I).

Our simulations do not intend to capture the whole set of stable steady-states at any level of international trade costs: we just obtain a stable steady-state for the initial value of trade costs, and as trade openness rises we make the economy follow the transitional dynamics: we increase (decrease) the local mass of varieties where profits are positive (negative), until the free-entry condition is satisfied. As a result, we obtain a sequence of steady states as trade costs decay.¹²

3.4.1 Trade Liberalization without Labor Mobility

We can observe our results for the fully-restricted-labor-mobility case in figures 5 and 6, where the horizontal axis in each panel shows the level of international trade costs (τ_B), assumed to be bigger or equal to $T = 1,08$.

We must emphasize that - at least under our parameterization - the revival of East relative to West, and of Hinterland relative to Border, does not take place in the absence of internal labor mobility. Initially, trade liberalization involves tougher competition for both Eastern locations, whereas the larger Western market is hardly affected by the scant Eastern competitors. This leads to a process of international (East-West) divergence (see figure 4).

Nevertheless, openness to the large market not only implies tougher competition, but also higher exports and cheaper imports of intermediates for the East, specially for the Border. That proximity to the largest market is crucial for the Border to absorb most of the manufacturing share of the Hinterland, which reduces the standards of living in the latter location and leads to a process of interregional divergence (see figure 5). Both characteristics seem to correspond roughly to the initial years of the transition period, when we know that migrations within East

2.96. The value of μ can be also inferred from the Input-Output tables of the Czech economy, where in 1995 the ratio of intermediate inputs to total output in current prices was around 0.62, although this value varies greatly across industries. The value of γ , if we consider food and housing as our primary goods, amounted to a 46.8% of household expenditure during 2000 in Umbria (Italy) (see Papalia (2006)).

¹²In a separate experiment, we have also tried to introduce the whole trade reform all at once, followed by a transition. Finally, once the steady state was reached, we incorporated the migratory reform. The results were not qualitatively different from those we will present next.



Figure 3-5: Ratio real wage East / West without labor mobility.



Figure 3-6: Ratio real-wage Hinterland/Border without labor mobility.

were still subject to significant restrictions.

3.4.2 Trade Liberalization and Labor Mobility within East

Since trade liberalization does not lead to any kind of recovery, we now see whether migration within the East had any effect. The evidence tells us that internal migration (within the East) started in earnest some time in the mid 1990s, whereas migration from East to West did not really take off until the present decade. We therefore focus on liberalization of migration within the East.

We have checked that, by introducing the migratory reform in the midst of the trade liberalization process - as we think it took place in the real world- we are able to replicate more closely our stylized facts, reflected on figures 1-3. To that purpose, we have tentatively chosen a level of $\tau_B = 1.49$ as the particular point where migrations within the East are fully allowed (the date we have in mind could be around 1993). We can observe in Figure 7 that, immediately after the migratory liberalization is enacted, an important contingent of population flows from Hinterland to Border in response to higher real income (net of congestion costs). This higher degree of population concentration within the East enlarges the home-market of this country and attracts a higher world share of manufacturing varieties, in such a way that international real-wage levels start to converge (see Figure 8).

We want to emphasize that - even in the context of asymmetric countries¹³- we get convergence between East and West without assuming labor mobility between East and West. It is true that Krugman and Venables (1995) and Puga (1999) also obtained that result, but they did it in a context of symmetric countries in which market size was evenly distributed. Once the eastern market is assumed to be smaller (due to internal trade costs), trade liberalization alone is unable to lead to a recovery, and the eastern population needs to be more concentrated in order to attract firms towards the Border. Of course, if one were to introduce East-West migration this would reinforce our results.

If we plot the average real wages of East and West (and Border and Hinterland within the East), we obtain two U-shaped curves very similar to Figures 1 and 2. It is noticeable that the

¹³The asymmetry in the size of the markets of East and West is derived from the internal trade cost (T) introduced within the eastern country.

