Cross-border migration and the world distribution of income*

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Abstract

This paper quantitatively investigates the effect of migration policy reforms (a repatriation of all migrants or a complete liberalization of cross-border migration) on the world distribution of income. We develop and parametrize a dynamic model with endogenous migration, fertility and education, and identify total migration costs and their legal component for each pair of countries. Our analysis reveals that increasing cross-border migration has a small impact on the world population but increases the proportion of college graduates and the world GDP. The effect of a migration reform is cumulative and permanent, since new migrants assimilate in terms of fertility and education behaviors in their destination country. A repatriation would reduce the world GDP per worker by 2.0 percent in the short-run and by 4.8 percent in the long-run; the Gini index would be 1.4 percentage points lower 50 years after the shock. On the contrary, a complete liberalization would increase the world GDP per worker by 13 percent in the short-run and by 23 percent in the long-run; the Gini index would be 2 percentage points higher after 50 years. These results are very robust to the parameter choice. Accounting for the endogeneity of skill premia and TFP levels hardly affects the magnitude of the effects.

Keywords: Migration, Migration policy, Liberalization, Growth, Human Capital, Fertility, Inequality

JEL codes: O15, F22, F63, I24.

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1 Introduction

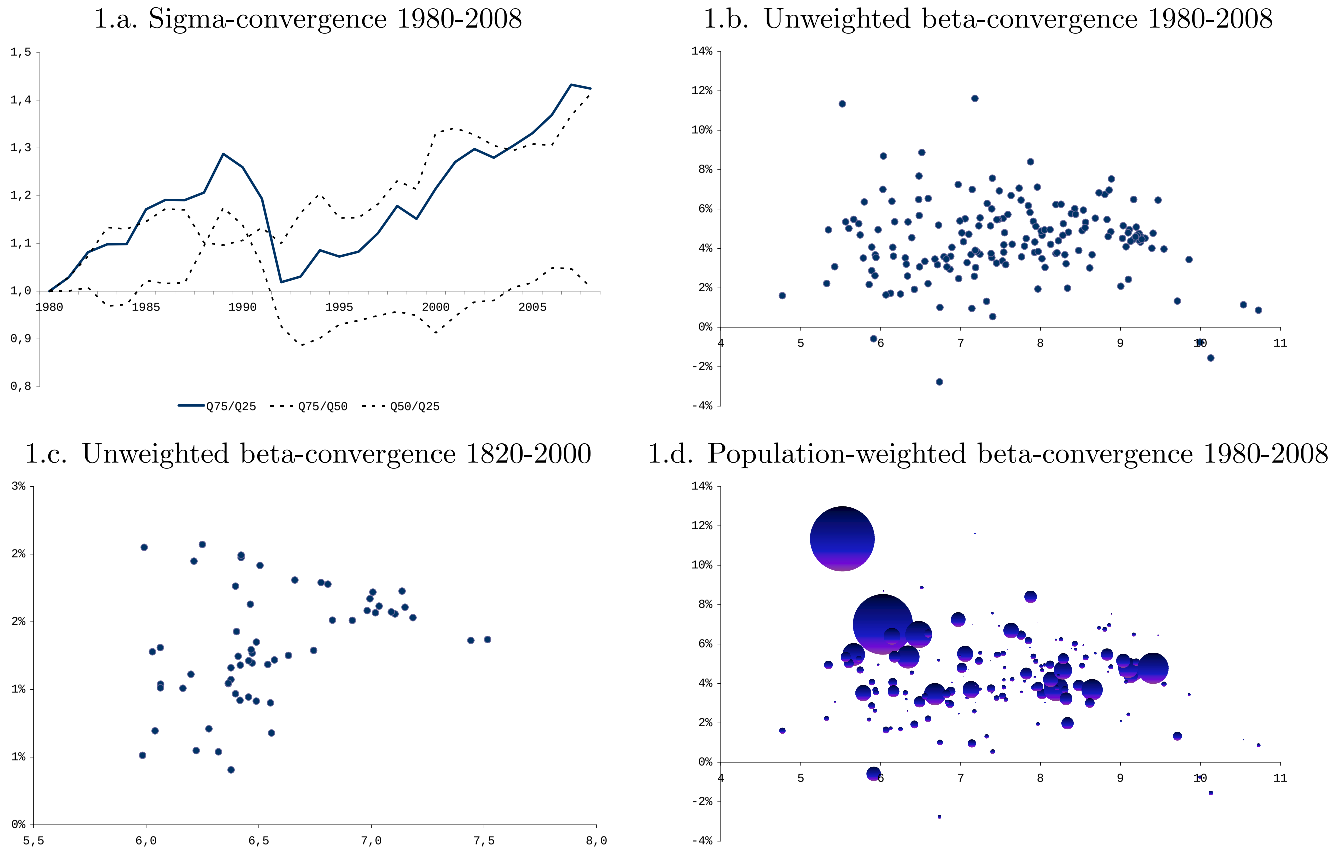
Inequality in the world distribution of income has steadily worsened since the industrial revolution. The Gini coefficient has increased from 0.50 to about 0.65 over that period and between-country inequality has become the major source of inequality (Bourguignon and Morrisson, 2002). Indeed, average growth rates in poor countries have been lower than growth rates in industrialized countries for the last two centuries. Divergence is not ineluctable. There are clearly forces that create the potential for explosive growth in poor countries and some countries (China, India, Brazil, etc.) and regions (East Asia) behind the technological frontier have experienced episodes of rapid growth. But there are also strong forces for stagnation or "implosive" decline. In particular, lack of economic growth, rampant poverty and correlates of poverty (bad institutions, discriminations, political repression, lack of freedoms, etc.) motivate people to flee their own country; with highly skilled workers found to be far more responsive to economic push-pull factors when compared to the low skilled (see Grogger and Hanson, 2011, or Docquier et al., 2007). This paper investigates the role of international migration in shaping the evolution of the world income and its distribution among the world's citizens. Our goal is to simulate how two drastic migration policy reforms, a repatriation of all migants to their home country or a complete liberalization of cross-boder migration, could affect the world distribution of income.

Although the percentage of international migrants in the world population has been stable and low since World War II (around 3 percent according to the United Nations database), immigration rates in high-income countries have been multiplied by three since 1960, following the same trajectory as the world trade/GDP ratio. An increasing proportion of these migrants come from developing countries and are more educated than those left behind (Docquier et al., 2009). Positive selection in emigration results from skill-biased private incentives to emigrate and selective immigration policies conducted in receiving industrialized countries. Brain drain rates observed in 2000 range from a few percent of the high-skilled native labor force to 85 percent in the most affected countries. The latter are small, poor, English-speaking countries located under the tropics. Most high-skilled migrants move to high-income countries (Docquier et al., 2007). Hence, high-skilled migration has been viewed as contributing to increased inequality at the international level, with rich countries becoming richer at the expense of poor countries. As for desired migration, the recent Gallup World Survey (see Esipova et al., 2011) estimates the number of adults who would like to emigrate permanently to another country and where they would like to go. It reveals that by 2007, nearly 700 million adults wanted to permanently emigrate to another country if they wouldbe given the opportunity. Most of these would-be migrants originate from poor countries and in particular from sub-Saharan Africa. People with higher education are the most likely to express a desire to emigrate although positive selection in desired migration is much smaller than in effective migration. The average skill ratio of desires to emigrate is around 1.5 in low-income countries while the same ratio computed for effective migration ranges between 10 and 20. Two-thirds of these potential migrants named the United States as the top desired destination; other important destinations are Canada, European countries and Saudi Arabia.

Absence of longitudinal data makes it difficult to assess the impact of cross-border migration on inequality retrospectively. However, from the databases described above, we have a better knowledge of the size and the educational structure of current migration flows and of prospective migration (i.e. people who intend to emigrate). These databases can be used to predict the impact of drastic migration policy reforms on the geographic allocation of human capital and the time path of income inequality. In particular, the question addressed in this paper is: What would be the world distribution of income if migrants were repatriated to their country of origin, or if all prospective migrants were allowed to move after 2025?

This paper combines several strands of literature. First, it contributes to the literature on income convergence and income inequality across nations. Bourguignon and Morrisson (2002) or Pritchett (1997) documented that inequality of world distribution of income worsened between the industrial revolution and World War I (the Gini index increased from 0.50 to 0.61), and has grown much more slowly since then (the Gini coefficient reached 0.64 in 1950, and 0.66 in the 1990's). In the early 19th century most inequality was due to differences within countries; later, it was due to differences between countries. The Theil index decomposition shows that the within-country inequality index decreased between 1820 and 1950, and has been relatively stable since then. On the contrary, the between-country index has steadily increased between 1820 and World War II, and has been relatively stable until 1992, a result due to two contrasting forces. On the one hand, the (sigma-) convergence literature has revealed that dispersion of income per capita across countries has increased since World War II. Figure 1.a shows that the dispersion of GDP per capita (in PPP value) increased between 1980 and 2008. The interquartile ratio, Q75/Q25, increased by 40 percent in that period, a phenomenon essentially due to the deterioration of the Q50/Q25 ratio. In addition, as illustrated on Figure 1.b, beta-convergence studies show that growth rates in poor countries have been lower or equal to the growth rate in rich countries (Barro and Sala-I-Martin 1992, Quah 1993). Figure 1.c shows that this results also hold on a very long period (1820-2000). On the other hand, very populated countries such as China and India have taken off since the late eighties. This is illustrated on Figure 1.d which uses the same data as Figure 1b, but accounts for the demographic size of countries (bubble sizes are proportional to population). Figure 1.d suggests that a population-weighted beta-convergence analysis would reveal a decrease in between-country inequality. This explains why Sala-I-Martin (2006) found a significant decrease in inequality indices during the 1990's. Still, between-country inequality represents today the major source of inequality (about two-third of the Theil index) and it is worth investigating its causes.

