Global competition for attracting talents and the world economy*

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Abstract

In this paper, we develop a micro-founded model of the education-migration nexus, and use it to predict the effect of a worldwide liberalization of high-skilled migration. The model is parametrized to fit migration, education, population and income data. It also matches the empirically estimated levels of the elasticity of migration to income and the average elasticity of college-education investment to high-skilled emigration prospects. Our results show that English-speaking, industrialized countries would benefit from increasing the competition for attracting talents. Europe would see its average income gap with the US increase. Despite its positive effect on education, globalizing the market for talents is a zero-sum game: it would drastically hurt developing countries and increase inequality in the world distribution of income.

Keywords: brain drain, human capital, migration policy, growth.


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1 Introduction

Two salient features of international labor mobility are that high-skilled people exhibit much greater propensity to emigrate than the less educated, and tend to agglomerate in countries with high rewards to skill (Grogger and Hanson, 2011; Docquier and Rapoport, 2013). Positive selection is partly due to self-selection mechanisms (high-skilled people being more responsive to economic opportunities and political conditions abroad, having more transferable skills, having greater ability to gather information or finance emigration costs, etc.) but obviously, it is also due to skill-selective immigration policies conducted in the major destination countries.

The global competition to attract talents is tough because inflows of high-skilled workers make immigration not only more economically advantageous, but also politically acceptable in destination countries (see Boeri et al. 2012). The reasons are that the high-skilled bring valuable knowledge which is key to stimulate productivity levels and growth (Peri et al. 2013), do not compete with nationals in their access to the welfare state and other public services, integrate faster in the labor market, and assimilate better in the society. So far, the US has been leading the race, attracting PhD candidates and graduates not only from emerging countries, but also from the European Union and other industrialized countries. The European high-skilled emigration rate was around 9 percent in 2000; this is much greater than Japan (1.2 percent) or the US (0.5 percent). Hitherto, Europe has been the land of missed opportunity, unable to attract talents from emerging countries and retain its brains.

There are good reasons to believe that the race to attract talents will get tougher in the coming decades. Intensification will be due to skill-biased technical changes and growing specialization of developed countries in skill-intensive activities, short supply of knowledge and entrepreneurial skills (translating into greater returns to skill and income inequality), ageing and the resulting pressure on the welfare states. A growing number of countries have already adopted immigration policies specifically aimed at selecting and attracting skilled workers (see Boeri et al. 2012). Examples are the recent introduction of a points-based system in the UK (the Swiss, Dutch and German governments are considering the same option), the new immigration act of 2005 in Germany, the adoption of the EU blue card and the increase in the number of H1B visas in the US. Are these policy measures the best to activate? Who will benefit from an increased global competition to attract talents? How will it impact the supply of human capital worldwide and its distribution? What will be the short-run and long-run impacts of such policy reforms on the world economy? These are the questions addressed in this paper.

Recent literature has greatly enhanced our knowledge of the determinants of international migration and their consequences for sending and receiving countries. Taking advantage of richer databases, the empirical literature has identified the determinants of skill-selection and provided consensual micro-foundations for pseudo-gravity analy-
sis of bilateral migration.\textsuperscript{1} In parallel, new theoretical models have emphasized the close links between skill-biased emigration prospects and education decisions.\textsuperscript{2} Empirical studies have confirmed the existence of such a relationship relying on various identification strategies. In this paper, we combine insights from the existing literature and provide a solid micro-foundation for the education-migration nexus, parametrize this micro-founded model on the world economy, and quantify the effects of various liberalization shocks on labor mobility, human capital accumulation and the world distribution of income.

Our theoretical model shows that emigration prospects and education decisions are governed by the same variables. We demonstrate that emigration-driven utility shocks induce a positive association between human capital formation and the high-skilled emigration rate (or the ratio of high-skilled to low-skilled emigration rates). Then, we parametrize the model to perfectly fit migration, education and income data, and to match the empirically estimated levels of the elasticity of migration to income and the average elasticity of college-education investment to high-skilled emigration prospects. Our results show that English-speaking industrialized countries would benefit from increasing the competition for attracting talents. Europe and developing countries are likely to be the real losers. In case of a worldwide liberalization of high-skilled migration, the average income gap between the EU15 and the US could increase by 11 percent. Despite its positive effect on education, globalizing the market for talents would drastically hurt developing countries, reducing their average income per capita by 24 percent. Contrary to a non-selective policy, a skill-selective worldwide liberalization is a zero-sum game which drastically increases inequality in the world distribution of income.

The rest of the paper is organized as following. Section 2 reviews the literature on migrant selection and human capital formation. The micro-foundation of this relationship is provided in Section 3. In Section 4, we parametrize a world economy model and discuss the effects of various liberalization experiments. Finally, Section 5 concludes.

\section{Education-Migration nexus}

By changing expectations about future migration opportunities, the increased competition for attracting talents affects returns to schooling and education decisions in the world. This link between emigration prospects and human capital formation has been identified in the recent literature. Identification strategies rely on survey data on the student population, regional heterogeneity in emigration and education patterns, quasi-natural emigration shocks, or cross-country regressions. All these studies con-
cur that education decisions are closely connected with the intensity of skill-selection in emigration.

*Education and intention to emigrate.* In their survey on Tonga and Papua New Guinea’s “best and brightest”, Gibson and McKenzie (2011) show that nearly all the very top high-school students (85%) contemplated emigration while still in high school, which led them to take additional classes (e.g. during school vacations or supplementary English classes) and make changes to their course choices (favoring disciplines such as science and commerce). According to Gibson and McKenzie, these substantial brain gain effects combined with high return rates explain the largely positive effects of migration in terms of net human capital formation.

Kangasniemi et al. (2007) use a survey of medical doctors in the UK and study whether migration prospects affected their own education decisions and whether they believe they affected migration by current students. On average, about 37 percent of doctors from low-income countries declare that the prospect to work abroad influenced their own effort to put into studies and the choice of a field of specialty. In addition, 46 percent of the same doctors estimate that emigration prospects are influencing the effort to put into studies of current students.

*Regional heterogeneity.* Batista, Lacuesta and Vicente (2012) use micro data to model the simultaneous decisions of educational attainment and own migration prospects in Cape Verde. To identify the effect of own migration prospects on education, they use as instruments the full history of migration in the household and the proportion of migrants in the region. They show that the brain drain is responsible for the bulk of human capital formation in the country, and has a net positive effect on human capital accumulation.