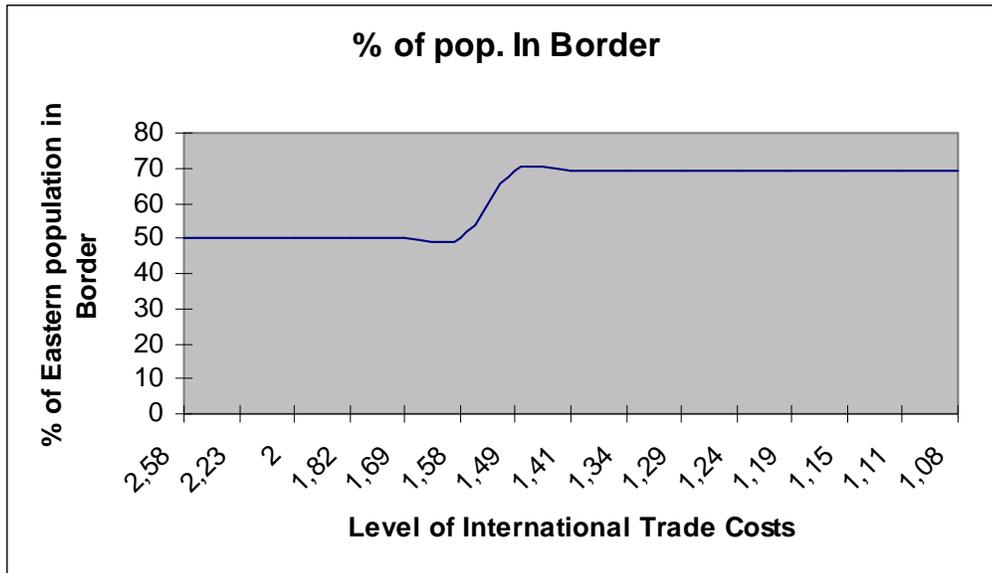


Figure 3-7: Migratory flow towards Border

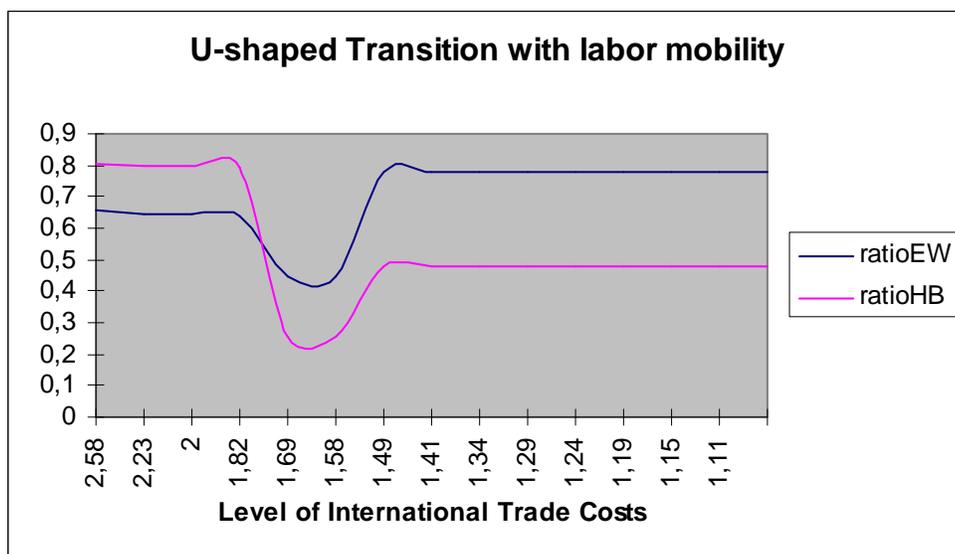


Figure 3-8: Ratio of East-West, Border-Hinterland local real wages.

