Opening the borders: immigration policy, migrants' selection and human capital accumulation*

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Abstract

This paper investigates the economic consequences of international migration from the point of view of destination countries. Consistently with international evidence on migration flows, we build a model where the migration rate is higher among the highly-educated. A negative relationship is shown to exist between the domestic wage level and the percentage of educated workers among immigrants, which raises interesting policy implications. In particular, the optimal immigration policy from the point of view of natives requires an immigration quota above a certain minimum level. Extending the analysis to a dynamic setting, we highlight additional effects of the immigration quota on human capital accumulation among natives.

Keywords: International Migration; Immigrants' selection; Human Capital Accumulation. *JEL Classification*: J24; F22.

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1 Introduction

Recent evidence on the composition of international migration flows shows that international mobility of workers is especially important at high and very high educational levels and confirms the existence of a substantial transfer of human capital from less developed to industrialized countries, the so-called “brain drain”. For instance, Carrington and Detragiache [6] provide estimates of the ratio of migrants to the US and other OECD countries to total population in sending countries by education achievement and find that “individuals with little or no education have little access to international migration, and migrants tend to be much better educated than the rest of the population of their country of origin. The very well educated tend to be the most internationally mobile group, and for the large majority of the countries in our sample (e)migration rates are the highest for this educational category” (pag.6).

In the light of this evidence, the causes and consequences of the brain drain from the point of view of sending countries have received renewed attention. Recent work in this area (see for example Beine et al. [2]) tends to attribute a beneficial effect to moderate brain drain and to policy interventions in the direction of labor flows liberalization, as the prospect of working abroad may increase the expected return of investment in education and foster human capital accumulation in source countries.

On the contrary, formal investigations of the effects of migration in destination countries typically do not incorporate in the analysis the fact that emigration rates are highest among the most educated.[1]

In the study of the determinants of the average quality of immigrants in receiving countries, an authoritative hypothesis is that of Borjas [5] who argues that a “negative selection” of immigrants, that is a situation where the individuals with the higher incentive to migrate to a particular country tend to be those with below-average skills levels in their home countries, may set in as the major sources of immigration shift from rich and relatively equalitarian countries to poor and unequal countries. This occurs as the education

[1] Boeri e alia [3] bring together a large empirical literature on the assessment of the effects of immigration in major destination countries.

(skill) premium is typically higher in relatively poorer and more unequal countries.

This argument has been used, for example, to explain the decline in the average quality of immigrants into the US in the postwar period, as well as the lower average quality of immigrants into the US relative to Canada.[2] However, this view of the immigration process has recently been challenged by Chiquiar and Hanson [7], who observe that Mexican immigrants to the US, though less educated on average than US natives, tend to have above-average education relative to Mexican residents, and thus are positively selected in their home countries.[3] The proposed explanation for this finding is that the less-educated bear relatively higher direct migration costs that may outweigh the skill premium effect. Also Chiswick [8], in his analysis of migrants selection, shows that the presence of direct costs of migration non-proportional to wages tends to generate favorable selection.

The main goal of this paper is therefore to develop a model of international migration which is consistent with evidence on emigration rates. Following the above discussion, our starting point will be the incorporation of differential migration costs in a simple model of international migration driven by economic incentives. Within this framework, we will study the endogenous determination of the composition of immigrants inflow as a result of the conditions prevailing on the domestic labor market and provide policy implications regarding the optimal level of the immigration quota.

By studying the immigration process in a general equilibrium context, our analysis provides some insights on the potential effects of immigration policy which have not yet been emphasized by the literature. We will show that the percentage of highly-educated immigrants may be increasing with the total number of immigrants, thus highlighting a

[2] The different experiences of the US and Canada is sometimes attributed to differences in the immigration policy in the two countries, as the US immigration policy tends to favor relatives of US citizens, while the Canadian point-system favors relatively young and highly-skilled individuals. However, evidence on this point suggests that this is not the most important factor. In a recent contribution Trejo [11] confirms previous findings by Borjas [4] and argues that "the comparatively low overall skill level of US immigrants may have more to do with geographic and historical ties with Mexico" (and Latin America) "than with the fact that skilled-based admissions are less important in the US than in... Canada".

[3] Note that, as discussed by Chiquiar and Hanson [7], Mexico is an ideal candidate to test the validity of Borjas' hypothesis, as returns to education and wage dispersion are high relative to the US.

novel reason why reducing rather than increasing restrictions on labor flows (e.g. increasing the immigration quota) may be beneficial also from the point of view of destination countries.

More specifically, we will consider an economy where a single good is produced by means of an immobile factor (land) and an internationally mobile factor (labor). Unskilled and skilled foreign workers decide whether to apply for entry, taking into account migration costs, the wage gap, and the probability of finding a job reflecting their skills in the host economy. The immigration policy places a cap on the number of foreign workers who are allowed to enter (immigration quota) and is otherwise non-selective.[4]

If the skilled face a positive probability of being hired as unskilled, a negative selection bias may emerge as the expected return from migration is relatively higher for the unskilled. This effect is possibly outweighed by the presence of higher direct migration costs for the unskilled.

Coherently with the stylized facts discussed above, we will concentrate on the case where the latter effect prevails so that the emigration rate is higher for the skilled, given the wage gap. This case has interesting consequences, as it determines a negative relationship between the percentage of skilled workers among immigrants and the domestic wage level. In turn, this implies that a low immigration quota (which avoids a sharp decrease in the domestic wage rate) has adverse effects on the number of skilled immigrants entering the economy and consequently on natives' welfare.