On the contrary, McKenzie and Rapoport (2011) study the impact of emigration on educational attainment in rural Mexico and find evidence of a significant negative effect of migration on schooling attendance and attainment of 12 to 18 year-old boys and 16 to 18 year-old girls. They use historical migration rates by state as instruments for current family migration. The same global negative outcome is found in China (see Ha, Yi and Zhang, 2009). On average, migration between Chinese provinces exhibits negative selection, as in the case of Mexican emigration. This shows that negative skill-selection is associated with lower education investments.

*Quasi-natural experiments.* Chand and Clemens (2008) compare the educational investment of ethnic Fijians with that of Fijians of Indian ancestry in the aftermath of the 1987 military coup (which resulted in physical violence and discriminative policies against the Indian minority). The coup sparked massive emigration among highly skilled Indo-Fijians, and led them to invest heavily in higher education in order to “clear the bar” raised by the Australian (and New Zealand) point system. While the political situation has stabilized since the mid-1990s, the Indian minority which remains in Fiji is now significantly more migratory and more educated than

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3 And 29 percent of doctors from middle-income countries.
4 And 41 percent of doctors from middle-income countries.
comparable ethnic Fijians, which was not the case prior to the military coup. The authors interpret this as quasi-experimental evidence on the brain gain channel.

Shrestha (2013) investigates another quasi-natural experiment. In 1993, the British army changed the education requirement for its Nepali recruits, unexpectedly imposing a minimum of education. For historical reasons, the main supplier of recruits is the Gurkhan ethnic group, and recruited soldiers earn on average 70 times more over their lifetime than those left behind. The rule change is expected to affect education of Nepali men of Gurkhan ethnicity. Using a set of difference-in-difference and synthetic control techniques, Shrestha (2013) shows that the rule change increased education of Gurkhan emigrants and, more interestingly, of Gurkhan men left behind.

Vasilakis (2013) uses detailed data on the mobility of talented players in football to quantify the effect of an important policy change in 1995 on players' migration decisions, European leagues' and national teams' performance. The 1995 Bosman rule can be assimilated to a liberalization shock inducing (i) an elimination of transfer fees which forced the small clubs to compete for players with big clubs having enormous budgets, and (ii) a relaxation of constraints on the number of extra-EU players in EU leagues. This shock was unexpected and is a great source of identification of the causal impact of migration policies. Using panel regressions, Vasilakis (2013) shows that the Bosman rule increased the scale of bilateral migration and the sensitivity of migration to the quality of European leagues. He shows that the relaxation of quotas on non-EU players stimulated training and production of talents in Africa and Latin America (except Brazil and Argentina, two traditional football nations).

Cross-country evidence. The average responsiveness of human capital formation to emigration prospects has also been empirically studied using cross-country data. The "macro" literature has implicitly adopted a myopic view of expectations, where the empirical counterpart of the "migration prospect" variable is simply the high-skill emigration rate, or the differential emigration propensity between high- and low-skill workers observed in previous periods. Beine et al. (2008) measure pre-migration human capital as the proportion of college graduates among native adults (all adults born in the country, wherever they live). They regress the log variation in human capital between 1990 and 2000 on the initial 1990 level (in logs) and the emigration rate of college graduates. They obtain a short-run elasticity of human capital formation to high-skill emigration around .05, and a long-run elasticity around .20 in a cross-section of 127 developing countries.5

Identification is always disputable in such cross-sectional regressions, due to reverse causality and omitted variables. To address this issue, Beine et al. (2008) use two sets of instrument variables (population size and networks, racial tensions). Similar qualitative results are obtained in Docquier, Faye and Pestieau (2008) or Easterly

5 Similar results are obtained using alternative brain drain estimates (controlling for whether migrants acquired their skills in the home or the host country), alternative definitions of human capital (e.g., school enrollment, youth literacy), alternative functional forms, or using the log of the skill-ratio of emigration rates (Beine, Docquier and Rapoport, 2010).
and Nyarko (2009) using other sets of instruments, and in Beine et al. (2011) using panel regressions with fixed effects.

3 Theory

To establish the micro-foundation of the education-migration nexus, we develop a dynamic, multi-country model with endogenous emigration and education decisions. Our model uses the following notations. The number of working-age natives from country $k$ ($k = 1, ..., K$) at time $t$ is denoted by $N_{k,t}$, which divides into $N_{k,t}^h$ college graduates and $N_{k,t}^l$ less educated. The proportion of college graduates in the native population equals $H_{k,t} = N_{k,t}^h / (N_{k,t}^h + N_{k,t}^l)$. Each native decides whether to emigrate or not; $N_{s_{j,t}}^k (s = h, l)$ denotes the number of emigrants from $k$ to $j$. After migration, the resident labor force of type $s$ is given by $L_{s_{k,t}}^k = \sum_i N_{i,k,t}^s$, and $h_{k,t} = L_{h_{k,t}}^k / (L_{h_{k,t}}^h + L_{l_{k,t}}^l)$ denotes the proportion of college graduates among residents. The skill-specific proportion of emigrants from country $k$ is denoted by $p_{s_{k,t}}^k = \sum_{i \neq k} N_{i,k,t}^s / N_{k,t}^s$. Our goal is to establish the micro-foundation of the link between emigration rates ($p_{k,t}$) and pre-migration human capital formation ($H_{k,t}$).

We want our model to be compatible with some salient stylized facts:

1. Macrodata show large cross-sectional variations in the proportion of college graduates ($H_{k,t}$) and strong persistence over time in each country;

2. An endogenous share of high-skill and low-skill individuals decides to emigrate to another country but all emigrants do not choose the same destination. Some migration corridors are empty while other corridors exhibit bidirectional migration flows;

3. Investment in college education is done under uncertainty about the future place of work: expectations about the size and structure of migration (i.e. emigration prospects) matter for education (Gibson and McKenzie, 2011; Kangasniemi et al., 2007).