Figure 1. Between-country inequality



Note. On Figures 1.a, 1.b and 1.d, GDP per capita is measured in PPP value (Source: World Development Indicators, 2010, 174 countries). On Figure 1.c, GDP per capita is measured in 1990 International Geary-Khamis dollars (Source: Maddison database, 59 countries)

A second wave of studies has investigated the effect of a complete liberalization of cross-border migration on the world GDP and its distribution across countries. Most of them assumed that liberalization leads to wage equalization across countries, which implies that about 50 percent of the world population would live in a foreign country after liberalization. These studies predict that eliminating all restrictions to labor mobility would induce huge efficiency gains in the range of 50 to 150 percent of world GDP. A summary of these predictions is provided in Clemens (2011). Another study by di Giovanni et al. (2012) argued that the welfare gains from migration can be magnified if migration increases market size and the number of varieties in the North and induces large amounts of remittances in the South. The first study accounting for the existence of "incompressible" moving costs is Docquier, Machado and Sekkat (2012). They quantified the effect of liberalization on the world economy using a model jointly endogenizing migration decisions and economic performances. Their model is calibrated using data on desired migration from the Gallup World Survey (see Esipova et al., 2011). In partial equilibrium or in general equilibrium without externality, they predict a 17 percent increase in the world GDP ater a liberalization. When human capital externalities are accounted for, the effect varies between 2 and 4 percent. All papers in this literature disregard the effect of effective migration and/or migration prospects on education and fertility decisions. These effects will be accounted for in this study.

Third, another set of studies has focused on the effect of skilled-biased emigration on development.[1] The brain drain has both detrimental and beneficial effects for origin countries. This new literature characterizes the conditions under which the net effect of high-skilled emigration on development and welfare is positive or negative in the origin country. The main contribution of this recent literature is that it is evidence-based, something which was not possible until recently due to the lack of decent comparative data on international migration by educational attainment. In line with the above studies, Mountford and Rapoport (2011) developed a model with endogenous education, fertility, and migration decisions by individual agents in both the sending and receiving economies. They show that high-skilled migration may improve the growth rate, and reduce the fertility rate, of all economies in the world. Furthermore, when both receiving and sending economies benefit from brain drain migration, it is possible that the more advanced economy benefits most from this process and for world inequality to increase as a result. In the case a brain gain is observed in large emigration countries, a shock in high-skilled emigration leads to a decrease in world inequality in the next few decades as large countries grow, but then a renewed increase as the forces for divergence become increasingly dominant. Our model will aslo establish a link between emigration prospects and education decisions, and will propose solid micro-foundations for the "brain gain" mechanism.

In order to study the impact of global migration policy reforms on the world

[1] See Docquier and Rapoport (2012) for a review of this literature with a special focus on macro and micro evidence.

economy, we use an abstract two-class (college graduates and the less educated) overlapping-generations model which highlights the major economic mechanisms underlying wage inequality and decisions about migration, fertility and education. We then confront theory to data. Although the model is large (because 195 countries are included), the mechanisms are transparent. The model has only a few equations per country, uses relatively consensual micro-foundations, and can be parametrized using proper identification methods. Such a quantitative theory approach is now the dominant research paradigm used by economists incorporating rational expectations and dynamic choice into short-run macroeconomic and monetary economics models (King, 1995). However, little has been done so far in comparative development studies. We calibrate the model to fit the evolution of the world economy between 1975 and 2000 and to fit the demographic projections of the United Nations for the period 2000-2075. We simulate two permanent migration shocks, a complete repatriation of cross-border migrants to their home country and a complete liberalization of migration from 2025, and investigate their effect on the world economy and the world distribution of income. Our main results are the following:

- Our first set of simulations considers exogenous TFP and skill premium trajectories in all countries. In the short-run, repatriating migrants to their home country would reduce the world GDP per worker and the Gini index by 2.0 percent and 0.8 percentage points, respectively (the same order of magnitude as in Kapur and McHale 2009). On the contrary, liberalizing migration would increase the world GDP and the Gini index by 13.3 percent and 1.8 percentage points, respectively (the same order of magnitude as in Docquier et al., 2012a).

- For the first time, we can characterize the dynamics of the world economy response to migration policy reforms. Although the migration response is decreasing over time (18 percent of foreigners in 2025, 15.5 percent in 2075 in case of a liberalization), the effects on the World GDP and the Gini index are increasing over time. In the long-run, repatriating migrants to their home country would reduce the world GDP per worker and the Gini index by 4.8 percent and 1.4 percentage points, respectively. On the contrary, liberalizing migration would increase the world GDP per worker and the Gini index by 22.9 percent and 2.4 percentage points, respectively. This is due to a cumulative impact of education and migration decisions: new migrants assimilate in terms of fertility and investments in children's education. Newly educated children in rich destination countries will have a greater probability to become high-skilled.

- Endogeneity of fertility decisions has a relatively low impact on our results while accounting for brain gain mechanism modifies the world proportion of educated: this effect accounts for two-thirds of the short-run and long-run impacts on the world proportion of college graduates and GDP per worker.

- In a model with endogenous skill premia or technological externalities of human capital on the TFP, the effects are very similar. In case of a liberalization, new migrants are more educated than natives left behind (positive selection in emigration) but less educated than workers in destination countries (negative selection in immigration). Other things being equal, a liberalization would reduce the proportion of high-skilled workers in all regions (as in Docquier et al., 2012a). However this mechanism is compensated by greater investments in education. Overall, the skill premia and TFP responses to migration policy reforms are negligible.

- Accounting for remittances [**To be done**]

The rest of this paper is organized as following. Section 2 describes the model. Its parametrization is presented in Section 3. Results are then commented in Section 4. Finally, Section 5 concludes.

2 The model

Our overlapping-generations model distinguishes three types of workers (high-skilled, low-skilled and young workers) and I countries. At each period of time, a generation of adults and another generation of non-adults coexist. The number of native adults from country i at time t is denoted by $N_{i,t}$, and their skill type s is equal to h for high-skilled workers (i.e. college graduates) and to l for the less educated or low-skilled. We have $N_{i,t}^{s}$ natives of type s. Each native adult decides whether to acquire higher education or not (we have $N_{i,t}^{h} = z_{i,t}N_{i,t}$ and $N_{i,t}^{l} = (1 - z_{i,t})N_{i,t}$), where to locate (we denote by $N_{ij,t}^{s}$ the number of type-s adults moving from country i that move to country j), and how to allocate her/his resources between consumption, raising children, and providing basic education to a fraction of them. The labor force of type s in country i is defined as:

$$L_{i,t}^{s} = \sum_{k=1}^{I} N_{ki,t}^{s}; \quad L_{i,t} = L_{i,t}^{h} + L_{i,t}^{l}, \tag{1}$$

and the proportion of college graduates in the resident adult population equals

$$h_{i,t} = \frac{L_{i,t}^{h}}{L_{i,t}}$$

It can be lower or larger than the proportion of college graduates in the native adult population, $z_{i,t}$, according to the migration-induced net balance of high-skilled and low-skilled labor.

Each country produces a homogenous good and is characterized by a production technology which is linear in high-skilled and low-skilled labor. Extensions with endogenous skill premium and total factor productivity will also be considered. Young individuals can also supply labor, being considered as perfect substitutes for low-skilled workers, albeit less productive.

The utility of an adult of type s, born in country k, living in country i can be written as

$$U^s_{ki,t} = \ln v^s_{i,t} + \ln(1 - x^s_{ki,t}) - \ln \tau^s + \varepsilon^s_{ki,t}$$

where $\ln v^s_{i,t} \in \Re$ is the deterministic component of utility, $x^s_{ki,t} \in [0, 1]$ measures total effort required to move from country k to country i (such that $x^s_{ii,t} = 0$), $\tau^s \geq 1$ is the individual-specific effort required to acquire college education (with $\ln \tau^l = 0$ and $\ln \tau^h \geq 0$), $\varepsilon^s_{ki,t} \in \Re$ is the individual-specific random taste for migrating from country k to i. As for the latter two variables, individual subscripts are omitted for convenience.

For each adult, the timing of decisions is the following:

- First, τ is revealed. New adults do not know their migration type ($\varepsilon^s_{ki,t}$) and form expectations about the expected utility gain from being educated or not. Comparing the expected gain from education with the effort required to educate ($\ln \tau^s$), young adults with basic education decide whether to acquire college education or not. Young adults without basic education have no access to college. Basic education is predetermined by parental decisions in the previous period.

- Second, $\varepsilon^s_{ki,t}$ is revealed for all possible destinations. Adults decide whether to emigrate or not, and where to emigrate. Their migration decision is based on disparities in country characteristics ($\ln v^s_{i,t}$), bilateral migration costs (reflected in $1 - x^s_{ki,t}$), and the individual-specific random component $\varepsilon^s_{ki,t}$.

- Third, once optimal education and location decisions are reached, individuals decide about their consumption level, the number of children, and the proportion of children receiving basic education (i.e. children sent to primary and secondary schools). The remaining fraction is on the labor market or plays no role. This determines the indirect utility function $\ln v^s_{i,t}$.

We solve this optimization problem backward.

2.1 Consumption, fertility and basic education

In the third stage, utility depends on the level consumption ($c^s_{j,t} \in \Re^+$), number of children ($n^s_{j,t} \in \Re^+$), and proportion of children receiving basic education ($q^s_{j,t} \in [0, 1]$). The location- and education-specific indirect utility is defined as

$$\ln v^s_{i,t} = \underset{c^s_{i,t}, n^s_{i,t}, q^s_{i,t}}{\arg\max} \, (1 - \theta) \ln c^s_{i,t} + \theta \ln n^s_{i,t} + \theta\lambda \ln q^s_{i,t} \tag{2}$$

where $\theta \in [0, 1]$ is a parameter of preference for children, and $\lambda \in [0, 1]$ is another parameter of preference for basic education.

Utility maximization is subject to $q^s_{i,t} \leq 1$ and to the budget constraint:

$$c^s_{i,t} + n^s_{i,t} q^s_{i,t} e^s_{i,t} = w^s_{i,t}(1 - \phi n^s_{i,t}) + n^s_{i,t}(1 - q^s_{i,t}) w^c_{i,t} \varphi^s_i \tag{3}$$

where $e^s_{i,t}$ is the cost of basic education child for a parent of type s, ϕ is the time cost to raise a child, $w^s_{i,t}$ is the wage rate for a type-s worke, $w^c_{i,t}$ is the wage rate for a child (reflecting social and institutional norms towards child labor), and φ^s_i is a variable measuring the extent to which parents of type s can rely on children's income (reflecting skill-specific attitudes towards child labor).