As the contribution of human capital to economic growth is fully recognized in the light of new growth theories, our model of immigration has also long-run implications. Extending the one-period model to an overlapping generations dynamic model, we can derive some interesting results. In particular, we will show that, if the immigration of highly-educated workers generates positive spillovers on natives' incentives to invest in education, there exists a threshold level of the immigration quota such that, for any quota

[4] Our assumptions are meant to keep the analysis as general as possible, avoiding reference to specific selectivity aspects of immigration policies implemented by single destination countries, and to focus the attention on economic incentives for legal migration, ruling family reunification, humanitarian reasons, and illegal migration.

below this threshold, the steady-state with immigration is characterized by a lower fraction of skilled natives than in the closed economy. This may bring about adverse effects on the welfare of natives.

Concerning the dynamic implications of the model, a related contribution is that of Zak, Feng and Kugler [12] who study the impact of immigration on the dynamics of the distribution of human capital in the host economy when fertility and migration decisions are endogenous. As in our model, the overall effect of immigration depends on its impact on human capital accumulation. The underlying mechanism is different from ours, however, and goes through the influence of immigration on the average fertility rate. Other contributions extend the neoclassical growth model to encompass international migration (see for instance chapter 9 in Barro and Sala-i-Martin [1] and references therein). Lundborg and Segerstrom [10] study the effects of immigration quotas in the context of a North-South quality ladders growth model, where immigration may have positive growth effects. However, none of these contributions investigates the endogenous determination of the average quality of immigrants and its relation with the immigration quota.

The remaining of the paper is organized as follows. Section 2 sets out the static model, characterizes the equilibrium with immigration, and discusses policy implications. Section 3 considers a dynamic extension of the model. Section 4 concludes.

2 The one-period model

Consider an economy populated by N agents (households) where a fraction π of agents is educated while a fraction $1 - \pi$ work is not.

Labor supply is inelastic and is higher in efficiency units for educated (skilled) agents than for uneducated (unskilled) agents. A non reproducible immobile factor available in fixed quantity (land) is used together with labor in the production of the final good. Land property is equally distributed among all households. The final good and the labor markets are competitive.

In the final good sector, the non durable consumption good (Y) is produced using land

(T) and labor (L), according to the following aggregate production function:

$$Y = T^{\eta} L^{1-\eta} \tag{1}$$

where T is the total supply of land. The total amount of labor in efficiency units L is given by the sum of labor supply from skilled workers L^s and unskilled workers L^u, that is:

$$L = L^s + L^u = \varepsilon^s \pi N + \varepsilon^u (1-\pi) N \tag{2}$$

where ε^s and ε^u denote the fixed productivity of the skilled and the unskilled respectively, with $\varepsilon^s > \varepsilon^u$.

Aggregate supply of production factors (skilled labor, unskilled labor and land) is exogenously given. Aggregate demand reflects first order conditions for profit maximization and equilibrium factor prices are determined by:

$$w^u = (1-\eta)(T/L)^{\eta}\varepsilon^u = W(L)\varepsilon^u \tag{3}$$

$$w^s = (1-\eta)(T/L)^{\eta}\varepsilon^s = W(L)\varepsilon^s \tag{4}$$

$$p = \eta(T/L)^{\eta-1} \tag{5}$$

where w^u, w^s and p represent the hourly wage for the unskilled and for the skilled and the (rental) price of land respectively and W is the wage per efficiency unit of labor.[5]

2.1 Labor mobility

We now consider the possibility of international labor mobility and study its effects on aggregate income and natives' welfare.

In the international labor market there exists a very large (possibly infinite) number of workers. A fraction π^* of these workers is educated (skilled) and has productivity equal to

[5] The existence of a fixed productivity gap between the skilled and the unskilled and the possibility of substituting one type of worker for the other in production implies that the skill premium $\varepsilon^s/\varepsilon^u$ is independent of factor quantities. This feature of the model, which greatly simplifies the analysis, can be justified in a model of migration. In fact, empirical evidence suggests that immigration has a limited impact on the skill premium. Instead, it seems to extert a downward pressure on the (low-skilled) wage. For the US case, see evidence surveyed by Hanson et alia [9].

ε^{s*} and a fraction $(1-\pi^*)$ is uneducated (unskilled) and has productivity equal to ε^{u*}. We will denote with w^{s*} and w^{u*} the (exogenously given) international skilled and unskilled hourly wage, respectively. Notice that our formulation can encompass situations where the international skill premium $\varepsilon^{s*}/\varepsilon^{u*}$ is higher or lower than the domestic skill premium $\varepsilon^{s}/\varepsilon^{u}$.

The immigration policy places a (enforceable) cap Q on the number of workers who are allowed to enter the country in each period. No restriction is placed on the quality of immigrants. The actual number of immigrants will be denoted with M.

Migration is costly. First, agents have a subjective cost of migration $\theta \in [0, \overline{\theta}]$, independent of their skills. We will assume that θ is uniformly distributed and denote with $G(\theta) = \theta/\overline{\theta}$ the cumulative distribution function. For each θ, there exist a very large (possibly infinite) number of agents whose subjective cost is equal to θ. Second, migration entails a fixed pecuniary cost which is higher for uneducated agents than for the educated. We denote these costs with P^u and P^s respectively, with $P^u > P^s$.

Finally, due to transaction costs in the labor market of the receiving country, a fraction z of the educated immigrants is hired as unskilled workers. In this case their productivity reduces to ε^{u*}.[6] Uneducated agents are always hired as unskilled workers. Thus, our model entails a self-selection bias against skilled workers since the positive probability of being hired as unskilled decreases their expected wage in the host country. Notice that this effect is possibly outweighed by the presence of higher migration costs for the unskilled.