In line with Delogu et al. 2013, we assume that college-educated residents have $n_{k,t}^h$ children who are all provided with basic education ($q_{k,t}^h = 1$), whereas low-skilled residents have $n_{k,t}^l > 1$ children and provide basic education to a fraction $q_{k,t}^l \leq 1$ of them. The average fertility rate and proportion of children receiving basic education are given by

\begin{align}
    n_{k,t} &\equiv h_{k,t} n_{k,t}^h + (1 - h_{k,t}) n_{k,t}^l, \\
    q_{k,t} &\equiv \frac{h_{k,t} n_{k,t}^h + q_{k,t}^l (1 - h_{k,t}) n_{k,t}^l}{n_{k,t}},
\end{align}
Combining (1) and (2), we have \( \frac{\partial q_{k,t}}{\partial h_{k,t}} = \frac{(1-q_{k,t})m^h_{k,t} n_{k,t}^h}{n^2_{k,t}} \geq 0 \). Basic education is a prerequisite for investing in college, but not all eligible individuals find it optimal to acquire higher education: if a fraction \( \pi_{k,t} \) of eligible young adults find it optimal to invest in college, we have \( H_{k,t} \equiv q_{k,t}-1 \pi_{k,t} \). Variables \( \pi_{k,t} \) and \( q_{k,t} \) are endogenous and substantially vary across countries, in line with the first stylized fact above.

To endogenize \( \pi_{k,t} \) and \( p^s_{k,t} \), we consider a random utility model with two sources of heterogeneity. Working-age individuals have heterogeneous abilities to acquire higher education, and heterogeneous preferences over destination countries. We assume the following logarithmic utility function:

\[
U^s_{k,i,t} = \ln v^s_{k,i,t} + \ln(1 - c^s_{k,i,t}) + \ln(1 - \tilde{e}^s_{ki}) + \tilde{\varepsilon}^s_{ki} \tag{3}
\]

where \( \ln v^s_{i,t} \in \mathbb{R} \) is the deterministic level of utility that can be reached in the location \( i \), \( c^s_{k,i,t} \in [0, 1] \) is the total effort required to emigrate from \( k \) to \( i \) (such that \( c^s_{k,k,t} = 0 \)), \( \tilde{e}^s_{k} \in [0, 1] \) is the individual-specific effort required to acquire college education, and \( \tilde{\varepsilon}^s_{ki} \in \mathbb{R} \) is the individual-specific random taste for migrating from \( k \) to \( i \). Variables with a tilde are the sources of heterogeneity across individuals.

As standard in the migration literature, we assume that the random component of utility \( \tilde{\varepsilon}^s_{ki} \) follows a Type I-Extreme Value distribution (also known as the double-exponential distribution) with a scale parameter \( \mu > 0 \). As far as the education cost is concerned, we assume that \( (e^e_{k,t}, e^e_{h,k}) = (0, 1) \) for individuals who did not receive basic education. For those who received basic education, we have \( e^e_{k,t} = 0 \) and assume that the monotonic and increasing transformation of the education effort, \( \tilde{e}^h_{k} \equiv (1 - \tilde{e}^h_{k})^{-1} \in [0, \infty] \), follows a Pareto distribution. The country-specific CDF is given by \( G_k(\tau) = 1 - \left( \frac{\tau}{\tau_k} \right)^\alpha \) where \( \tau_k > 0 \) is the lower bound of the distribution of effort in country \( k \) and \( \alpha > 0 \) determines the slope of the CDF. Parameter \( \tau_k \) is country-specific and reflects access to higher education; it is likely to be large in poor countries with low urbanization rates and low levels of public spending for college education.

The timing of decisions is the following:

- First, individuals who received basic education discover their education type \( (\tilde{e}^s_{k,t}) \). They do not know their migration type \( (\tilde{\varepsilon}^s_{ik,t}) \) but know its distribution. Given their expectations about \( v^s_{i,t} \) and \( c^s_{k,i,t} \), they decide whether to acquire higher education or not.
- Second, they discover their migration type \( (\tilde{\varepsilon}^s_{ik,t}) \) and decide whether to emigrate or to stay in the home country.

In the first stage, individuals acquire higher education if the expected utility gain from being college educated exceeds the effort cost. Under the Type I Extreme Value distribution, de Palma and Kilani (2007) derived the expression for the ex-ante
expected utility. Using their theorem, the expected utility of choosing type $s$ is given by

$$ E(U_{ki,t}^s) = E \left[ \ln v_{i,t}^s + \ln(1 - c_{ki,t}^s) + \ln(1 - e_{k,t}^s) \right] + \ln(1 - e_{k,t}^s) $$

$$ = \ln \sum_{i=1}^I e^{I^s_i \ln v_{i,t}^s + \ln(1 - c_{ki,t}^s) + \ln(1 - e_{k,t}^s)} + \ln(1 - e_{k,t}^s) $$

Investing in college education is optimal if $E(U_{ki,t}^h) > E(U_{ki,t}^l)$, i.e.

$$ \tau_{k,t}^e \leq \frac{\sum_{i=1}^I (v_{i,t}^h)^{1/\mu} (1 - c_{ki,t}^h)^{1/\mu}}{\sum_{i=1}^I (v_{i,t}^l)^{1/\mu} (1 - c_{ki,t}^l)^{1/\mu}} \equiv \frac{(v_{k,t}^h)^{1/\mu} + (V_{k,t}^h)^{1/\mu}}{(v_{k,t}^l)^{1/\mu} + (V_{k,t}^l)^{1/\mu}} $$

(4)

where $v_{k,t}^s$ determines the component of expected utility explained by the home country characteristics, and $(V_{k,t}^s)^{1/\mu} \equiv \sum_{i \neq k} (v_{i,t}^s)^{1/\mu} (1 - c_{ki,t}^s)^{1/\mu}$ is the component related to emigration prospects. The effect of emigration prospects is large if the levels of $V_{k,t}^s/v_{k,t}^s$ are large. This is the case if the origin country is poor and if emigration costs are small.

In a closed economy framework ($c_{ki,t}^s = 1 \forall s, i \neq k$), the critical level of effort below which college education is beneficial is determined locally ($\tau_{k,t}^e = (v_{k,t}^h/v_{k,t}^l)^{1/\mu}$). In an open economy (i.e. when $V_{k,t}^s > 0$), the expected return to education is clearly affected by emigration prospects:

**Lemma 1** Emigration prospects increase incentives to acquire higher education if $V_{k,t}^h/V_{k,t}^l > v_{k,t}^h/v_{k,t}^l$

**Proof.** Under this condition, we have $\frac{(v_{k,t}^h)^{1/\mu} + (V_{k,t}^h)^{1/\mu}}{(v_{k,t}^l)^{1/\mu} + (V_{k,t}^l)^{1/\mu}} > \frac{(v_{k,t}^h)^{1/\mu}}{(v_{k,t}^l)^{1/\mu}}$.