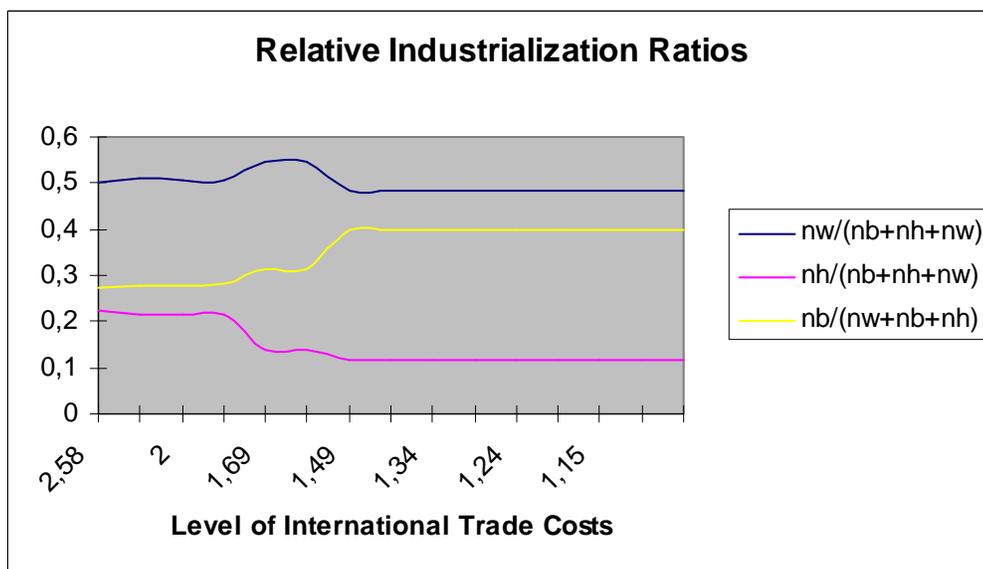


Figure 3-9: Patterns of relative industrialization.

policy shock triggers an international convergence trend that is reinforced by the last stages of trade openness, once lower labor costs finally induce firms to relocate towards the East. The same policy reform is responsible for the relative improvement of the living standards in the Hinterland relative to the Border, given that the labor-supply effect outweighs the home-market gain in the Border and the deterioration in the Hinterland.

It is easily observable that our simulations find an amazing recovery, whereas in our empirical evidence the upward part of the U-shape is much flatter. It would be interesting to see what would happen if we assumed that migration is costly. That may account for the gradual recovery of the East relative to the West and the Hinterland relative to the Border.

The evolution of local manufacturing shares under labor mobility can be observed in Figure 9, where we can observe how - though real wages in the Hinterland recover in relative terms - the Hinterland continues losing industry throughout the decade, which conforms with our stylized facts (see Figure 4).

3.4.3 Some Normative Implications

Nevertheless, the migratory liberalization has also a different, unexpected effect on real wages. Since almost the whole manufacturing sector gets concentrated in West and Border, there is no longer need to trade in intermediates with Hinterland. Therefore, internal transport costs within the East are mostly skipped, which allows firms to quote lower prices and provide higher real wages everywhere. That is the sense in which internal labor mobility turns out to be Pareto-improving for an appropriate parameterization. To see this, compare Figure 10, which plots real wages when there is labor mobility in the East, to Figure 11, which plots real wages when there is no labor mobility.

This happens because, in essence, the migration has a double effect on Western indirect utility: on the one hand, the West loses part of its manufacturing share in favor of the Border, which reduces the effectiveness of vertical linkages; on the other hand, the Hinterland is left 'out of the game', which reduces trade costs and increases that effectiveness. Therefore, the model can help us understand the forces at stake, though we can not make definite predictions about local welfare¹⁴, since they will always be very dependent on our parameterization.

3.5 Conclusions

In this paper we have examined some mechanisms - exclusively related to economic geography, trade openness and freedom to migrate - as possible ingredients to account for the recent real-income profile of CEE countries. We have deliberately disregarded any interference of technological differences across regions or unrelated public-policy factors. As a result, the belated incorporation of freer international trade and new labor mobility emerge as candidates to explain the evolution of both external and internal disparities.

Initially, a higher trade openness generates a flow of productive capacity from the East towards the largest market (the West), and also from the Hinterland to the Border, where foreign inputs are much cheaper. As a result, the early stages of trade liberalization are characterized by both international (East-West) and interregional (within the East) divergence. Later, it is

¹⁴Those predictions would always depend on our particular choice of parameter values. For instance, our choice of δ looks specially relevant for the convenience of agglomeration in a single location.