Agents are risk-neutral and decide whether to apply for entry by comparing their total cost of migration with the expected difference between the labor income they can earn abroad and at home.

[6] We could think that, with probability z, the education attainment of educated immigrants is not recognized by firms who hire them in the destination country, who thus pay them the unskilled foreign workers' hourly wage $\varepsilon^{u*}W$. As higher productivity is not remunerated, educated agents provide lower effort and reduce their productivity in this case.The probability z may reflect institutional features of the domestic labor market as well as the existence of specific integration policies for immigrants.

2.2 The equilibrium with immigration

As before, each agent earns a wage which is equal to W times her own productivity. So, for instance, a skilled worker employed in the domestic economy has a wage equal to $W(L)\varepsilon^{s*}$ where L now includes domestic and foreign labor supply.

Skilled agents will be willing to migrate if and only if their subjective cost is lower than θ^s, where:

$$\theta^s = zW\varepsilon^{u*} + (1-z)W\varepsilon^{s*} - w^{s*} - P^s \tag{6}$$

Similarly, unskilled agents will be willing to migrate if and only if their subjective cost is lower than θ^u, where:

$$\theta^u = W\varepsilon^{u*} - w^{u*} - P^u \tag{7}$$

Assuming that M is sufficiently large, the percentage of skilled agents in the total migrants' inflow is equal to the probability that an agent who is willing to migrate is skilled. We will denote this percentage with $\widetilde{\pi}^*$ and write:

$$\widetilde{\pi}^* = \frac{\pi^* G(\theta^s)}{(1-\pi^*)G(\theta^u) + \pi^* G(\theta^s)} \tag{8}$$

Clearly, the percentage of unskilled agents in the total migrants' inflow is equal to $1 - \widetilde{\pi}^*$.

2.2.1 The labor supply with immigration

In order to characterize the competitive equilibrium with migration, we need to study the behavior of labor supply when immigrants are allowed to enter the domestic labor market. This will require some additional definitions.

First of all, let us define a threshold value of the unit wage W below which no skilled agent is willing to migrate. This threshold value is the one that makes foreign skilled agents with the lowest subjective cost of migration just indifferent between migrating or not and is given by:

$$W_s' \equiv \frac{w^{s*} + P^s}{z\varepsilon^{u*} + (1-z)\varepsilon^{s*}} \tag{9}$$

Similarly, a threshold value can be defined for the unskilled, that is:

$$W'_u \equiv \frac{w^{u*} + P^u}{\varepsilon^{u*}} \tag{10}$$

Second, we can define a threshold value such that all the skilled are willing to migrate. This value is given by:

$$W''_s \equiv \frac{\overline{\theta} + w^{s*} + P^s}{z\varepsilon^{u*} + (1-z)\varepsilon^{s*}} \tag{11}$$

Similarly, for the unskilled, we have:

$$W''_u \equiv \frac{\overline{\theta} + w^{u*} + P^u}{\varepsilon^{u*}} \tag{12}$$

Following the stylized facts that we have discussed in the Introduction, we will focus on the case where $W'_u > W'_s$ which implies $\theta^s > \theta^u \frac{z\varepsilon^{u*}+(1-z)\varepsilon^{s*}}{\varepsilon^{u*}}$ so that the migration rate is higher among skilled agents than among the unskilled.[7].

We are now ready to characterize the labor supply locus and prove the following result:

Proposition 1 *Labor supply decreases with W for $W \in (W'_u, W''_u)$ and is inelastic elsewhere.*

Proof. For $W \in [0, W'_s)$ no foreign worker is willing to migrate so that labor supply is inelastically equal to domestic supply $L = [\varepsilon^s \pi + \varepsilon^u(1-\pi)]N$. For $W \in [W'_s, W'_u]$, only skilled workers migrate so that $\widetilde{\pi}^* = 1$ and $L = \varepsilon^s \pi N + \varepsilon^u (1-\pi)N + [z\varepsilon^{u*} + (1-z)\varepsilon^{s*}]\, Q$, which again does not depend on W. For $W \in (W'_u, W''_u)$,both skilled and unskilled immigrants enter the domestic economy. In this case, $\widetilde{\pi}^* \in (\pi^*, 1)$ and $L = [\varepsilon^s \pi + \varepsilon^u (1-\pi)]N + [\widetilde{\pi}^*(1-z)\varepsilon^{s*} + \widetilde{\pi}^* z\varepsilon^{u*} + (1-\widetilde{\pi}^*)\varepsilon^{u*}]\, Q$. As $\widetilde{\pi}^*$ depends on W, the sign of $\dfrac{dL}{dW}$ is determined by the sign of $G'(\theta^s)\frac{d\theta^s}{dW}G(\theta^u) - G'(\theta^u)\frac{d\theta^u}{dW}G(\theta^s)$, which in turn depends on the sign of $[z\varepsilon^{u*} + (1-z)\varepsilon^{s*}]\theta^u - \varepsilon^{u*}\theta^s$. As $W'_u > W'_s$, this expression is negative. Finally, for $W > W''_u$, all foreign workers are willing to migrate. The proportion between skilled and

[7] If $W'_u < W'_s$, at least for some W we have $\theta^s < \theta^u$ so that the migration rate is higher for the unskilled.

unskilled immigrants is exogenously given by π^* and $1-\pi^*$ and labor supply is inelastically equal to $L = [\varepsilon^s \pi + \varepsilon^u (1-\pi)] N + [\pi^*(1-z)\varepsilon^{s*} + \pi^* z \varepsilon^{u*} + (1-\pi^*)\varepsilon^{u*}]\, Q$. ■

Figure 1 illustrates the labor supply locus, where $\underline{L} = [\varepsilon^s \pi + \varepsilon^u (1-\pi)] N$ and $L^* = [\widetilde{\pi}^*(1-z)\varepsilon^{s*} + \widetilde{\pi}^* z \varepsilon^{u*} + (1-\widetilde{\pi}^*)\varepsilon^{u*}]\, Q$ denote the national and foreign component of labor supply respectively.