Lemma 1 can be used to explain the empirical findings described in Section 2. The skill structure of emigration costs is a key determinant of $V_{k,t}^h/V_{k,t}^l$; because of skill-selective immigration policies and the greater ability of educated workers to gather information about destination countries, many migration corridors are such that $c_{ki,t}^h < c_{ki,t}^l$ and exhibit positive selection. There are shocks reinforcing the effect of emigration prospects on education. When the British army decided to impose a minimum of education to its recruits, $V_{k,t}^h/V_{k,t}^l$ increased for the Gurhans; after the 1987 coup d’etat in Fiji, discriminative policies against the Indian minority decreased $v_{k,t}^h/v_{k,t}^l$. In general, macroeconomic evidence surveyed in the previous section shows that human capital formation is positively associated with the ratio of high-skill to low-skill emigration rates. In Cape Verde, skill-biased emigration prospects stimulate education in islands/households with lower emigration costs; and higher education decisions are clearly affected by the skill-selective immigration policies conducted in Australia and New Zealand. On the contrary, in the case of Mexico-to-US migration...
or rural-to-urban migration in China, there is no positive selection and the condition in Lemma 1 does not hold.

Using (4) and the Pareto distribution, we can determine the proportion of college graduates among native adults:

\[ H_{k,t} \equiv q_{k,t-1} \pi_{k,t} = q_{k,t-1} \left[ 1 - \left( \frac{(v_{k,t}^l)^{1/\mu} + (V_{k,t}^{h})^{1/\mu}}{(v_{k,t}^h)^{1/\mu} + (V_{k,t}^{h})^{1/\mu}} \right)^\alpha \right] \quad (5) \]

This gives the following result:

**Lemma 2** The average responsiveness of investment in college education to skill-biased emigration prospects depends on past education levels (determining \( q_{k,t-1} \)) and access to higher education (determining \( \pi_k \)).

**Proof.** We have \( \frac{\partial H_{k,t}}{\partial q_{k,t-1}} > 0 \) and \( \frac{\partial H_{k,t}}{\partial \pi_k} < 0 \). Hence, the effect of emigration prospects on the proportion of college graduates varies across nations with the lagged enrollment rate in secondary education and with the determinants of \( \pi_k \), i.e. development level, urbanization rate, public spending on tertiary education, etc. Given (2), the enrollment rate in basic education depends on the lagged proportion of college graduates; this explains the strong persistence in human capital data (in line with the first stylized fact) and implies that a shock in emigration prospects induces gradual changes in human capital.

In the second stage, education is determined and individuals choose to emigrate to country \( i \) if \( \ln v_{i,t}^s + \ln(1 - c_{k,t}) + \bar{\epsilon}_{ki}^s \) exceeds the level attainable in any other location. Under the Type I Extreme Value distribution, McFadden (1984) showed that the probability to emigrate is governed by a logit expression. The emigration rate and emigrant-to-stayer ratio are given by:

\[ \frac{N_{kj,t}^s}{N_{k,t}^s} = \frac{e^{[\ln v_{j,t}^s + \ln(1 - c_{k,t})]/\mu}}{\sum_{i=1}^I e^{[\ln v_{i,t}^s + \ln(1 - c_{k,t})]/\mu}} = \left( \frac{v_{j,t}^s}{v_{k,t}^s} \right)^{1/\mu} (1 - c_{k,t}^s)^{1/\mu} \]

\[ \frac{N_{kj,t}^s}{N_{k,t}^s} = \frac{e^{[\ln v_{j,t}^s + \ln(1 - c_{k,t})]/\mu}}{e^{[\ln v_{k,t}^s]/\mu}} = \left( \frac{v_{j,t}^s}{v_{k,t}^s} \right)^{1/\mu} (1 - c_{k,t}^s)^{1/\mu} \quad (6) \]

In line with the second stylized fact above, these expressions show that emigration rates are endogenous and comprised between 0 and 1; heterogeneity in migration tastes implies that emigrants select all destinations such that \( c_{k,t}^s < 1 \) (if \( c_{k,t}^s = 1 \), the corridor is empty), and all corridors such that \( c_{j,t}^s, c_{k,t}^s < 1 \) exhibit bidirectional migration flows.
In addition, the aggregate emigration rate \( p_{k,t}^s \) and the ratio of emigration rates \( \rho_{k,t} \) from country \( k \) are given by the following expressions:

\[
\begin{align*}
p_{k,t}^s & = \sum_{i \neq k} \frac{N_{k,i}^s}{N_{k,t}^s} = \frac{(V_{k,t}^s)^{1/\mu}}{(v_{k,t}^s)^{1/\mu} + (V_{k,t}^s)^{1/\mu}} \\
\rho_{k,t} & = \frac{p_{k,t}^h}{p_{k,t}^l} = \frac{(V_{k,t}^h)^{1/\mu}}{(V_{k,t}^l)^{1/\mu}} \left[ \frac{(v_{k,t}^h)^{1/\mu} + (V_{k,t}^h)^{1/\mu}}{(v_{k,t}^l)^{1/\mu} + (V_{k,t}^l)^{1/\mu}} \right]^{-1}
\end{align*}
\]

The ratio of emigration rates increases with \( V_{k,t}^h \) and decreases with \( V_{k,t}^l \). We thus have:

**Proposition 1** Emigration-driven expected utility shocks \( \Delta V_{k,t}^s \) induce a positive correlation between human capital formation \( (H_{k,t}) \) and the ratio of emigration rates \( (\rho_{k,t}) \). Local expected utility shocks \( \Delta v_{k,t}^s \) induce a negative correlation between \( H_{k,t} \) and \( \rho_{k,t} \).