The first-order conditions are:

$$\frac{(1-\theta)\left[\phi w^s_{i,t} + q^s_{i,t} e^s_{i,t} - (1 - q^s_{i,t}) w^c_{i,t} \varphi^s_i\right]}{c^s_{i,t}} - \frac{\theta}{n^s_{i,t}} = 0 \tag{4}$$

$$\frac{(1-\theta)\, n^s_{i,t}\left[e^s_{i,t} + w^c_{i,t} \varphi^s_i\right]}{c^s_{i,t}} - \frac{\theta \lambda}{q^s_{i,t}} \geq 0 \tag{5}$$

From (4), the total cost of children is equal to a fraction θ of the wage rate, and total consumption is equal to the remaining fraction, $1 - \theta$. It follows that

$$n^s_{i,t} = \frac{\theta w^s_{i,t}}{\phi w^s_{i,t} + q^s_{i,t} e^s_{i,t} - (1 - q^s_{i,t}) w^c_{i,t} \varphi^s_i}$$

Interior solution – Assume (5) holds with equality. Combining (4) and (5) gives the optimal fertility rate and investment in basic education:

$$n^s_{i,t} = \frac{\theta(1-\lambda) w^s_{i,t}}{\phi w^s_{i,t} - w^c_{i,t} \varphi^s_i} \tag{6}$$

$$q^s_{i,t} = \frac{\lambda}{1-\lambda} \frac{\phi w^s_{i,t} - w^c_{i,t} \varphi^s_i}{e^s_{i,t} + w^c_{i,t} \varphi^s_i} \tag{7}$$

The fertility rate decreases with the wage rate ($w^s_{i,t}$) and increases with child labor's income ($w^c_{i,t}$). Education increases with the wage rate ($w^s_{i,t}$) and decreases with its costs ($e_{i,t}$) and with child labor's income ($w^c_{i,t}$).

The condition for an interior solution writes as

$$w^s_{i,t} \leq \frac{(1-\lambda) e^s_{i,t} + w^c_{i,t} \varphi^s_i}{\phi \lambda} \tag{8}$$

Corner solution – If (8) does not hold, we have a corner solution with $q^s_{i,t} = 1$. Substituting $q^s_{i,t} = 1$ in (4) determines the fertility rate:

$$n^s_{i,t} = \frac{\theta w^s_{i,t}}{\phi w^s_{i,t} + e^s_{i,t}} \tag{9}$$

2.2 Migration

In the second stage, individuals discover their migration tastes $\varepsilon^s_{ki,t}$, know the distribution of $\ln v^s_{i,t}$ in all countries, and migration costs $x^s_{ki,t}$ for all country pairs. They choose the location maximizing their utility. The proportion of individuals from country k choosing to emigrate to country i is given by

$$P^s_{ki,t} = \Pr\left[\ln v^s_{i,t} + \ln(1 - x^s_{ki,t}) + \varepsilon^s_{ki,t} = \max_j \ln v^s_{j,t} + \ln(1 - x^s_{kj,t}) + \varepsilon^s_{kj,t}\right]$$

As standard in the literature on the determinants of migration, we assume that the random component of utility $\varepsilon^s_{ki,t}$ follows a Type I-Extreme Value distribution (also known as the double-exponential distribution). The CDF is given by

$$F(\varepsilon) = \exp\left[-\exp\left(-\frac{\varepsilon}{\mu} - \gamma\right)\right], \quad \varepsilon \in \Re \tag{10}$$

where $\mu > 0$ is a scale parameter and $\gamma \approx 0.577$ is the Euler's constant.

Under this hypothesis, the choice probabilities reduce to the multinomial logit model (see McFadden 1984):

$$P^s_{ki,t} = \frac{e^{\left[\ln v^s_{i,t} + \ln(1 - x^s_{ki,t})\right]/\mu}}{\sum_{j=1}^{I} e^{\left[\ln v^s_{j,t} + \ln(1 - x^s_{kj,t})\right]/\mu}},$$

The ratio of bilateral migrants to stayers is given by

$$\begin{aligned}\frac{N^s_{ki,t}}{N^s_{kk,t}} &= \frac{e^{\left[\ln v^s_{i,t} + \ln(1 - x^s_{ki,t})\right]/\mu}}{e^{\left[\ln v^s_{k,t}\right]/\mu}} \\ &= (1 - x^s_{ki,t})^{\frac{1}{\mu}} \left(\frac{v^s_{i,t}}{v^s_{k,t}}\right)^{\frac{1}{\mu}} \end{aligned} \tag{11}$$

2.3 Higher education

In the first stage, individuals do not know their migration type ($\varepsilon^s_{ik,t}$) but they know its distribution. Under the Type I Extreme Value distribution (10), de Palma and Kilani (2007) showed that the unconditional and conditional distributions of maximum utility coincide. Ex-ante (i.e. before knowing their migration type), individuals form expectations about the maximum utility of being college educated or not. For an individual born in country k, investing in college education gives rise to an expected utility level given by

$$\mu \ln \sum_{i=1}^{I} e^{\left[\ln v^h_{i,t} + \ln(1 - x^h_{ki,t})\right]/\mu} - \ln \tau = \mu \ln \sum_{i=1}^{I} (1 - x^h_{ki,t})^{1/\mu} (v^h_{i,t})^{1/\mu} - \ln \tau$$

whereas the expected utility of a less educated worker amounts to

$$\mu \ln \sum_{i=1}^{I} e^{\left[\ln v_{i,t}^{l}+\ln(1-x_{ki,t}^{l})\right]/\mu} = \mu \ln \sum_{i=1}^{I} (1-x_{ki,t}^{l})^{1/\mu}(v_{i,t}^{l})^{1/\mu}$$

It follows that individuals deciding to invest in higher education are such that:

$$\ln \tau < \mu \ln \left(\frac{\sum_{i=1}^{I}(1-x_{ki,t}^{h})^{1/\mu}(v_{i,t}^{h})^{1/\mu}}{\sum_{i=1}^{I}(1-x_{ki,t}^{l})^{1/\mu}(v_{i,t}^{l})^{1/\mu}} \right)$$

Assuming that τ is uniformly distributed on the range $[1, \overline{\tau}_{k,t}]$, the proportion of individuals with basic education who decide to invest in college education is given by

$$\pi_{k,t} = \frac{1}{\overline{\tau}_{k,t}-1} \left(\frac{\sum_{i=1}^{I}(1-x_{ki,t}^{h})^{1/\mu}(v_{i,t}^{h})^{1/\mu}}{\sum_{i=1}^{I}(1-x_{ki,t}^{l})^{1/\mu}(v_{i,t}^{l})^{1/\mu}} \right)^{\mu} - \frac{1}{\overline{\tau}_{k,t}-1} \tag{12}$$

It clearly appears from (12) that a skill bias in emigration prospects ($x_{ki,t}^{h} < x_{ki,t}^{l}$) affects the incentive to educate, providing solid micro-foundations to the brain gain mechanism (reviewed in Docquier and Rapoport, 2012).

2.4 Aggregates and dynamics

From (6), the average fertility rate in country i is given by

$$n_{i,t} = h_{i,t}n_{i,t}^{h} + (1-h_{i,t})n_{i,t}^{l} \tag{13}$$

From (6) and (7), the proportion of children with basic education is given by

$$q_{i,t} = \frac{h_{i,t}n_{i,t}^{h}q_{i,t}^{h} + (1-h_{i,t})n_{i,t}^{l}q_{i,t}^{l}}{n_{i,t}} \tag{14}$$

Labor supply of high-skilled adults, low-skilled adults and younger individuals are given by

$$\ell_{i,t}^{h} = L_{i,t}^{h}(1-\phi n_{i,t}^{h}) \tag{15a}$$
$$\ell_{i,t}^{l} = L_{i,t}^{l}(1-\phi n_{i,t}^{l}) \tag{15b}$$
$$\ell_{i,t}^{c} = L_{i,t}^{h}n_{i,t}^{h}(1-q_{i,t}^{h})\varphi_{i}^{h} + L_{i,t}^{l}n_{i,t}^{l}(1-q_{i,t}^{l})\varphi_{i}^{l} \tag{15c}$$

The equations hereinbefore allow us to characterize the dynamics of the economy. The dynamics of the native population and the proportion of college graduates in the adult population are given by

$$N_{i,t} = L_{i,t-1}n_{i,t-1} \tag{16a}$$
$$z_{i,t} = \pi_{i,t}q_{i,t-1} \tag{16b}$$

It clearly appears that $N_{i,t}$ is a pre-determined variable, whereas $z_{i,t}$ is not.

Finally, the size of the resident labor force in (1)is the outcome of the optimal location decision in (11).

2.5 Technology

We assume the following simple technology:

$$Y_{i,t} = A_{i,t}\left[\sigma_{i,t}\ell_{i,t}^{h} + \ell_{i,t}^{l}\right] \tag{17}$$

Younger workers are employed in the informal sector (hidden part of the economy) and receive a fraction $\omega_{i,t}$ of the low-skilled wage rate. Wage rates are given by

$$w_{i,t}^{h} = A_{i,t}\sigma_{i,t} \tag{18}$$

$$w_{i,t}^{l} = A_{i,t} \tag{19}$$

$$w_{i,t}^{c} = A_{i,t}\omega_{i,t} \tag{20}$$

In the benchmark model, we consider total factor productivity (henceforth labeled as TFP), the skill premium and the income of children as exogenous. Later, the TFP level can be modeled as a non-decreasing function of $h_{i,t}$ (the proportion of college graduates in the adult population), and the college wage premium $\sigma_{i,t} > 1$ can also be modeled as a non-increasing function of $h_{i,t}$.

2.6 Competitive equilibrium

Hence, an intertemporal equilibrium for the world economy can be defined as following:

Definition 1 *For a set of structural parameters* $\{\theta, \lambda, \phi, \mu\}$*, a set of country-specific exogenous variables* $\left\{e_{i,t}^{s}, \varphi_{i}^{s}, A_{i,t}, \overline{\tau}_{j,t}, \sigma_{i,t}, \omega_{i,t}\right\}_{\forall i,t}$*, a set of bilateral migration costs* $\left\{x_{ij,t}^{s}\right\}_{\forall i,j,t,s}$*, and a set of predetermined variables or initial conditions* $\{N_{i,t}, q_{i,t-1}\}_{\forall i,t}$*, an intertemporal equilibrium is a set of* $\left\{w_{i,t}^{s}, \pi_{i,t}, z_{i,t}, h_{i,t}, n_{i,t}^{s}, q_{i,t}^{s}, N_{ij,t}^{s}, L_{i,t}^{s}\right\}_{\forall i,j,t,s}$ *such that (i) wages* $w_{i,t}^{s}$ *maximize profits, as depicted in (18), (19) and (20), (ii) investment in higher education* $\pi_{i,t}$ *maximizes expected utility, as depicted in (12), (iii) the proportion of college graduates in the native labor force satisfies (16b), (iv) adults' fertility rates and investment in basic education maximize location-specific utility, as depicted in (6) and (7), (v) the allocation of the world labor force maximize utility, as depicted in (11), (vi) aggregation constraints (1), (6), (14) are satisfied, and (vii) the evolution of the native adult population is governed by (16a)*

In the rest of this paper, we parametrize a baseline intertemporal equilibrium for the world economy and simulate the effects of two drastic policy reforms, a repatriation of all migrants to their home country and a complete liberalization of cross-border migration.