INSERT FIGURE 1 HERE

The intuition for the non-standard shape of labor supply is the following. At high levels of the wage, all foreign agents are willing to migrate and the proportion of skilled immigrants is exogenously given by π^*. In this case, given Q, the foreign contribution to labor supply is minimum and total labor supply is inelastic. At low levels of the wage, only skilled immigrants find it profitable to enter the domestic labor market and the proportion of skilled immigrants is equal to 1. Foreign contribution is maximum and labor supply is again inelastic. For intermediate levels between W_u' and W_u'', the percentage of skilled immigrants in the total inflow is decreasing with the wage and so is labor supply. This result is crucially dependent on the assumption of a higher migration rate for the skilled, due to higher costs of mobility for the unskilled.

Having discussed the properties of labor supply, we are ready to characterize the equilibrium with immigration. The formal statement will require an additional definition. Thus, let us define the maximum inflow of immigrants compatible with the labor market equilibrium as[8]:

$$\overline{M} \equiv \left\{ T \left[(1-\eta) / W_s' \right]^{\frac{1}{\eta}} - [\varepsilon^s \pi + \varepsilon^u (1-\pi)] N \right\} / \left[z \varepsilon^{u*} + (1-z) \varepsilon^{s*} \right]$$

Then, we can write:

Proposition 2 *In a competitive equilibrium with immigration, either:*

(i) $M = Q < \overline{M}$

(ii) $W > W_s'$, $\widetilde{\pi}_t^* \in [\pi^*, 1], \theta_t^s > 0, \theta_t^u \geq 0$

[8]For our purposes, the only interesting case is where $\overline{M} > 0$, which is equivalent to assume that in the closed economy case, $W > W_s^{'}$.

or

(i) $M = \overline{M} \leq Q$

(ii) $W = W_s'$, $\widetilde{\pi}_t^* = 1$, $\theta_t^s = \theta_t^u = 0$

Proof. When $Q < \overline{M}$, $M < \overline{M}$ and $W > W_s'$. By definition of W_s', we have $\widetilde{\pi}^* \in [\pi^*, 1]$. If $Q \geq \overline{M}$, labor market equilibrium implies $M = \overline{M}$. Thus, $W = W_s'$ so that $\theta^s = 0$ and $\widetilde{\pi}^* = 1$. ■

As the proposition shows, there are two possible equilibrium types. In the former, the immigration quota is binding and labor market clears with Q foreign workers, of which a fraction $\widetilde{\pi}^* \in [\pi^*, 1]$ is skilled. At this equilibrium $W > W_s'$. In the latter, the immigration quota is high (and possibly not binding) and the labor market clears with the maximum number of immigrants $\overline{M}$. The unit wage rate is at the minimum level W_s' compatible with immigration and only skilled workers enter the domestic economy.[9]

2.3 Policy implications

In our context, it is interesting to consider what would be the optimal immigration policy for a government whose objective were to maximize the income (and consequently the welfare) of domestic citizens.

To discuss this issue, let us assume that a given quota Q is currently in place. If the government restricts immigration further, by setting $Q' > Q$, it would increase the level of domestic wages, both for the skilled and the unskilled. However, it would also bring about a decrease in the percentage of skilled workers among immigrants. Thus, total labor supply decreases and so does aggregate income and consumption.

Therefore, we can state the following result:

Proposition 3 *National income is maximized if and only if* $Q \geq \overline{M}$.

[9] A non-increasing labor supply implies that the equilibrium wage may not be unique. A sufficient condition for uniqueness is that labor supply is steeper than labor demand between W_u' and W_u''. We restrict the analysis to this case as the presence of multiple equilibria would not change the main qualitative results of the model.

Proof. National income can be written as:

$$NI = T^{\eta} \left(\underline{L} + L^{*} \right)^{1-\eta} - (1-\eta)\, T^{\eta} \left(\underline{L} + L^{*} \right)^{-\eta} L^{*} \tag{13}$$

Note that NI is increasing with L^{*} and the latter is maximized when $Q \geq \overline{M}$.

Clearly, the maximization of national income entails possible redistributive conflicts as long as for domestic agents labor income is reduced while land income is increased. If land were unequally distributed, the immigration policy that we have just described may not be Pareto improving.

3 The dynamic model

Skilled workers migration is likely to determine positive long-run effects in the receiving economy, for instance by stimulating knowledge accumulation[10] or by contributing to human capital formation. The overall growth effect of immigration could be negative, however, if immigrants are less educated than natives on average.[11] This may happen because the foreign educational attainment is low relative to the domestic level ($\varepsilon^{s*} < \varepsilon^{s}$, $\varepsilon^{u*} < \varepsilon^{u}$) and/or because the percentage of unskilled agents is higher among immigrants than among natives ($\widetilde{\pi}^{*} < \pi$). In presence of negative growth effects, the impact of immigration on natives welfare may also be negative.

As we have seen in the previous section, when migration entails larger direct costs for the unskilled, the selection of immigrants will be more favorable the larger the inflow of immigrants. The level of the immigration quota may therefore play an important role in determining the long-run effects of immigration.

[10] See Lundborg and Segerstrom [10].