**Proof.** From (5) and (7), we have 
\[
\text{sgn} \left( \frac{\partial H_{k,t}}{\partial V_{k,t}^s} \right) = \text{sgn} \left( \frac{\partial \rho_{k,t}}{\partial V_{k,t}^s} \right) \text{ and } \text{sgn} \left( \frac{\partial H_{k,t}}{\partial v_{k,t}^s} \right) \neq \text{sgn} \left( \frac{\partial \rho_{k,t}}{\partial v_{k,t}^s} \right)
\]

In particular, shocks increasing the expected utility of college graduates abroad (e.g., greater skill selection in the major destination countries) have a positive effect of \( H_{k,t} \) and \( \rho_{k,t} \). Shocks increasing the expected utility of the less educated abroad have a negative effect on both variables, in line with the third stylized fact above.

### 4 Numerical experiments

In this section, we develop and parametrize a world economy version of the aforementioned model and simulate the effect of skill-selective liberalization shocks. Section 4.1 describes the identification of skill-specific levels of utility in each country \( v_{k,t}^s \) and migration costs between all country pairs \( c_{kj,t} \). The model is calibrated on the year 2000 and therefore does not account for the emergence of some developing countries and the effect of the recent economic crisis. In Section 4.2, we consider three skill-selective liberalization reforms (conducted in the 15 member states of the European Union (EU15), in the United States, or in the global economy) and quantify their effect on the skill structure of the labor force in industrialized countries. Assuming that the global competition for attracting talents leads to a total liberalization of high-skilled immigration in all the countries, we investigate the effect on the ranking of GDP per capita in Section 4.3. Section 4.4 presents the effect on human capital accumulation in developing countries. Finally, Section 4.5 discusses the effect on the world distribution of income.
4.1 Parametrization

The model is calibrated on the year 2000 and the horizon of our simulations is 2075 (one period represents 25 years). First, we use cross-country data on the skill structure of the labor force (Artuc et al., 2013), GDP per capita (Penn World Tables) and returns to schooling (Hendricks, 2004). In all the countries, skill-specific wage rates are calibrated to perfectly match data on GDP and returns to schooling in the year 2000. For subsequent years, we assume that the wage rates are growing at the same rate in all the countries (1.5 percent per year).

Second, we calibrate \( v_{k,t}^s \) following Delogu et al. (2013). We consider that \( v_{k,t}^s \) is a Cobb-Douglas function of consumption \( (c_{s,i}^s) \), fertility \( (n_{s,i}^s) \) and the proportion of children receiving basic (primary and secondary) education \( (q_{s,i}^s) \), i.e. \( \ln v_{k,t}^s = (1 - \theta) \ln c_{k,t}^s + \theta \ln n_{k,t}^s + \theta \lambda \ln q_{k,t}^s \) with \( (\theta, \lambda) = (.3,.6) \) in line with the existing quantitative literature on fertility and education. This function is maximized subject to a budget constraint and \( q_{k,t}^s \leq 1 \) so that a fraction \( (1 - \theta) \) of the full-time equivalent wage rate is devoted to consumption: We thus have

\[
\ln v_{k,t}^s = 0.7 \ln w_{k,t}^s + \ln C_{k,t}^s \tag{8}
\]

where \( \ln C_{k,t}^s \) depends on fertility and basic education decisions.

Under the identifying assumptions that \( n_{h,k,t}^b = q_{h,k,t}^b = 1 \), we calibrate \( n_{t-1}^l \) and \( q_{t-1}^l \) to perfectly match the average fertility rate \( (n_{k,t}) \) and proportion of natives with secondary education \( (q_{k,t}) \) in the year 2000. This determines \( \ln C_{k,t}^s \) in (8). For subsequent years, \( n_{k,t}^l \) and \( q_{k,t}^l \) are adjusted to match the UN population labor force projections.

Third, we identify the migration technology. Bertoli, Fernandez-Huertas Moreaga and Ortega (2013) found an elasticity of bilateral migration to the wage ratio \( (w_{j,t}^s/w_{k,t}^s) \) between 0.6 and 0.7. Plugging (8) into (6), the elasticity in our model equals 0.7/\( \mu \). By choosing \( \mu = 1 \), the responsiveness of migration to wage disparities is in line with the empirical literature. We then use the comprehensive matrices of bilateral migration described in Artuc et al. (2013). We identify \( (1 - c_{k,j,t}^s) \) as a residual of (6). Hence, our calibration strategy perfectly fits migration data.

In the benchmark trajectory of the world economy, we assume that migration costs are constant. Migration costs sum up the legal costs incurred to obtain a visa and the private costs incurred by migrants to assimilate in the destination country. As in Docquier et al. (2012), we use the Gallup World Poll data on desired migration to identify the magnitude of private costs \( (c_{s,j,t}^s) \). Again, we identify \( (1 - c_{k,j,t}^s) \) as a

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\[ \text{Note:} \] Delogu et al. (2013) provide a fully micro-founded model in which \( n_{k,j}^s \) and \( q_{k,t}^s \) are chosen to maximize utility. The optimal levels of \( n_{k,t}^s \) and \( q_{k,t}^s \) depend on the skill premium, education cost as percentage of high-skilled wages, and children’s wage rate as percentage of low-skilled wages. Assuming these determinants are exogenous is equivalent to assuming exogenous fertility rates and basic education investments.

\[ \text{Note:} \] Bilateral migration stocks \( (N_{k,j,t}^s) \) are available for all country pairs and for college graduates and the less educated.

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residual of (6) after adding the skill-specific numbers of individuals who express a desire to emigrate to the effective migration stocks. A skill-selective liberalization of immigration to country $j$ means that $c^h_{kj,t}$ is decreased to $c^h_{kj,t}$ for all $k$.

Fourth, decisions about higher education are governed by the Pareto distribution of education costs. Parameter $\tau_k > 0$, the lower bound of the distribution, is allowed to vary across countries, and $\alpha > 0$ is assumed to be common to all countries. For a given $\tau$, $\tau_k$ is calibrated so as to match the proportion of college graduates in the labor force of country $k$ in 2000. We iterate on $\alpha$ to match the elasticity found in the empirical literature on brain drain and human capital formation. To conduct this iterative exercise, we simulate a liberalization of high-skilled migration for all country pairs and select $\alpha$ to have an average long-run elasticity of the pre-migration proportion of college graduates $(H_{k,t})$ to the high-skilled emigration rate $(p^h_{k,t})$ equal to .20 in developing countries, as in Beine et al. (2008). This requires $\alpha = .1$. The model can now be used to simulate the effect of immigration policy reforms.