2.7 Parametrization

Before simulating repatriation and liberalization shocks, we calibrate the model to fit the evolution of the world economy between 1975 and 2000 and to fit the demographic projections of the United Nations for the period 2000-2075. Then we identify migration barriers that would be removed in case of a complete liberalization of cross-border migration. A precise description of our calibration strategy and of the BAU scenario can be found in the Appendix.

The BAU trajectory - We summarize here our calibration strategy and the assumption underlying the "Baseline as Usual" or "before shock" trajectory of the world economy (henceforth denoted BAU). The calibration of the BAU is based on the six steps:

- First, preferences are assumed to be identical across countries and time invariant. In line with the recent literature (Haveman and Wolfe, 1995, Knowles, 1999, de la Croix and Gooseries, 2009,de la Croix an Doepke, 2004, Docquier, Müller and Naval, 2013, de la Croix an Doepke, 2003), the time-cost of having a child (ϕ), the altruism parameter (θ) and the preference for basic education (λ) are equal to 0.3, 0.6 and 0.15, respectively. We also normalize the scale parameter μ to unity in the distribution of random component of utility, a standard assumption in the literature on the determinants of migration.

- Second, we collect data on the size and education structure of the native and resident labor forces in 1975 and 2000 from Docquier, Lowell and Marfouk (2009) and Defoort (2008). We can directly calculate human capital indicators ($q_{i,75}$, $\pi_{i,00}$, $z_{i,00}$) and the average growth rate of the population ($n_{i,75} = N_{i,00}/L_{i,75}$).

- Third, we observe the wage ratio between college graduates and the less educated ($\sigma_{i,00}$) using data for 54 countries from Hendricks (2004) and estimate the wage ratio for other countries. In the baseline scenario, we assume $\sigma_{i,t}$ is time invariant (i.e. we fix within-country inequality to its level in 2000). On this basis, we calibrate total factor productivity (TFP) in 1975 and 2000 as residuals of the technology. We estimate a convergence process in TFP and predict the evolution of the TFP from 2025 to 2075.

- Fourth, we calibrate the deterministic part of utility, $\ln v_{i,t}^{s}$. Our identification strategy assumes that (i) high-skilled parents educate all their children ($q_{i,75}^{h} = 1$), (ii) high-skilled parents have a fixed number of children $\overline{n}_{i,75}^{h}$ close to the replacement rate, and (iii) for cultural reasons, child labor is only envisaged in low-skilled families. Variable $\omega_{i,75} \equiv w_{i,75}^{c}/w_{i,75}^{l}$ is calibrated to match the labor force growth rate between 1975 and 2000. In the BAU, the evolution of $\omega_{i,t}$ is calibrated to fit the United Nations population forecasts. Then, we calibrate $\varepsilon_{i,75}^{h} \equiv e_{i,75}^{h}/w_{i,75}^{h}$ by equalizing the fertility of college graduates to the replacement rate, and $\varepsilon_{i,75}^{l} \equiv e_{i,75}^{l}/w_{i,75}^{h}$ by matching data on the proportion of children with basic education in 1975. The BAU assumes that $\varepsilon^s_{i,75}$ are time invariant for all s. On this basis, we can compute the fertility rates, investments in children's education and the optimal levels of the deterministic component of utility, $\ln v^s_{i,t}$ $\forall i, t$.

- Fifth, bilateral migration costs $(1-x^s_{ki,00})$ are calibrated for each pair of countries as residuals of (11). Data on bilateral migration stocks in 2000 for all pairs of countries $(N^s_{ki,00})$ and stocks of native stayers $(N^s_{kk,00})$ by education level are obtained from Docquier et al. (2012b). In the BAU, we assume that $x^s_{ki,t} = x^s_{ki,00}$ are constant for all s.

- Sixth, the upper bound of the higher education cost $\overline{\tau}_{k,00}$ can then be obtained as a residual of (12) to match the proportion of college graduates in 2000. In the BAU, we assume that $\overline{\tau}_{k,t}$ is time invariant.

Given this calibration strategy, our BAU trajectory matches the United Nations population forecasts and is characterized by (i) a progressive decline in between-country inequality, (ii) slower TFP growth in Northern Africa and Middle-East oil producing countries, (iii) greater TFP and income growth in emerging economies and least developed countries, (iv) an increase in the world proportion of college graduate workers after 2050, (v) stable immigration rates in rich countries.

Migration policy reforms - Once the BAU is calibrated, we can simulate two migration shocks, a complete repatriation of people ($x^s_{ij,t} = 0$ $\forall s, j \neq i$) or a complete liberalization of international migration, i.e. $x^s_{ij,t} = \underline{x}^s_{ij,t}$ $\forall s, j \neq i$ where $\underline{x}^s_{ij,t}$ stands for incompressible migration costs after policy restrictions have been removed. We assume the shock happens in 2025 and is permanent. To identify incompressible migration costs, we use the backsolving strategy and identify legal costs as residual of the migration technology (11) in which effective migration stocks are replaced by desired migration stocks. Data on desired migration stocks are obtained from the Gallup World Survey.

3 Results

We simulate the model over 4 periods of 25 years (2000, 2025, 2050, 2075) and compute the evolution of the world GDP, the world population and the world distribution of income. First, in the benchmark scenario (Section 3.1), we assume exogenous TFP and skill premia. In such a partial equilibrium framework, skill-specific fertility rates and basic education decisions are constant within countries. What changes the average fertility rate and the average investment in basic education is the skill structure of the population. However, because population growth is greater in poor countries, the Gini index is not constant over time. Second, we evaluate the robustness of our results to changes in the key parameters θ and λ (Section 3.2). For these simulations, the model is perfectly recursive. Third, we allow TFP and skill premia to vary with the proportion of college graduates in the resident labor force (Sections 3.3). Finally, we introduce remittances and simulate the model with a constant propensity to remit (Section 3.4). The extensions in Sections 3.3 and 3.4 involve interdependencies between economic aggregates (TFP, skill premia or remittances) and decisions about migration, education and fertility. We use a Gauss-Seidel "shooting" (or iterative) algorithm to compute the new intertemporal equilibrium.

3.1 Benchmark scenario

We first simulate the repatriation and liberalization shocks in a model with exogenous TFP and wages, i.e. in a partial equilibrium framework. In the absence of technological externalities, Docquier et al. (2012a) have shown that general equilibrium effects are relatively small. The partial equilibrium trajectory gives a very good approximation of the total change. Figure 2 illustrates how country-specific changes in the labor force and in GDP per worker relate to the initial level of GDP per worker in 2000, and describes the world distribution of income in 2025 and 2075. Table 1 gives complementary information about changes in human capital and income per worker by region.

First, we notice that although the global demographic impact of our two shocks is small, the geographic allocation of the world population is important. By 2075, a repatriation increases the world population by only 0.4 percent, but induces a 18.2 percent decrease in population in high-income countries and a 4.2 percent increase in developing countries. In case of a liberalization, the share of international migrants in the world population increases from 3 to 18 percent in 2025, and then progressively falls to 15.5 percent in 2075 due to convergence of TFP levels. Figure 2.a illustrates this and shows that changes are much greater in small countries. Figure 2.b reveals that liberalization increases the share of the world population living in rich countries. By 2075, a complete liberalization decreases the world population by only 1.8 percent but induces a 82.2 percent increase in population in high-income countries and a 19 percent decrease in developing countries.

As far as the concentration and accumulation of human capital are concerned, a repatriation reduces the world proportion of college graduates by 3.5 percent, whereas a complete liberalization increases this proportion by 31.1 percent (see Table 1). In case of repatriation, human capital decrease in high-income countries (especially in countries conducting selective immigration policies like Canada, Australia and New-Zealand and in the oil producing countries of the Persian Gulf). Short-run gains are observed in developing countries but the gains are decreasing over time because, in line with the brain gain literature, absence of skill-biases in emigration prospects reduces incentives to educate. For example, the human capital gain of sub-Saharan Africa equals 7.4 percent in 2025 and falls to 1.4 percent in 2075. These changes impact the level of GDP per worker. Figure 4.c illustrates the redistributive effect of a repatriation. The main winners are small islands developing states which currently suffer from severe brain drain effects (high-skilled emigration rates around 75 percent). In larger countries, the effects are very small.

In case of a complete liberalization, the proportion of college graduates decreases in virtually all regions. As explained in Docquier et al. (2012a), the reason is that new migrants are more educated than natives left behind (positive selection in emigration described on Figure A.2.b in the Appendix) but less educated than workers in destination countries (negative selection in immigration). The effect is lower in the long-run for two reasons. First, new migrants in rich countries invest more in the education of their children; although the migration response is decreasing over time, this explains why the effects on the World GDP and the Gini index are cumulative and increasing over time. Second, increased migration prospects stimulate education of adults. To quantify the role of this second effect, we simulate the liberalization shock without the latter incentive effect (i.e. with $\pi_{i,t}$ constant) in the last columns of Table 1. In the long-run, the incentive mechanism explains one third of the rise in educational attainment and GDP per worker. A liberalization increases the world GDP per worker by 13.3 percent in the short-run[2] and by 22.9 percent in 2075.