[11] Most growth models with immigration (see e.g. chapter 9 in Barro and Sala-i-Martin [1]) assume that the human capital of immigrants is low on average relative to natives. This assumption is mainly motivated by the US experience, as the percentage of individuals with low education attainment is much higher among immigrants into the US than among natives. However, this is not the case in other major destination countries, such as Canada for example. Moreover, immigrants are generally more concentrated than natives at very high levels of education attainment. This is also true in the US, as reported by Hanson et alia [9].

To explore this issue, in this section we study a dynamic extension of our model, where the distribution of skills among the native labor force π_t is determined by previous private education decisions.

3.1 The closed economy case

We first set up the dynamic model in the closed economy case ($Q = 0$) and then consider the possibility of international migration ($Q > 0$).

We consider an OLG framework with a constant mass N of households, each composed by a grand-parent (old retiree), a parent (adult worker) and a child. All agents are born with some level of innate ability a^i which determines their attitude to learn and is stochastically generated by a random process. We assume that there is no correlation between a parent's and his offspring's ability and between the latter and the parent's skill (education) level, that is the random variable a^i is identically and independently distributed over the interval $[\underline{a}, \overline{a}]$ in each generation and class. The distribution function of ability is uniform.

Children who attend school become high-productivity workers in adulthood. Children who do not attend school become low-productivity workers in adulthood. The individual cost of acquiring education is denoted with e_t^i and is proportional to the skilled hourly wage w_t^s by a factor $0 < \mu_t^i < 1$ which depends inversely on the child's innate ability a^i and on a measure of the average level of human capital λ_t. In particular, we assume:

$$e_t^i = \mu_t^i w_t^s = (1 - a^i - b\lambda_t) w_t^s \tag{14}$$

where $b > 0$ and:

$$\lambda_t \equiv (\varepsilon^s - \varepsilon^u)\, \pi_t + \varepsilon^u \tag{15}$$

To ensure $0 < \mu_t^i < 1$ we impose $0 < \underline{a}$ and $\overline{a} < 1 + b$.

We assume that there are no capital markets, so that altruistic parents allocate wage income I_t (which depends on skill level) between consumption (including that of their children) and education expenditure, by deciding whether or not to send their children to school.

Land belongs to the old, who use rental income to finance consumption. In the absence of voluntary transfers, land property is passed from one generation to the next in the form of (involuntary) bequest.

The utility function of an agent born at time $t-1$ takes the form:

$$U = \alpha \ln c_t + \beta \ln d_{t+1} + \gamma \ln I_{t+1} \tag{16}$$

where $\alpha, \beta, \gamma \in (0,1)$, c_t denotes adult-age consumption and d_{t+1} denotes old-age consumption. Altruism takes a "warm glow" form, such that parents positively value their children's income in adulthood I_{t+1}.

The budget constraints faced by this agent are:

$$I_t = c_t + e_t^i \tag{17}$$

$$d_{t+1} = p_{t+1}(T/N) \tag{18}$$

3.2 Schooling decisions and the dynamics of natives' human capital

The only economic decision that household members need to take is for adults to decide whether or not to send their children to school. Such decision is taken by parents after observing children's ability.

At time t, a skilled worker will send her child to school if and only she has a level of ability at least equal to $a_t^s = a^s(\pi_t) \in (\underline{a}, \overline{a})$, where $a^s(\pi_t)$ is defined by:

$$-\alpha \ln(a_t^s + b\lambda_t) = \gamma \ln(\varepsilon^s/\varepsilon^u) \tag{19}$$

Similarly, an unskilled worker will send her child to school if and only if she has a level of ability at least equal to $a_t^u = a^u(\pi_t) \in (\underline{a}, \overline{a})$, where $a^u(\pi_t)$, is defined by:

$$-\alpha \ln[1 - (\varepsilon^s/\varepsilon^u)(1 - a^u - b\lambda_t)] = \gamma \ln(\varepsilon^s/\varepsilon^u) \tag{20}$$

By observation of equations (19) and (20) and taking into account that $0 < \mu_t^i < 1$ we can conclude that $a_t^s < a_t^u$ $\forall t$.[12]

[12] To ensure interior solutions for a_t^s and a_t^u, we will assume that $-\alpha \ln(\underline{a} + b\varepsilon^s) < \gamma \ln(\varepsilon^s/\varepsilon^u)$ and $-\alpha \ln[1 - (\varepsilon^s/\varepsilon^u)(1 - \overline{a} + b\varepsilon^u)] > \gamma \ln(\varepsilon^s/\varepsilon^u)$.

At time t, a fraction $1 - F[a^s(\pi_t)]$ of the children born from skilled parents and a fraction $1 - F[a^u(\pi_t)]$ of the children born from unskilled parents are sent to school. In equilibrium, the proportion of skilled workers at time $t+1$ is thus given by:

$$\pi_{t+1} = \Pi(\pi_t) = \pi_t \{1 - F[a^s(\pi_t)]\} + (1 - \pi_t) \{1 - F[a^u(\pi_t)]\}$$

which simplifies to:

$$\pi_{t+1} = \Pi(\pi_t) = \frac{1}{\overline{a} - \underline{a}}(\Gamma\pi_t + \Delta + b\lambda_t) \tag{21}$$

where $\Gamma = a^u - a^s = (\varepsilon^s/\varepsilon^u)^{-(\gamma+\alpha)/\alpha} + \frac{\varepsilon^s - \varepsilon^u}{\varepsilon^s} - (\varepsilon^s/\varepsilon^u)^{-(\gamma/\alpha)} > 0$ and $\Delta = \overline{a} - (\varepsilon^s/\varepsilon^u)^{-(\gamma+\alpha)/\alpha} - \frac{\varepsilon^s - \varepsilon^u}{\varepsilon^s} > 0$.