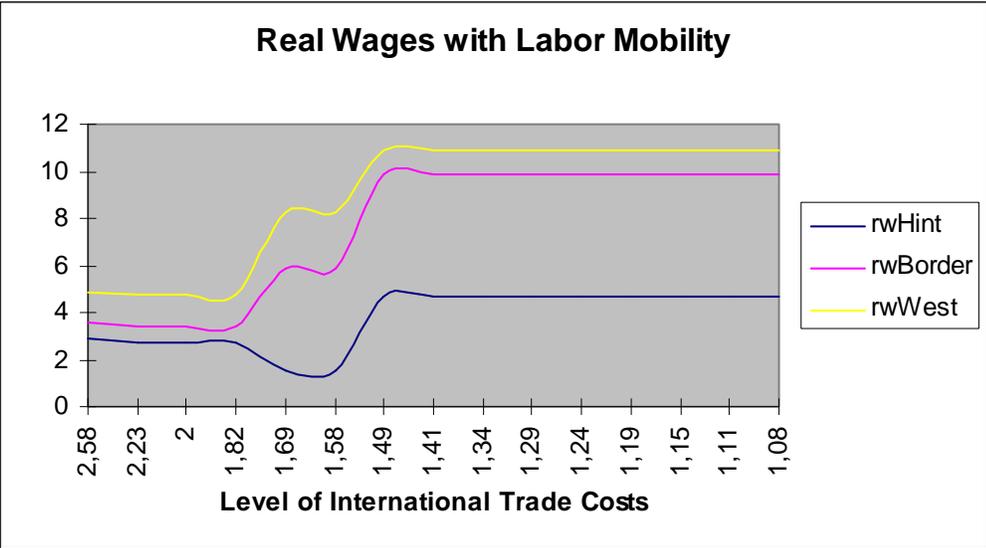


Figure 3-10: Normative Implications: local real wages with labor mobility

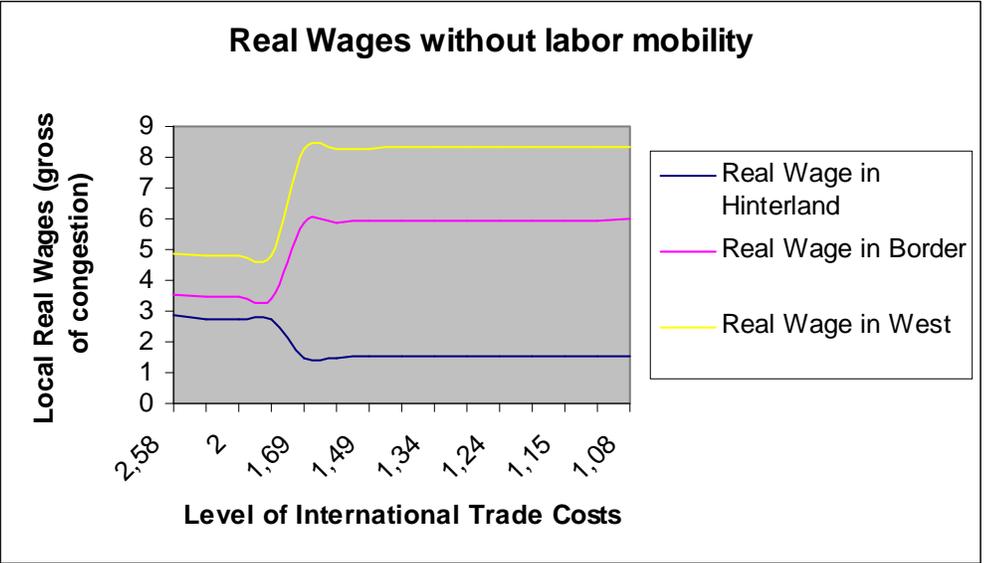


Figure 3-11: Local real wages without labor mobility.

internal (Hinterland-Border) migration which drives both the revival of the East with respect to the West and the recovery of the Hinterland with respect to the Border (in terms of real wages), though subsequently the Hinterland deindustrializes.

A different normative implication points at internal labor mobility as a potentially Pareto-improving measure, at least in a context where labor-force heterogeneity, assimilation costs,... do not play a major role. The reason for such a welfare gain is a concentration of the productive chain within a highly integrated area (the West and the Border), which allows saving trade costs and spurs global industrialization.

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