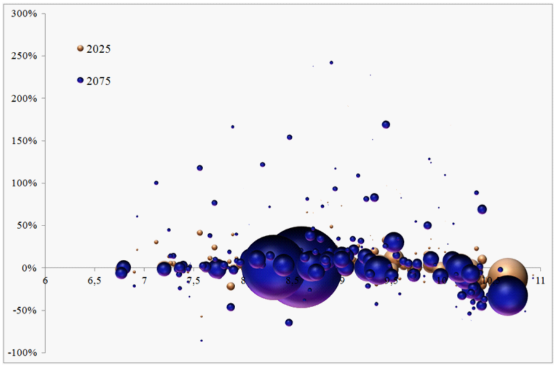
The regional effects are very heterogeneous. Although high income countries see the global performance declining (due to declining average level of human capital), the European Union experience large gains because of free mobility from Eastern to Western Europe, mobility from Europe to the United States, and incentives to educate more. Although developing countries are globally benefitting from a complete liberalization because of increased education, India, as well as other Asian countries, experience a negative effect in the short-run. As illustrated on Figure 2.d, very small countries are among the main winners and middle-sized and middle-income countries are likely to benefit from liberalization too.

As for inequality, a repatriation of all cross-border migrants decreases the Gini index by 0.8 percentage points in the short-run (2025) and by 1.4 percentage points in 2075. On the contrary, a complete liberalization of migrants increases the Gini index by 1.8 percentage points in the short-run (2025) and by 2.4 percentage points in 2075. Compared to the changes observed since the industrial revolution, these changes may look small. However, they are important when compared to the evolution since World War II (the Gini index has increased by only 2 percentage points).

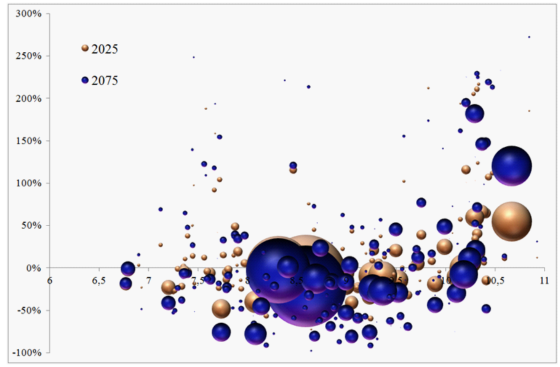
[2] This is less than in Docquier et al. (2012a) who found a 17.7 percent increase in the year 2000 without accounting for education responses. In fact, Table 1 shows that a simulation with constant education gives a 10.6 percent increase in the world GDP in 2025. The reason why the effect is lower is that we assume a convergence in TFP and wages. Hence, wage disparities across nations and efficiency gains from South-North migration are lower in 2025 than in 2000.

Figure 2. Migration shocks, population, convergence, inequality

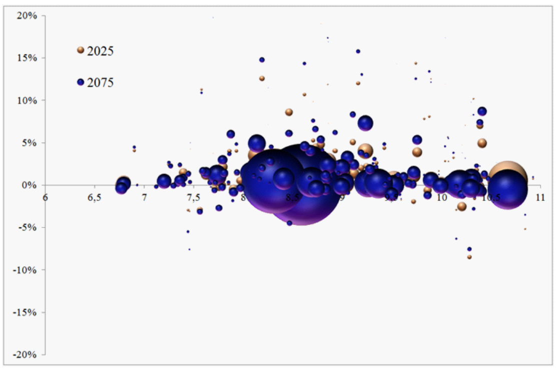
2.a. ΔLF and $\ln y_{00}$ - Repatriation



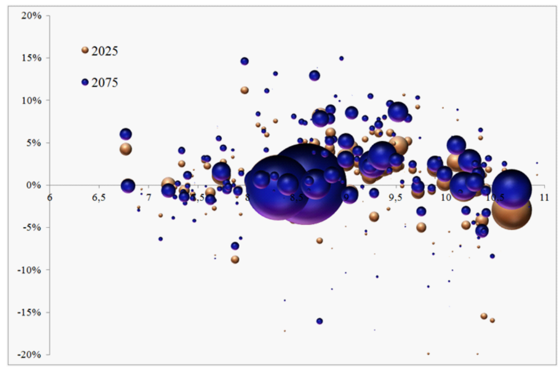
2.b. ΔLF and $\ln y_{00}$ - Liberalization



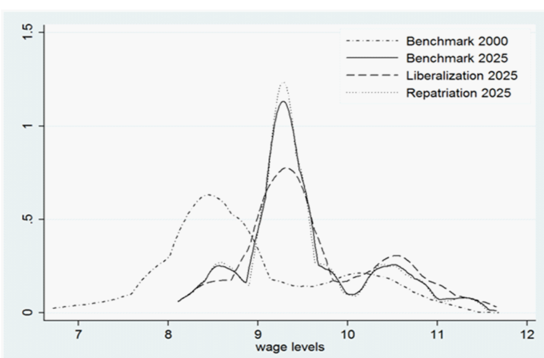
2.c. Growth and $\ln y_{00}$ - Repatriation



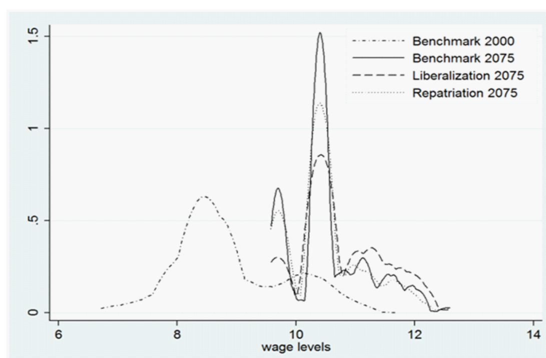
2.d. Growth and $\ln y_{00}$ - Liberalization



2.e. Income distribution in 2025



2.f. Income distribution in 2075



Note. Figures 2.a and 2.b plot changes in the labor force (percentage deviations from the baseline) over the log of GDP per worker in 2000. Figures 2.c and 2.d plot changes in GDP per worker (percentage deviations from the baseline) over the log of GDP per worker in 2000. Bubble sizes are proportional to the size of the labor force in 2000. Figures 2.e and 2.f compare the kernel distribution of wages in the world in 2000 (BAU) with 2025 and 2075 (BAU, after repatriation and after liberalization), respectively.

Table 1. Efficiency effects of migration shocks

	Repatriation				Liberalization				Liberalization (constant π)			
	Share college		GDP p.w.		Share college		GDP p.w.		Share college		GDP p.w.	
Year	2025	2075	2025	2075	2025	2075	2025	2075	2025	2075	2025	2075
WORLD	0,0%	-3,5%	-2,0%	-4,8%	16,0%	31,1%	13,3%	22,9%	0,0%	20,5%	10,6%	20,1%
HIGH	-0,3%	-4,9%	-1,2%	-4,0%	-4,0%	3,0%	1,8%	4,9%	-15,8%	-2,8%	-0,4%	3,2%
DEV	5,6%	6,7%	0,8%	0,3%	8,3%	4,2%	1,5%	3,1%	-8,1%	-6,8%	-0,6%	0,9%
LOW	8,0%	2,8%	1,3%	1,0%	-2,8%	-5,7%	-2,2%	-2,3%	-22,5%	-20,8%	-3,9%	-4,2%
LDC	7,6%	5,7%	1,2%	1,3%	-2,9%	-8,4%	-2,0%	-2,1%	-19,7%	-19,8%	-3,5%	-3,7%
SIDS	25,6%	27,8%	0,8%	-4,1%	-5,4%	5,3%	24,6%	62,7%	-24,0%	-6,8%	19,7%	55,5%
EU27	2,8%	-0,2%	-0,2%	-0,5%	14,3%	18,8%	3,6%	5,4%	-17,3%	-9,5%	0,4%	1,8%
USA	1,7%	-1,9%	0,5%	-0,5%	-10,6%	-1,9%	-3,0%	-0,5%	-15,2%	-3,2%	-4,3%	-0,9%
CANZ	-3,2%	-4,2%	-0,6%	-0,8%	-20,8%	-24,8%	-2,6%	-3,6%	-13,8%	-2,8%	-1,7%	-0,3%
CIS	1,4%	0,7%	-0,3%	-2,7%	33,2%	31,4%	3,6%	6,8%	-7,4%	-7,4%	-1,2%	0,6%
INDIA	2,9%	1,9%	0,4%	0,4%	-1,8%	-1,5%	-0,3%	-0,3%	-3,7%	-2,2%	-0,6%	-0,5%
CHINA	3,1%	2,0%	0,0%	0,0%	5,9%	6,3%	0,1%	0,1%	-2,6%	-0,7%	0,0%	0,0%
ASIA	4,7%	4,7%	0,4%	0,0%	-1,8%	10,4%	8,9%	13,0%	-9,6%	4,4%	7,7%	11,8%
GCC	-15,0%	-4,8%	-3,2%	-1,4%	-25,6%	-15,5%	-4,7%	-4,2%	-31,8%	-17,8%	-5,9%	-4,8%
MENA	9,5%	10,6%	1,1%	2,2%	18,9%	18,5%	13,9%	16,4%	-3,7%	-2,1%	9,1%	10,4%
SSA	7,2%	1,4%	0,4%	-0,3%	1,5%	7,1%	6,6%	7,4%	-23,3%	-12,4%	3,2%	3,8%
LAC	4,9%	3,9%	0,5%	-1,5%	8,0%	10,5%	4,7%	9,8%	-12,8%	-6,1%	-0,9%	2,8%

Note. Pop 25+ is the population aged 25 and over in million (proxy for the labor force). College graduates (as %) is the percentage of high-skilled adults 25+ in the labor force. Children per adult is the number of children per resident. GDP per worker is total GDP divided by the labor force in thousands of USD. We use the following abbreviations for country groups: HIGH = high-income countries, DEV = developing countries, LOW = low-income countries, LDC = least developed countries, SIDS = small islands developing states, EU27 = 27 members of European Union, USA = United States, CANZ = Canada, Australia and New Zealand, CIS = Commonwealth of Independent States (ex-Soviet Union), GCC = countries of the Gulf Cooperation Council, MENA = Middle East and Northern Africa, ASIA = other Asian countries (not included in the MENA or GCC), SSA = Sub-Saharan Africa, LAC = Latin American and Caribbean countries.

Figures 2.e and 2.f give the kernel distribution of the world income in 2000 (on both figures), 2025 (Fig 2.e) and 2075 (Fig 2.f), respectively. The distribution is based on the simulated wage data for 380 groups (195 countries times 2 education levels). In 2025 and 2075, the "three-peak" feature of the income distribution is progressively reinforced. A repatriation increases the density at low wages, and slightly decreases the mass of probability for high-income countries. A liberalization has more drastic effects going in the opposite direction. Changes in 2075 simply magnify those obtaied for 2025.