We are now ready to establish the following result:

Proposition 4 *In the closed economy, the fraction of skilled native workers π_t converges to a globally stable steady state π^c defined by:*

$$\pi^c = \frac{\overline{a} - a^u(\pi^c)}{\overline{a} - \underline{a} + a^s(\pi^c) - a^u(\pi^c)}$$

Proof. Note that $\Pi(0) > 0$, $\Pi(1) < 1$ and $\dfrac{d\pi_{t+1}}{d\pi_t} = \dfrac{\Gamma + b(\varepsilon^s - \varepsilon^u)}{\overline{a} - \underline{a}} > 0$. ■

In the absence of immigration, the economy converges to a steady state characterized by a constant fraction of skilled native workers π^c and constant labor supply L^c.

3.3 The dynamics with immigration

We now extend the analysis to investigate the dynamic effects of immigration. For simplicity, we restrict attention to temporary migration. In particular, we assume that, in each period, a mass $M_t \leq Q$ of adult workers is admitted into the country. Immigrants are required to return home at the end of the period.

Even if temporary, immigration may have relevant long run effects in our model. In fact, if the average human capital of immigrants is high relative to natives, then immigration of relatively skilled individuals will reduce the individual cost of education and stimulate human capital formation among natives, by reducing the threshold levels of ability that make schooling the preferred option. On the contrary, if the average human capital of immigrants is low relative to natives, immigration will reduce domestic average human capital with negative spillover effects on individual incentives for human capital accumulation.

In each period, given the fraction of skilled natives π_t (predetermined at time t), the domestic average level of human capital λ_t depends on the number of immigrants M_t and their selection $\widetilde{\pi}_t^*$. In particular, we have:

$$\lambda_t \equiv \frac{\left[\left(\varepsilon^s - \varepsilon^u\right)\pi_t + \varepsilon^u\right] N + \left[\left(1-z\right)\left(\varepsilon^{s*} - \varepsilon^{u*}\right)\widetilde{\pi}_t^* + \varepsilon^{u*}\right] M_t}{N + M_t} \tag{22}$$

As in the static case, $\widetilde{\pi}_t^*$ and M_t are determined in equilibrium along with the unit wage $W_t = W(L_t)$. The immigration quota Q will be binding whenever it is lower than the maximum inflow of immigrants compatible with equilibrium on the labor market $\overline{M}_t$. The dynamics of natives human capital with international migration is then determined by equation (21). Notice that $d\Pi/d\pi_t = \Gamma + b(d\lambda_t/d\pi_t)$ is certainly positive for $Q < \overline{M}_t$.[13]

Let us now consider the dynamic effects of a liberalization of labor flows (setting $Q > 0$). We will denote with T the time of liberalization and assume that at T the economy starts from the closed economy steady-state position (that is, $\pi_T = \pi^c$).

At the opening of borders, domestic labor supply increases ($L_T > L^c$), due to the inflow of immigrants, and the unit wage jumps down ($W_T < W^c$). Domestic average human capital λ_T will decrease (increase) relative to the closed economy steady-state level λ^c if and only if the average human capital of immigrants is low (high) relative to natives, that is if and only if:

$$\widetilde{\pi}_T^* < (>) \frac{\pi^c(\varepsilon^s - \varepsilon^u) + (\varepsilon^u - \varepsilon^{u*})}{(1-z)(\varepsilon^{s*} - \varepsilon^{u*})} \equiv \pi_T^*$$

[13] To ensure monotonicity, we will assume that this derivative is positive also for $Q \geq \overline{M}_t$. In fact, when the immigration quota is not binding, the number of immigrants decreases with π_t. In this case, it could happen that $d\lambda_t/d\pi_t < 0$ if the (indirect) negative effect of a decreasing number of immigrants dominates.

The dynamic evolution of the economy after T depends crucially on the equilibrium value of $\widetilde{\pi}_T^*$, which is determined by the level of the quota Q, given π^c.

To state our main regarding the dynamics of the model with immigration, we need one additional definition. Thus, let us define the wage level which is required for $\lambda_T = \lambda^c$as follows:

$$\overline{W} \equiv \frac{w^{s*} + P^s - (w^{u*} + P^u)A}{(1-z)\varepsilon^{s*} - (A-z)\varepsilon^{u*}}$$

where $A \equiv \pi_T^*(1-\pi^*)/\pi^*(1-\pi_T^*)$.[14] We can then write the following:

Proposition 5 *If and only if* $Q < \frac{L^d(\overline{W}) - L^c}{\left[\pi_T^*[(1-z)\varepsilon^{s*} + z\varepsilon^{u*}] + (1-\pi_T^*)\varepsilon^{u*}\right]}$, *the fraction of skilled natives converges to a steady-state level which is lower than the steady-state level in the closed economy.*

Proof. Consider equation 8. Setting $\widetilde{\pi}^* = \pi_T^*$, it yields $\theta^s/\theta^u = A$. Consider now equations 6 and 7. Substituting equation 7 into 6 and dividing by θ^u, we obtain $\theta^s/\theta^u = z + [zw^{u*} + zP^u + (1-z)W\varepsilon^{s*} - w^{s*} - P^s]/\theta^u$. Thus, for $\widetilde{\pi}_T^* = \pi_T^*$ we must have $\theta^u = [zw^{u*} + zP^u + (1-z)W\varepsilon^{s*} - w^{s*} - P^s]/(A-z)$. Taking again into account equation 7, we get $W = \frac{w^{s*}+P^s-(w^{u*}+P^u)A}{(1-z)\varepsilon^{s*}-(A-z)\varepsilon^{u*}} \equiv \overline{W}$. This is the level of wage that ensures that $\widetilde{\pi}_T^* = \pi_T^*$. To find the level of the quota that triggers this level of wage, we must solve the following equation (which represents the equation of the labor market equilibrium at time T):