4.2 The race for attracting talents

It is not obvious that migration policy is the best policy instrument to activate in the race of talents. Economic incentives (skill premium, economic freedom, political rights, taxation and social contributions, etc.) and private migration costs (linguistic barriers, xenophobia in the destination country, discrimination practices, etc.) are also governing the size and skill structure of migration flows. For example, the Schröder government adopted a new immigration act in 2005 targeting scientists, teaching personnel, managers and specialists. Candidates are entitled to permanent residence permits. Only 466 residence permits were granted on this basis, and only 155 of these permits were granted to newcomers (see Boeri et al. 2012). The German green card launched a few years before was also a failure.

Our model can be used to quantify the effect of an increasing race for attracting talents and identify the winners and losers (i.e. countries with high or low capacity to attract talents). We simulate three skill-selective liberalization reforms, considering the reform is conducted in the EU15, in the USA, or in the whole world economy. In each case, the reform is equivalent to the adoption of a simple points-based system in which all individuals having at least one year of college and desiring to emigrate are granted a permanent residence permit. Table 1 shows the impact of these reforms on the proportion of college graduates in the countries involved. Our analysis assumes exogenous wages (partial equilibrium).

Liberalizing high-skilled immigration only to the EU15 is obviously good for Europe. The proportion of immigrants increases by 5 percentage points (henceforth p.p.). On average, it increases the proportion of college graduates by 4.7 p.p. in the short-run (column SR), and by 7.7 p.p. in the long-run (column LR). The most attractive countries are the United Kingdom, Ireland, Belgium and Sweden. The lowest effects are obtained for Finland, Greece, Italy and Portugal. In line with the theory, opening
European borders to high-skilled migration stimulates human capital investment in the sending countries. Without such an incentive mechanism, the effectiveness of the reform would be smaller (+6.7 p.p. in column LR). A remarkable result is that this shock has minor negative spillover effects on the other major destination countries: in the long-run, the proportion of college graduates falls by 0.3 p.p. in the United States, and by an average of 0.5 p.p. in the other major settlement countries (henceforth, we refer to Canada, Australia, New Zealand as CANZ).

If the same reform is conducted in the US, it has a larger effect in the short-run and similar effects in the long-run. The US proportion of college graduates increases by 8.4 in the short-run and 7.1 p.p. in the long-run. On average, the negative spillover effect for CANZ is small; however, the negative effect on Europe is much larger. In the long-run, the EU15 proportion of high-skilled decreases by 2.4 p.p. There are two reasons for this: high-skilled workers who considered the EU15 as their preferred destination decide to move to the US, and Europe suffers from an increased brain drain to the US.

To identify the winners and losers of an increasing race for attracting talents, we simulate the effect of a global liberalization of high-skilled migration between all country pairs and quantify the country-specific changes in human capital. In the short-run, the proportion of college graduates increases by 10.4 p.p. in CANZ, 7.1 in the US, and only 0.8 in the EU15. The effects are larger in the long-run because better emigration prospects stimulate human capital formation in many countries, and newly educated parents invest more in their offspring, as demonstrated in Section 2. In the race for attracting talents, seven countries of the EU15 lose human capital (Austria, Denmark, Finland, France, Greece, Italy and Portugal). The only European country exhibiting large benefits is the United Kingdom. These results are in line with the anecdotal evidence presented above about Germany. They show that English-speaking industrialized countries would benefit from increasing the competition for attracting talents, whereas Europe would fall behind. This result is likely to be reinforced by the emergence of new economic powers such as China, Brazil or India.
Table 1. Effect of skill-selective liberalization shocks on human capital

<table>
<thead>
<tr>
<th>Country</th>
<th>Lib. to EU15</th>
<th>Lib. to USA</th>
<th>Global lib.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SR</td>
<td>LR</td>
<td>LR&lt;sub&gt;π&lt;/sub&gt;</td>
</tr>
<tr>
<td>Austria</td>
<td>3.2</td>
<td>4.9</td>
<td>4.4</td>
</tr>
<tr>
<td>Belgium</td>
<td>7.5</td>
<td>13.1</td>
<td>9.2</td>
</tr>
<tr>
<td>Denmark</td>
<td>2.1</td>
<td>4.5</td>
<td>3.9</td>
</tr>
<tr>
<td>Finland</td>
<td>1.3</td>
<td>2.4</td>
<td>2.0</td>
</tr>
<tr>
<td>France</td>
<td>4.2</td>
<td>8.7</td>
<td>7.6</td>
</tr>
<tr>
<td>Germany</td>
<td>3.9</td>
<td>6.1</td>
<td>5.6</td>
</tr>
<tr>
<td>Greece</td>
<td>1.9</td>
<td>3.1</td>
<td>2.7</td>
</tr>
<tr>
<td>Ireland</td>
<td>9.1</td>
<td>12.9</td>
<td>10.9</td>
</tr>
<tr>
<td>Italy</td>
<td>0.5</td>
<td>2.2</td>
<td>1.6</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>5.9</td>
<td>8.8</td>
<td>7.7</td>
</tr>
<tr>
<td>Netherlands</td>
<td>6.1</td>
<td>8.6</td>
<td>8.0</td>
</tr>
<tr>
<td>Portugal</td>
<td>1.7</td>
<td>5.6</td>
<td>4.9</td>
</tr>
<tr>
<td>Spain</td>
<td>4.7</td>
<td>9.4</td>
<td>9.0</td>
</tr>
<tr>
<td>Sweden</td>
<td>6.2</td>
<td>10.0</td>
<td>9.0</td>
</tr>
<tr>
<td>UK</td>
<td>12.5</td>
<td>15.3</td>
<td>14.2</td>
</tr>
<tr>
<td>Australia</td>
<td>-0.6</td>
<td>-0.5</td>
<td>-0.8</td>
</tr>
<tr>
<td>Canada</td>
<td>-1.3</td>
<td>-1.0</td>
<td>-1.4</td>
</tr>
<tr>
<td>New Zealand</td>
<td>-0.3</td>
<td>0.1</td>
<td>-0.2</td>
</tr>
<tr>
<td>United States</td>
<td>-0.2</td>
<td>-0.3</td>
<td>-0.3</td>
</tr>
</tbody>
</table>

Notes. Effects of eliminating visa costs on the proportion of college graduates in the resident labor force in percentage points. SR: effect in 2025 with α = .1. LR: effect in 2075 with α = .1. LR<sub>π</sub>: effect in 2075 under constant π.