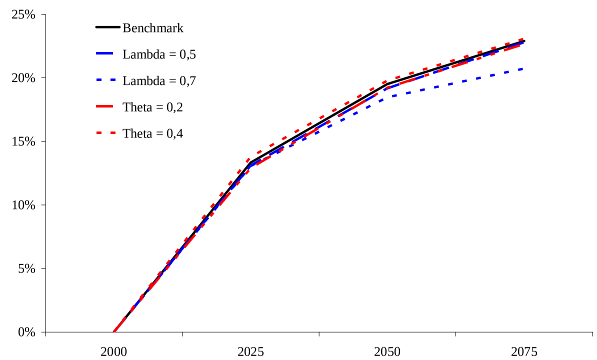
3.2 Robustness

In this section, we evaluate the robustness of the effect of a complete liberalization shock when the altruism parameter, θ, and the preference for education, λ, vary. The literature provides a range of estimates for these two parameters ($\theta \in [0.1, 0.3]$, $\lambda \in [0.5, 0.65]$). In the benchmark, we used 0.3 and 0.6, respectively. We now let each of these two parameters vary by ± 0.1 and, for each parameter set, examine the effect of a complete liberalization shock only. Other parameters and exogenous variables are left to their benchmark values. For each parameter set, we compute the new BAU and the new trajectory with liberalized migration. Figure 3 plots the percentage deviations from the new BAU for GDP per worker, the proportion of college graduates, the world labor force and the world stock of international migrants.

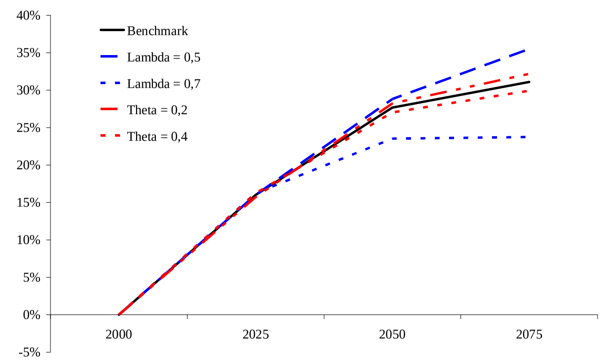
Simulations show that results are very robust to the value of these two parameters. The altruism factor θ has almost no effect on the time path of economic variables. The preference for children's education is more important. As λ increases, the human capital response to a liberalization is larger. More migrants will move if people care more about education. A liberalization will then induce more investments in basic and college education, lower fertility and population growth. The effect on GDP per worker will be slightly greater. Figure 3 shows that increasing λ by 0.10 has a relatively small impact on our results. Decreasing λ by 0.10 has greater effects on human capital, population growth and GDP per worker. The total income effect of a liberalization in the long-run decreases from 22.9 to 20.7 percent. Still, the orders of magnitude of all responses are comparable to that obtained in the benchmark scenario.

Figure 3. Effect of a liberalization shock with alternative parameter values (Percentage deviation from the BAU)

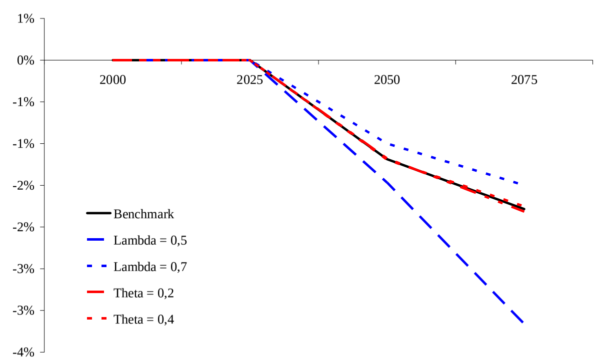
3.a. World GDP per worker



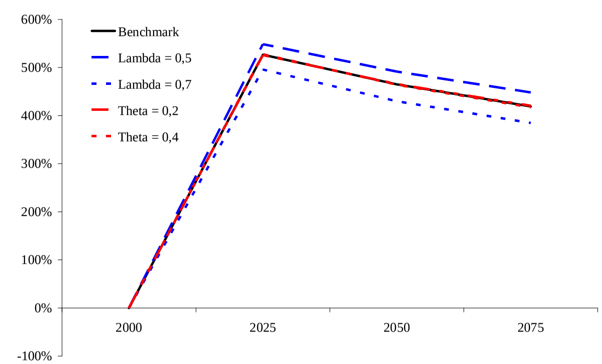
3.b. World proportion of college graduates



3.c. World labor force



3.d. World stock of international migrants



Note. Figure 3.a to 3.d plot the percentage deviation from the BAU scenario for the years 2000 to 2075 and for four variables: GDP per worker, proportion of college graduates, population over age 25 and the stock of international migrants.

3.3 Endogenous technology

We now compute the impact of a liberalization shock when general equilibrium effects are factored in. We allow the skill premium and the TFP to vary with the proportion of college graduates in the country. Docquier et al. (2012a) compared partial and general equilibrium responses to a liberalization shock. They concluded that general equilibrium effects are small in a framework without externality. When they use a CES production function with exogenous TFP and account for the endogeneity of the skill premium, the world income response to liberalization decreases from 17.5 to 16.5 percent. However, when they endogenize TFP, the income response is divided by two and falls to 8.5 percent.

We first simulate the model with exogenous TFP and endogenous skill premium. We assume an elasticity of the skill premium to the skill ratio (ratio of college graduates to less educated workers) of one third and use the following ad hoc specification:

$$\sigma_{i,t}^{NEW} = \sigma_{i,t}^{BAU} \left(\frac{h_{i,t}^{NEW}}{1 - h_{i,t}^{NEW}} / \frac{h_{i,t}^{BAU}}{1 - h_{i,t}^{BAU}} \right)^{1/3} \qquad \forall i, t$$

where $x_{i,t}^{BAU}$ stands for the value obtained in the BAU scenario for any variable x, and $x_{i,t}^{NEW}$ is the value obtained after the shock. A similar prediction would be obtained if production was governed by a CES technology combining high-skilled and low-skilled workers with an elasticity of substitution equal to 3 (as in Docquier et al., 2012a). Given our production function (17), the difference with a CES framework is that the wage rate of low-skilled workers is here treated as constant: changes in skill premia only affect the wage rates of college graduates.

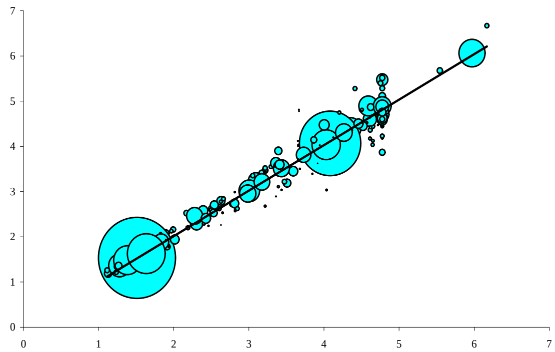
Second, we simulate the model with exogenous skill premium and endogenous TFP. We assume an elasticity of TFP to the proportion of college graduates of 0.3 (as in Docquier et al., 2012a):

$$A_{i,t}^{NEW} = A_{i,t}^{BAU} \left(\frac{h_{i,t}^{NEW}}{h_{i,t}^{BAU}} \right)^{0.3} \qquad \forall i, t$$

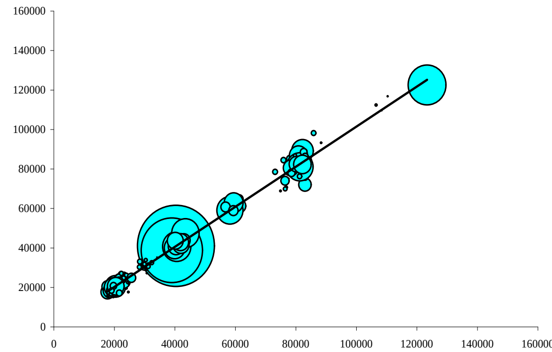
Figure 4.a and 4.b plot the new levels of skill premia and TFP levels in 2075 over the BAU levels in 2075. Figures 4.c and 4.f plot the percentage deviations from the new BAU for GDP per worker, the proportion of college graduates, the world labor force and the world stock of international migrants. Figure 4.a shows thet skill premia after the shock are almost identical to the BAU values, except in a few small countries. Hence, on figure 4.c to 4.f, the endogeneity of the skill premium has almost no impact on our results. This is because education is here endogenized and better migration prospects increase investment in education in the world. Due to increased human capital and contrary to Docquier et al. (2012a), the short-run effect on GDP per worker is slightly higher than in a partial equilibrium framework. However, differences with a partial equilibrium framework are very small.

Figure 6. Effect of a liberalization shock with endogenous technology

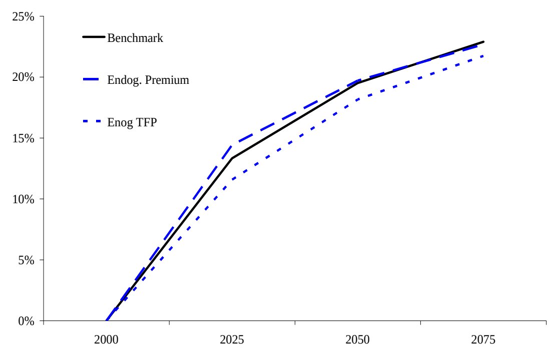
4.a. Skill premium in 2075 (Lib.. over BAU)



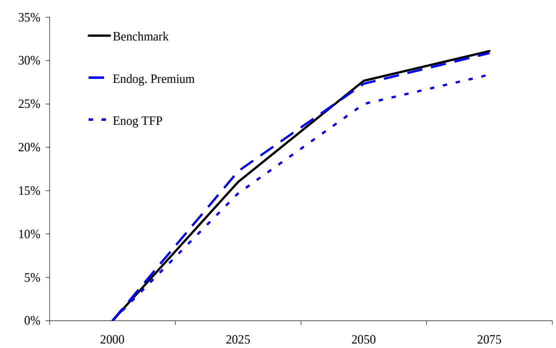
4.b. TFP in 2075 (Lib. over BAU)



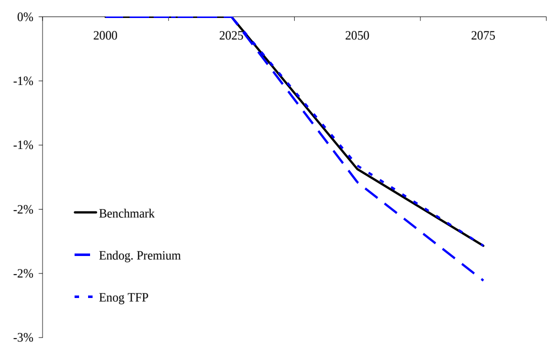
4.c. World GDP per worker



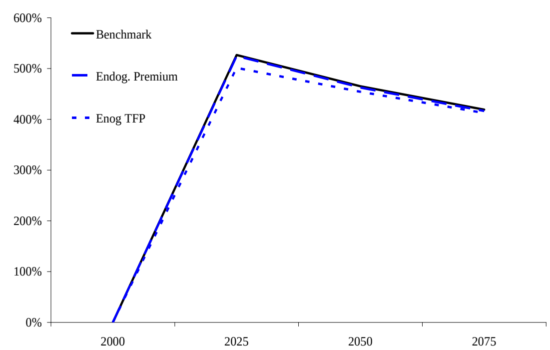
4.d. World proportion of college graduates



4.e. World labor force



4.f. World stock of international migrants



Note. Figure 4.c to 4.f plot the new (endogenous) skill premia and TFP level over those of the BAU levels. Figure 4.c to 4.f plot the percentage deviations from the BAU scenario for the years 2000 to 2075 and for four variables: GDP per worker, proportion of college graduates, population over age 25 and the stock of international migrants.