$\{[\varepsilon^s\pi^c + \varepsilon^u(1-\pi^c)]N + [\pi_T^*[(1-z)\varepsilon^{s*} + z\varepsilon^{u*}] + (1-\pi_T^*)\varepsilon^{u*}]\, Q\} = [\overline{W}/(1-\eta)T^\eta]^{-\frac{1}{\eta}}$
which yields $Q = \frac{L^d(\overline{W}) - L^c}{\left[\pi_T^*[(1-z)\varepsilon^{s*} + z\varepsilon^{u*}] + (1-\pi_T^*)\varepsilon^{u*}\right]}$ where $L^d(\overline{W}) \equiv [\overline{W}/(1-\eta)T^\eta]^{-\frac{1}{\eta}}$.

$\Rightarrow$ If $Q < \frac{L^d(\overline{W}) - L^c}{\left[\pi_T^*[(1-z)\varepsilon^{s*} + z\varepsilon^{u*}] + (1-\pi_T^*)\varepsilon^{u*}\right]} \Rightarrow W_T > \overline{W} \Rightarrow \widetilde{\pi}_T^* < \pi_T^*$. Thus, $\lambda_T < \lambda^c$ and $\pi_{T+1} < \pi_T$.To clear the labor market at $T+1$, given Q, we must have $W_{T+1} > W_T \Rightarrow \widetilde{\pi}_{T+1}^* < \widetilde{\pi}_T^*$. Then, $\lambda_{T+1} < \lambda_T \Rightarrow \pi_{T+2} < \pi_{T+1}$ and so on. Recalling that by equation 21 $\Pi(0) > 0$ and $\Pi(1) < 1$, the dynamic path converges to a positive $\pi < \pi^c$ and $\widetilde{\pi}^* \in [\pi^*, \pi_T^*)$.

$\Leftarrow$ If $Q \geq \frac{L^d(\overline{W}) - L^c}{\left[\pi_T^*[(1-z)\varepsilon^{s*} + z\varepsilon^{u*}] + (1-\pi_T^*)\varepsilon^{u*}\right]} \Rightarrow W_T \leq \overline{W} \Rightarrow \widetilde{\pi}_T^* \geq \pi_T^*$. To clear the labor market at $T+1$, given Q, we must have $W_{T+1} \leq W_T \Rightarrow \widetilde{\pi}_{T+1}^* \geq \widetilde{\pi}_T^*$. Then, $\lambda_{T+1} \geq \lambda_T \Rightarrow$

[14] Our assumption that $W_s' < W_u'$ implies that $\pi_T^* > \pi^*$ and $\overline{W} > 0$. To make our analysis interesting, we assume that $\pi_T^* < 1$.

$\pi_{T+2} \geq \pi_{T+1}$ and so on. As we assumed that $d\Pi/d\pi_t > 0$ even when $Q \geq \overline{M}_t$, we can conclude that the economy converges to a $\pi \geq \pi^c$ and $\widetilde{\pi}^* \in [\pi_T^*, 1)$. ■

With international migration there are two possible steady states. In the first one, the steady-state fraction of skilled natives is lower than in the closed economy. The path toward the long-run equilibrium is characterized by decreasing π_t and $\widetilde{\pi}_t^*$. The wage rate jumps down at the time of liberalization of labor flows and increases in each subsequent period. The overall effect on the steady-state level of unit wage is ambiguous. On the one hand, the decrease in the fraction of skilled natives shifts labor supply to the left and consequently increase the wage rate relative to the closed economy. On the other hand, independently from their skills, the entry of foreign workers shifts labor supply to the right, thereby pushing the wage rate up.

In the second equilibrium, the steady-state fraction of skilled natives is higher than in the closed economy. The path toward this equilibrium is characterized by increasing π_t and $\widetilde{\pi}_t^*$. The wage rate jumps down at the time of liberalization of labor flows and decreases in each subsequent period. The steady-state unit wage is lower than in the closed economy.

Whether the economy ends up in the first or in the second type of equilibrium depends on the level of the immigration quota which in turn affects the average human capital λ right after the opening of borders.

When the quota is low, the wage rate after liberalization is high and the quality of immigrants is low. Thus, the initial effect on λ will be negative, the next period proportion of skilled national workers will be lower and the wage rate higher, further reducing the proportion of skilled immigrants. In turn this will decrease λ and so on. If the quota is sufficiently high, the effect on λ is positive, the opposite will happen and the equilibrium will be of the second type.

3.4 Policy implications

As we know, immigration increases welfare in the short run, as labor supply and national income increase due to the intial inflow of immigrants. However, if the immigration policy is too restrictive, human capital accumulation is reduced in the host country. The implied reduction in labor supply by natives may outweigh the positive effect of immigration on aggregate labor supply with negative *long-run* effects on the welfare of natives.

More specifically, when $Q < \frac{L^d(\overline{W})-L^c}{\left[\pi_T^*[(1-z)\varepsilon^{s*}+z\varepsilon^{u*}]+(1-\pi_T^*)\varepsilon^{u*}\right]}$ and the wage rate reaches a level higher than W^c, immigration lowers national income in the long-run. In this case, the steady-state equilibrium of the closed economy is Pareto superior (given an appropriate redistribution) relative to the equilibrium with immigration.