4.3 Economic supremacy

What could be the implications of an increased competition for attracting talents on the economic performance of industrialized countries? Considering the global skill-selective liberalization reform, we compute the changes in GDP per capita in each country. Results are described in Table 2. The first column (y_i/y_{US}) expresses the level of GDP per capita of each country as percentage of the US level in 2000: all countries except Luxembourg have a lower income per capita than the US. Col. 2 and 3 give the short-run and long-run impact on GDP per capita in partial equilibrium, i.e. for given wage rates. Delogu et al. (2013) shows that endogenizing returns to schooling has a minor effect on the results. However, assuming that total factor productivity (TFP) is endogenous drastically changes predictions. Hence, in col. 4 and 5, we consider a general equilibrium framework in which TFP is endogenous: we assume an elasticity of TFP to the proportion of college graduates in the labor force equal to 0.32.
With exogenous TFP, the income gap with the US deteriorates in all the countries, except the United Kingdom and Ireland. In the latter two countries, the long-run gap is reduced by 3.3 percent. On the contrary, the "distance to the frontier" increases by 5.7 percent in Italy, 4.5 in Portugal, 4.0 in Finland, 3.6 in Greece. On average, it increases by 2 percent in the EU15.

These partial equilibrium effects are exacerbated if TFP increases with human capital. In the endogenous TFP framework, the UK improves by 6.6 percent compared to the US, whereas Italy and Portugal deteriorate by about 28 percent. We also obtain -21 percent in Greece, -19 percent in Finland, -13 percent in Austria and Portugal. On average, the EU15 loses 11 percent while CANZ only loses 2.9. An increasing race for attracting talents is likely to reinforce the US economic supremacy.

Table 2. Effect of a global skill-selective liberalization on GDP per capita

<table>
<thead>
<tr>
<th>Country</th>
<th>y_i/y_{US} 2000</th>
<th>dy_i/y_i - Exo TFP</th>
<th>dy_i/y_i - End TFP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Short-run Long-run</td>
<td>Short-run Long-run</td>
</tr>
<tr>
<td>Austria</td>
<td>0.711</td>
<td>-0.2 0.2</td>
<td>-3.3 -7.2</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.661</td>
<td>0.5 1.9</td>
<td>-2.0 -2.9</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.750</td>
<td>-0.8 0.0</td>
<td>-5.1 -7.3</td>
</tr>
<tr>
<td>Finland</td>
<td>0.620</td>
<td>-1.7 -1.0</td>
<td>-7.2 -12.2</td>
</tr>
<tr>
<td>France</td>
<td>0.693</td>
<td>-0.3 1.4</td>
<td>-4.7 -6.9</td>
</tr>
<tr>
<td>Germany</td>
<td>0.648</td>
<td>0.2 0.8</td>
<td>0.0 0.0</td>
</tr>
<tr>
<td>Greece</td>
<td>0.383</td>
<td>-0.6 -0.5</td>
<td>-6.6 -15.2</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.771</td>
<td>4.3* 6.6*</td>
<td>10.5* 1.7</td>
</tr>
<tr>
<td>Italy</td>
<td>0.578</td>
<td>-2.8 -2.7</td>
<td>-15.5 -20.9</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>1.281</td>
<td>0.7 1.1</td>
<td>-1.5 -7.1</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.710</td>
<td>1.1 2.0</td>
<td>2.4 -3.5</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.474</td>
<td>-2.5 -1.4</td>
<td>-13.4 -21.9</td>
</tr>
<tr>
<td>Spain</td>
<td>0.524</td>
<td>1.1 2.3</td>
<td>-0.3 -7.4</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.677</td>
<td>0.4 1.3</td>
<td>0.3 -1.1</td>
</tr>
<tr>
<td>UK</td>
<td>0.682</td>
<td>5.2* 6.6*</td>
<td>15.5* 6.8*</td>
</tr>
<tr>
<td>Australia</td>
<td>0.767</td>
<td>3.3 2.1</td>
<td>12.3* 0.4</td>
</tr>
<tr>
<td>Canada</td>
<td>0.747</td>
<td>2.8 1.7</td>
<td>7.1* 1.1</td>
</tr>
<tr>
<td>New Zealand</td>
<td>0.618</td>
<td>2.4 2.5</td>
<td>10.8* 2.9</td>
</tr>
<tr>
<td>United States</td>
<td>1.000</td>
<td>3.7 3.2</td>
<td>6.6 3.4</td>
</tr>
</tbody>
</table>

Notes. Effects of eliminating visa costs for college graduates on GDP per capita as percentage of deviation from the benchmark. A * indicates that benefits are larger than in the US. SR: effect in 2025 with \( \alpha = .1 \). LR: effect in 2075 with \( \alpha = .1 \). Exogenous TFP: constant wages; Endogenous TFP: elasticity of skill-specific wage rates to the proportion of college graduates equal to .3.
4.4 Effects on the world distribution of income

In line with the recent literature, our model formalizes the link between migrant selection and education decisions. Following Proposition 1, any reform increasing skill-selection in emigration translates into greater human capital investments and ambiguous effects on post-migration human capital accumulation. In a cross-section of 127 developing countries, Beine et al. (2008) quantified the net effect of the brain drain on human capital accumulation. On the whole, their numerical simulations reveal that the brain drain reduces human capital in most countries. Cases of brain gain are obtained in countries combining low levels of human capital (below 5 percent) and low high-skill emigration rates (below 15 percent).

We should not expect a global liberalization of high-skilled migration to be beneficial for the sending countries. A global liberalization increases the average emigration rate of high-skilled workers by 25 p.p.8 After the shock, only five countries exhibit brain drain rates below 15 percent, including 4 high-income countries (Australia, Saudi Arabia, United Arab Emirates, United States) and Thailand. According to the criterion of Beine et al. (2008), all developing countries exceed the threshold emigration rate above which brain drain reduces human capital. However, it can be the case that the average elasticity obtained in Beine et al. (2008) does not fit well the situation of some developing countries. In our parametrized model, the elasticity varies across countries: it is low in large (developing and developed) countries and high in small developing countries.