When TFP is endogenized, the human capital and GDP per worker effects are reduced. In Docquier et al. (2012a), the effect was divided by two because liberalization reduced the proportion of high-skilled workers in all countries. This is due to the fact that new migrants are more educated than natives left behind (positive selection in emigration) but less educated than workers in destination countries (negative selection in immigration). In our framework with endogenous education, this selection mechanism is compensated by greater investments in education. As shown on Figure 4.d, the world proportion of college graduated adults increases by about 15 percent in the short-run, and 30 percent in the long-run (with a partial equilibrium model, we had +16.0 and +31.1 percent, respectively). Hence, the TFP levels are very similar to those obtained in a partial equilibrium framework, as shown on Figure 4.b. Contrary to Docquier et al. (2012a), endogenizing the TFP has a very small impact on the efficiency gains from a liberalization and on its distributive impact.

3.4 Remittances

We now study how remittances affect the gains and redistributive effects of a liberalization. As in Marchiori et al. 2012, we modify the model and assume that migrants from country i living in country j derive utility from a combination of consumption goods $(g^s_{j,t})$ and remittances $(r^s_{j,t})$. In the utility function, this means that $c^s_{j,t} = \left(g^s_{j,t}\right)^{1-\rho_i} \left(r^s_{j,t}\right)^{\rho_i}$. Maximizing this subject to $c^s_{j,t} = g^s_{j,t} + r^s_{j,t}$ gives $r^s_{j,t} = \rho_i c^s_{j,t}$. Assuming all migrants from country i share the same ρ_i and remittances are equally shared among recipients, the amount of remittances received by each stayer left behind equals $b_{i,t} = \rho_i \sum_{j,s} N^s_{ij,t} c^s_{j,t} / \sum_s N^s_{ii,t}$.

Parameter ρ_i can be calibrated to match the amount of remittances received by stayers in country i. The amount $b_{i,t}$ must be introduced in the budget constraint of non-migrants. Remittances affect the indirect utility and incentive to move.

[To be continued]

4 Conclusion

This paper investigates the effect of migration policy reforms (repatriation or liberalization) on the world distribution of income. We develop and parametrize a dynamic model with endogenous migration, fertility and education. With exogenous TFP and skill premium trajectories in all countries, repatriating migrants to their home country would reduce the world GDP per worker and the Gini index by 2.0 percent and 0.8 percentage points, respectively (as in Kapur and McHale 2009). On the contrary, liberalizing migration would increase the world GDP per worker and the Gini index by 13.3 percent and 1.8 percentage points, respectively. Although the migration response is decreasing over time, the effects on the World GDP per worker and the Gini index are increasing over time. This is due to a cumulative impact of education and migration decisions: new migrants assimilate in terms of fertility and investment in children's education. In the long-run, repatriating migrants to their home country would reduce the world GDP per worker and the Gini index by 4.8 percent and 1.4 percentage points, respectively. On the contrary, liberalizing migration would increase the world GDP per worker and the Gini index by 22.9 percent and 2.4 percentage points, respectively. Endogeneity of fertility decisions has a relatively low impact on our results. However, accounting for the brain gain mechanism modifies the world proportion of educated: this effect accounts for two-thirds of the short-run and long-run impacts on the world proportion of college graduates and GDP per worker. In a model with endogenous skill premia or human-capital technological externalities on the TFP, the effects are very similar. Although selection in migration affects the distribution of human capital across countries, this effect is compensated by greater investments in education. Overall, the skill premia and TFP responses to migration policy reforms are negligible.

References

[1] Barro, Robert & Jong-Wha Lee (2010). A New Data Set of Educational Attainment in the World, 1950-2010. NBER Working Paper No. 15902.

[2] Barro Robert J. & Xavier Sala-i-Martin (1992). Convergence. Journal of Political Economy 100 (2): 223-251.

[3] Bourguignon, François & Christian Morrisson (2002): Inequality Among World Citizens: 1820-1992. American Economic Review 92 (4), 727-744.

[4] de Palma, André & Karim Kilani (2007). Invariance of conditional maximum utility. Journal of Economic Theory 132, 137-146.

[5] Caselli Francesco (2005). Accounting for cross-country income differences. Handbook of Economic Growth, Aghion P, Durlauf S (eds). Elsevier: Amsterdam, 1445–1775.

[6] Clemens, Michael A. (2011). Economics and Emigration: Trillion Dollar Bills on the Sidewalk? Journal of Economic Perspectives 25 (3): 83-103.

[7] Defoort, Cecily (2008). Tendances de long terme des migrations internationales: Analyse a partir des 6 principaux pays receveurs. Population 63 (2): 285-318.

[8] de la Croix, David & Matthias Doepke (2003). Inequality and Growth: Why Differential Fertility Matters. American Economic Review 93: 1091-1113.

[9] de la Croix, David & Matthias Doepke (2004). Public versus private education when differential fertility matters. Journal of Development Economics 73: 607–629.

[10] de la Croix, David & Axel Gosseries (2009). Population policy through tradable procreation entitlements. International Economic Review 50 (2): 507-542.

[11] di Giovanni, Julian & Andrei Levchenko & Francesc Ortega (2012). A Global View of Cross-Border Migration. CReAM Discussion Paper Series 1218.

[12] Docquier, Frédéric & Olivier Lohest & Abdslam Marfouk (2007). Brain drain in developing countries. World

[13] Bank Economic Review 21: 193-218.

[14] Docquier, Frédéric & B. Lindsay Lowell & Abeslam Marfouk (2009). A gendered assessment of highly skilled emigration. Population and Development Review, 35 (2), 297-322.

[15] Docquier, Frédéric & Joël Machado & Khalid Sekkat (2012a). Efficiency gains from liberalizing labor mobility. IRES Discussion Paper 2012-023.

[16] Docquier, Frédéric & Tobias Müller & Joaquin Naval (2013). Informality and long-run growth. IRES Discussion Paper 2013-xxx.

[17] Docquier, Frédéric & Çağlar Ozden & Christopher Parsons & Ehran Artuc (2012b). A Global Assessment of Human Capital Mobility: the Role of non-OECD Destinations. IRES Discussion Paper 2012-022.

[18] Docquier, Frédéric & Hillel Rapoport (2012). Globalization, brain drain and development. Journal of Economic Literature 50 (3): 681-730.

[19] Esipova, Neli & Julie Ray & Rajesh Srinivasan (2011). The World's Potential Migrants. Who They Are, Where They Want to Go, and Why It Matters. Gallup, Inc: Washington DC.

[20] Grogger, Jeffrey & Gordon Hanson (2011). Income Maximization and the Selection and Sorting of International Migrants. Journal of Development Economics 95 (1): 42-57.

[21] Haveman, Robert & Barbara Wolfe (1995). The determinants of children's attainments: a review of methods and findings. Journal of Economic Literature 33 (4): 1829–1878.

[22] Knowles, John (1999). Can Parental Decisions Explain U.S. Income Inequality? Working Paper. University of Pennyslvania.

[23] Hendricks, Lutz (2004). A Database of Mincerian Earnings Regressions. Available online at: www.lhendricks.org/Mincer.htm.

[24] Kapur, Devesh & John McHale (2009): International migration and the world income distribution. Journal of International Development 21, 1102-1110.

[25] King, Robert G. (1995). Quantitative theory and econometrics. Economic Quarterly, Federal Reserve Bank of Richmond, 53-105.

[26] Marchiori, Luca & I-Ling Shen & Frédéric Docquier (2012). Brain drain in globalization: a general equilibrium analysis from the perspective of sending countries. Economic Inquiry, forthcoming.

[27] McFadden, Daniel L. (1984). Econometric analysis of qualitative response models. In: Griliches, Z., Intriligator, M. (Eds.), Handbook of Econometrics, Volume 2. Elsevier/North-Holland, Amsterdam.

[28] Pritchett, Lant (1997). Divergence, Big Time. Journal of Economics Perspetives 11 (3): 3-17.

[29] Quah, Danny (1997). Empirics for Growth and Distribution: Polarization, Stratification, and Convergence Clubs. Journal of Economic Growth 2: 27-59.

[30] Sala-I-Martin, Xavier (2006): The world distribution of income: falling poverty and convergence period. Quarterly Journal of Economics 121 (2): 351–397.

Appendix on parametrization

Before simulating repatriation and liberalization shocks, we calibrate the model to fit the evolution of the world economy between 1975 and 2000 and to fit the demographic projections of the United Nations for the period 2000-2075. Section A describes our calibration strategy and defines the "Baseline as Usual" trajectory of the world economy (henceforth denoted BAU). Then, in Section B, we identify migration barriers that would be removed in case of a complete liberalization of cross-border migration.

A. Calibration of the BAU

The calibration of the BAU is based on the six steps described below. Figure A1 and Table A1 illustrate some major stylized facts.