However, as the last proposition suggests, the trade-off between short-run and long-run welfare consequences can be avoided by setting $Q > L^d(\overline{W}) - L^c$. In this case, national income increases in the long run with immigration. We can strengthen this result by showing that there exists a level of the quota such that in the open economy welfare is maximized *in each period.* In particular, we can write:

Proposition 6 *National income is maximized in each period if and only if* $Q \geq \overline{M}_T$

Proof. *As* $\overline{M}_t \leq \overline{M}_T \quad \forall t \geq T$, $W_t = W_s' \quad \forall t \Rightarrow \widetilde{\pi}_t^* = 1$ *and* $M_t = \overline{M}_t \quad \forall t$. *Thus,* $\forall t \geq T$, λ_t *is maximized; hence* π_t *is also maximized and so is aggregate labor supply. By equation (13) national income is also maximized* ■

Setting $Q \geq \overline{M}_T$ drives the wage down to the level W_s' in each period. Thus, only skilled immigrants enter and, at each point in time, their number is the maximum compatible with the equilibrium on the labor market.

4 Conclusions

In this work we provided a formal investigation of the economic consequences of international migration from the point of view of destination countries, assuming that migration costs are higher for the less-educated. Consistently with international evidence on migration flows, this implies that the migration rate is higher among the highly-educated. In this framework, we showed that there exists a negative relation between the domestic wage level and the percentage of educated workers among immigrants in equilibrium, yielding interesting policy implications regarding the effects of quantitative restrictions on immigration on natives' welfare and human capital accumulation.

In particular, we showed that the optimal immigration policy from the point of view of natives requires an immigration quota above a certain minimum level. This policy drives down the domestic wage and results in high labor demand and positive selection of immigrants. In turn, this determines a substantial brain gain through the inflow of highly-educated individuals with positive consequences on national income and welfare and significant dynamic effects in terms of higher human capital accumulation among natives.

Our analysis may be extended along several dimensions. On the one hand, dropping perfect substitutability of skilled and unskilled labor in production, we may study the influence of migration on the skill premium and on the return to investment in education. Another fruitful extension may explore the political economy of migration in a dynamic perspective. We leave these extensions for our future research.

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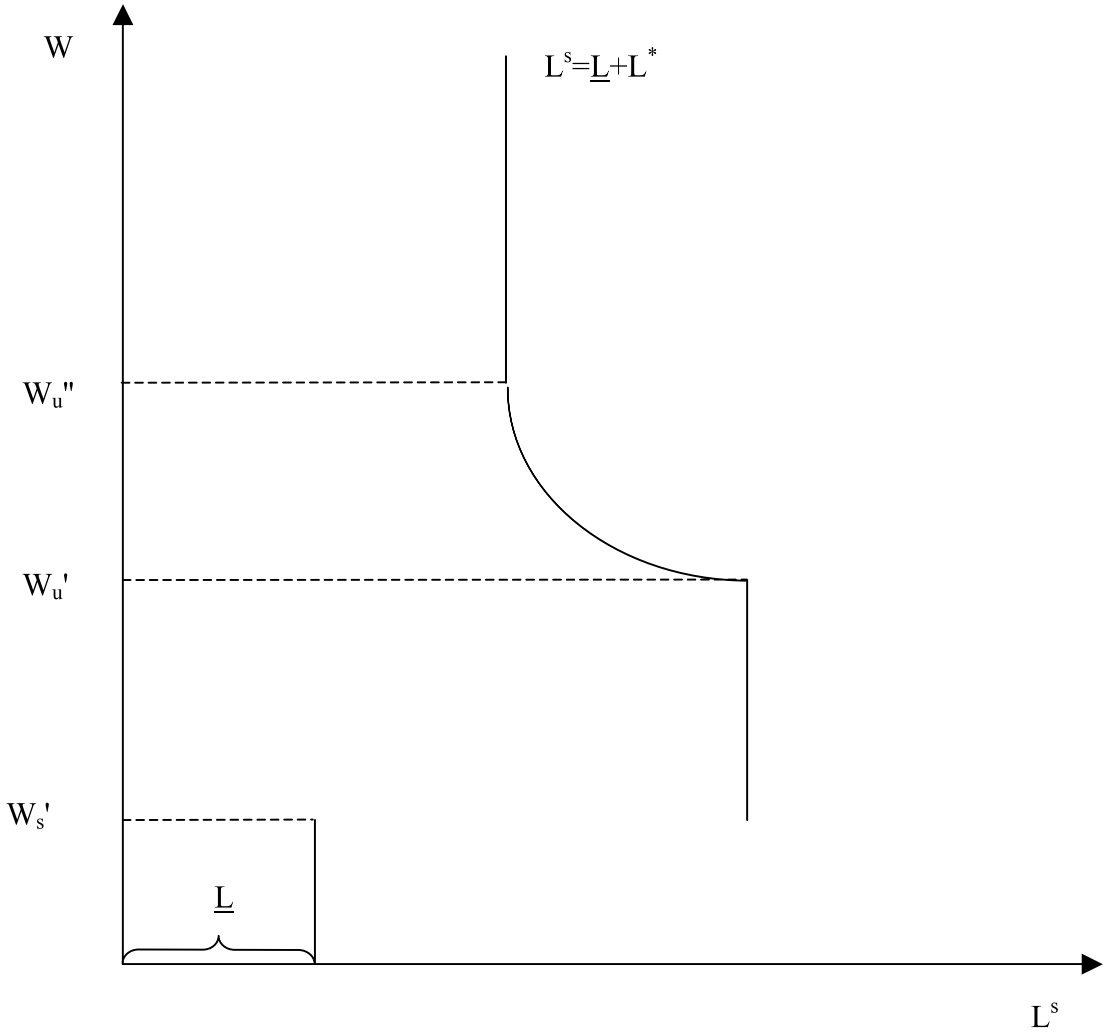

Figure 1: Labor supply