However our numerical experiments confirm that the global liberalization shock is too large to benefit sending countries. In the long-run, we identify an average decrease in the proportion of college graduates of 1.4 p.p. in developing countries. This is important because the current proportion of college graduates only equals 5.9 percent in developing countries, and our baseline scenario assumes it will be equal to 10 percent by 2075. The effect is large in Latin America (-5.1 p.p.) and smaller in the other regions (1.5 p.p. MENA, 1.2 p.p. in sub-Saharan Africa, 1.0 p.p. in the rest of Asia, 0.4 p.p. in CIS, and 0.2 p.p. in China and India).

Figure 1 shows the long-run impact on income per capita. The black bar corresponds to our benchmark scenario with exogenous TFP; the grey bars correspond to alternative values of the elasticity of education to emigration prospects: no effect (i.e. \( \pi_{k,t} \) constant) or higher elasticity (\( \alpha = .2 \)),9 the white bar gives the general equilibrium response with endogenous TFP.

Under exogenous TFP, income per capita decreases by 4.5 percent in developing countries. The effect is twice as large in Latin America and much less important in Asia and sub-Saharan Africa. Changing the elasticity of education to emigration quantitatively affects the results, but not qualitatively. Under endogenous TFP, the

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8This is the unweighted average of 195 countries. Note that liberalizing high-skilled migration to the EU15 or to the US only increases the average emigration rate by 10 and 11 p.p., respectively.

9With \( \alpha = .2 \), the long-run elasticity of the pre-migration proportion of college graduates to the high-skilled emigration rate equals .2 in large developing countries.
average decrease in income per capita amounts to 24 percent; the effect becomes important in regions where human capital is low (23 percent in sub-Saharan Africa, 24 in the MENA).

**Figure 1. Effect on income per capita in developing regions**

![Chart showing the effect on income per capita in developing regions](image)

Notes. Effects of eliminating visa costs for college graduates on GDP per capita in 2075 as percentage of deviation from the benchmark. Regions: MENA=Middle-East and Northern Africa, SSA=sub-Saharan Africa, CIS=Commonwealth of Independent States, ASIA=rest of Asia, CHIND=China and India, LAC=Latin America and the Caribbean, Dev=all developing countries. Black bar: $\alpha = .1$; Grey bars: constant $\pi_{k,t}$ and $\alpha = .2$; white bar: Endogenous TFP: elasticity of skill-specific wage rates to the proportion of college graduates equal to .3.

We also quantify the effect of skill-selective liberalization reforms on the world economy. Figures 2 Figure 3 give results obtained with exogenous and endogenous TFP respectively. Each one is divided into four panels: panel a shows the impact on the world proportion of migrants, panel b shows the effect on the world proportion of college graduates, the effect on the world average level of income per capita (i.e. efficiency effect) is presented on panel c, and panel d gives the effect on the Theil index of inequality.

Under exogenous TFP, a global liberalization doubles the world proportion of migrants and increases the proportion of college-educated in the world labor force by 1.8 percentage point in the long-run. In line with Lemma 2, the effect is clearly gradual: new emigration prospects stimulate investment in education in the short-run, and the new educated adults invest more in the basic education of their children. Income per capita increases by 4 percent in the short-run and by 11 percent in the long-run. However, as discussed in the previous sub-section, human capital agglomerates in the most attractive nations. Hence, developing countries and many less attractive
developed countries have lower economic performance. The Theil index increases by 2 percentage points in the long-run.\footnote{Figure 2 also shows that these effects are much less important if the liberalization reform is only conducted in the EU15 or in the US.}

Figure 3 compares the effect of a skill-selective and a non-selective global liberalization reform with exogenous or endogenous TFP. Two results emerge. First, although TFP endogeneity has almost no implications for migration and human capital responses (panels $a$ and $b$), it drastically changes the economic impact of liberalization. Under endogenous TFP, the adverse effect in GDP per capita is much larger for poor, sending regions (see Figure 1). Consequently, the world efficiency response becomes negligible: liberalizing high-skilled migration worldwide is a zero-sum game inducing a large increase in inequality.

Second, skill-selective policies induce smaller efficiency and inequality gains compared to non-selective policies. A non-selective global liberalization increases the world proportion of migrants by about 15 p.p. (to be compared with 3 p.p. for a skill-selective reform). Although it has only a moderate effect on education investments in the short-run, it has a much stronger effect in the long-run. In line with Lemma 2, the reason is that many low-skilled migrants moving from South to North face a new environment in which basic education is largely subsidized and (partly) mandatory. This increases the fraction of children receiving basic education and becoming eligible for higher education. In the long-run, the proportion of college graduates increases by 4.8 percent. Under exogenous TFP, the efficiency and inequality benefits are important. Under endogenous TFP, the efficiency response remains large and the inequality index slightly deteriorates.
Figure 2. Effects of skill-selective liberalization shocks on the world economy with exogenous TFP

2.a. Proportion of migrants
2.b. Proportion of college grads
2.c. GDP per capita
2.d. Theil inequality index

Figure 3. Effects of global liberalization shocks on the world economy with exogenous and endogenous TFP

3.a. Proportion of migrants
3.b. Proportion of college grads
3.c. GDP per capita
3.d. Theil inequality index
5 Conclusion

Recent literature has greatly enhanced our knowledge of the determinants of international migration and its interdependencies with education decisions. This paper combines insights from this literature and provides a solid micro-foundation for the education-migration nexus. We parametrize the model to perfectly fit migration, education and income data, and to match the average elasticities of the empirical literature. Our results show that English-speaking industrialized countries would benefit from increasing the competition for attracting talents. Europe and developing countries are likely to be the real losers. In case of a worldwide liberalization of high-skilled migration, the average income gap between the EU15 and the US could increase by 11 percent. Despite its positive effect on education, globalizing the market for talents would drastically hurt developing countries, reducing their average income per capita by 24 percent. Contrary to a non-selective liberalization, such a policy reform is a zero-sum game which drastically increases inequality in the world distribution of income. Our model is calibrated on 2000 and could be extended to predict the effect of the emergence of some developing countries on the world distribution of income.

References