First, preferences are assumed to be identical across countries and time invariant. The set of structural parameters, (θ, λ, ϕ) , is calibrated using insights from the recent literature. As for parameter ϕ, the time-cost of having a child, evidence in Haveman and Wolfe (1995) and Knowles (1999) suggests that the opportunity cost of a child is equivalent to about 15 percent of the parents' time endowment. This means that the maximal/biological fertility rate equals 6.7 children per adult, or 13 per couple. As for the altruism parameter θ, the literature provides a range of values between 0.10 in de la Croix and Gooseries (2009), 0.17 in de la Croix an Doepke (2004), 0.19 in Docquier et al. (2013), 0.27 in de la Croix an Doepke (2003). As for the preference for basic education λ, de la Croix and Doepke (2003, 2004) used values of 0.635 and 0.6, respectively, while de la Croix and Gooseries (2009) used 0.578. We use $(\theta, \lambda, \phi) = (0.3, 0.6, 0.15)$. In a robustness analysis, we will let parameters θ and λ to vary by ± 0.1. We also normalize the scale parameter μ to unity in the distribution of random component of utility, a standard assumption in the literature on the determinants of migration.

Second, data on the size and education structure of the native and resident labor forces in 2000 ($N^s_{i,00}$, $L^s_{i,00}$ and $h_{i,00}$) are obtained from Docquier, Lowell and Marfouk (2009). Data on the size and structure of the resident labor force in 1975 ($N^s_{i,75}$ and $h_{i,75}$) are taken from Defoort (2008). Aggregating natives with secondary and tertiary education in 2000, $q_{i,75}N_{i,00}$, we identify the number of children who received basic education in the previous period. Calculating the proportion of college educated natives among adults with basic education, $\pi_{i,00} = N^h_{i,00}/q_{i,75}N_{i,00}$, allows us to identify the proportion of skilled among the labor force $z_{i,00} = \pi_{i,00}q_{i,75}$. The average growth rate of the population is given by $n_{i,75} = N_{i,00}/L_{i,75}$.

Third, we calibrate wages and Total Factor Productivity (TFP) in 1975 and 2000. Data on GDP in USD in 1975 and 2000 are obtained for the World Development Indicators. We estimate the wage ratio between college graduates and the less educated using data on returns to schooling and average years of education. Mincerian returns to schooling, MR_i, are available for 54 countries in Hendricks (2004) around the year

2000. For the same countries, we use Barro and Lee (2010) data and compute the difference in years of schooling in 2000, $DY_{i,00}$, between college graduates and the less educated. The wage ratio is then computed as $\sigma_{i,00} = (1 + MR_{i,00})^{DY_{i,00}}$. For countries where data are not available, we predict the wage ratio using a log-linear function of the skill ratio in the resident labor force, $\ln \sigma_{i,00} = 0.25 - 0.31 \ln \frac{h_{i,00}}{1-h_{i,00}}$ (see Figure A.1.a). These parameters are obtained from a simple OLS regression (R^2=0.57). The slope of this function is compatible with a CES production function combining high-skilled and low-skilled workers with an elasticity of substitution of 3 (as in Docquier et al., 2012a). In the baseline scenario, we assume $\sigma_{i,t}$ is time invariant (i.e. we fix within-country inequality to its level in 2000). For the years 1975 and 2000, we identify $A_{i,t}$ as a residual of the production function (17), and wages, $w_{i,t}^s$, using (18) and (19). Figure A.1.b clearly shows a convergence process in TFP levels: the growth rate of TFP has been large in initially poorer countries. Hence, in the BAU, we assume a 1.3 average annual growth rate of TFP in the United States and use the following estimated specification for other countries

$$\begin{aligned} \ln\left(\frac{A_{i,t+1}}{A_{i,t}}\right) &= -0.53 + 0.52 \ln\left(\frac{A_{US,t}}{A_{i,t}}\right) + 0.69 HIGH_i \\ &\quad +0.37 EMER_i + 0.65 GCC_i + 0.19 LAC_i \end{aligned}$$

where $(HIGH_i, EMER_i, GCC_i, LAC_i)$ is a set of regional dummies for high-income countries, emerging countries, members of the Gulf Cooperation Council and Latin America and the Caribbean. All coefficients are significant at less than 1 percent while other regional dummies are not. Given this convergence process in the BAU, the TFP interquartile ratio and its coefficient of variation are divided by two between 2000 and 2075 (from 7.04 to 3.65 and from 1.32 to 0.65, respectively). The combination of convergence forces and regional dummies is such that TFP growth will be lower in Northern Africa and Middle-East oil producing countries than in other high-income countries. Our baseline is compatible with a long-run decline of TFP in the oil industry.

Fourth, we calibrate the deterministic part of utility, $\ln v_{i,t}^s$. Our identification strategy assumes that (i) high-skilled parents educate all their children ($q_{i,75}^h = 1$), (ii) high-skilled parents have a fixed number of children $\overline{n}_{i,75}^h$ close to the replacement rate, and (iii) for cultural reasons, child labor is only envisaged in low-skilled families ($\varphi_i^l = 1$ and $\varphi_i^h = 0$). Using data on $n_{i,75}$ and $h_{i,75}$, we identify $n_{i,75}^l$ as the residual of (13). As for the choice of $\overline{n}_{i,75}^h$, we use data from Kremer and Chen (1999) who computed the differential fertility in 1985-89 for 26 developing countries. On average, the fertility differential between college graduates and less educated workers, $n_{i,t}^h/n_{i,t}^l$, equals 0.605, and the correlation between country-specific fertility differentials and the human capital of women is so low (0.14) that we can consider the fertility differential as independent of the level of development. We set $\overline{n}_{i,75}^h$ in such a way that the world average level of $n_{i,t}^h/n_{i,t}^l$ equals 0.605 which gives a value of 1.025 (i.e. the high-skilled fertility rate equals the demographic replacement rate). We calibrate $w_{i,t}^c$ as a residual of (6) and have:

$$\omega_{i,75} \equiv \frac{w^c_{i,75}}{w^l_{i,75}} = \phi - \frac{\theta(1-\lambda)}{n^l_{i,75}} > 0.$$

Since $n^l_{i,75}$ exceeds unity in every country, a sufficient condition for $\omega_{i,t}$ to be positive is $\phi > \theta(1-\lambda)$. This variable governs the growth rate of the labor force. In 1975, the calibrated level of $\omega_{i,75}$ is negatively correlated with GDP per capita (coefficient of correlation of -0.5). We expected such a negative correlation since child labor and labor participation rates of young individuals below age 25 are decreasing with development. In the BAU and in line with the convergence in TFP levels, we assume $\omega_{i,t}$ will be 2, 20 and 40 percent lower than $\omega_{i,75}$ in the years 2000, 2025 and 2050, respectively. With this trend in $\omega_{i,t}$, our population projections in the BAU (a world labor force of 4.956, 6.722 and 7.874 billion in 2025, 2050 and 2075, respectively) fit very well the medium demographic projections of the United Nations (4.903, 6.370 and 7.202 billion in 2025, 2050 and 2075, respectively). Then, we calibrate $e^h_{i,75}$ as a residual of (9) and express it as a fraction of $w^h_{i,75}$, the wage of high-skilled workers (i.e. teachers):

$$\varepsilon^h_{i,75} \equiv \frac{e^h_{i,75}}{w^h_{i,75}} = \frac{\theta}{\overline{n}^h_{i,75}} - \phi > 0.$$

Because $\overline{n}^h_{i,75}$ is constant across countries, we obtain a constant value of 0.143 for all countries. Finally, we calibrate $e^l_{i,75}$ as a residual of (14), accounting for (6) and (7):

$$e^l_{i,75} = \frac{\lambda n^l_{i,75}(1-h_{i,75})(\phi w^l_{i,75} - w^c_{i,75})}{(1-\lambda)(n_{i,75}q_{i,75} - \overline{n}^h_{i,75}h_{i,75})} - w^c_{i,75}$$

and compute $\varepsilon^l_{i,75} \equiv e^l_{i,75}/w^h_{i,75}$, which is not correlated with the level of GDP per capita (coefficient of correlation of -0.015). The BAU assumes that $\varepsilon^s_{i,75}$ are time invariant for all s. On this basis, we can compute the optimal level of the deterministic component of utility, $\ln v^s_{i,t}$ $\forall i, t$.

Fifth, the data set in Docquier et al. (2012b) documents bilateral migration stocks in 2000 for all pairs of countries ($N^s_{ki,00}$) and stocks of native stayers ($N^s_{kk,00}$) by education level. Bilateral migration costs $(1-x^s_{ki,00})$ are calibrated for each pair of countries as residuals of (11). In the BAU, we assume that $x^s_{ki,t} = x^s_{ki,00}$ are constant for all s. Hence, two forces are governing the evolution of cross-border migration. On the one hand, population growth is larger in poor countries: this would increase the immigration pressure in high-income countries at constant wages. On the other hand, TFP convergence reduces wage disparities across countries and incentives to emigrate. In the BAU, these two forces balance out so that immigration rates in rich countries are almost constant over time. Figure A.1.c shows the strong correlation between immigration rates in 2000 and 2075. Due to the TFP decline in oil producing countries, large decrease in immigration rates are predicted for these countries.

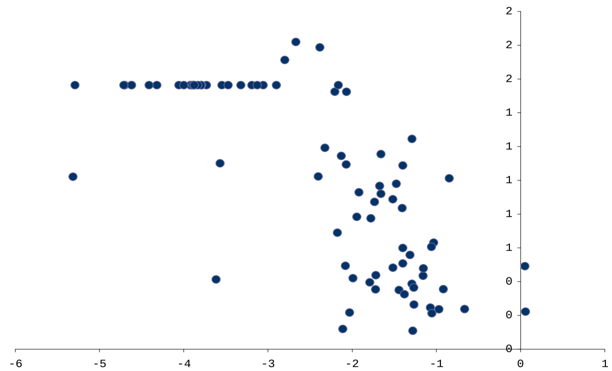
Once levels of $\ln v^s_{i,00}$ and $(1-x^s_{ki,00})$ are calculated, the (before-migration) expected utility of college graduates and less educated workers from country k can be calculated as $\ln \sum_{i=1}^{I}(1-x_{ki,00}^{h})v_{i,00}^{h}$. The upper bound of the higher education cost $\overline{\tau}_{k,00}$ can then be obtained as a residual of (12). This gives

$$\overline{\tau}_{k,00} = \frac{\sum_{i=1}^{I}(1-x_{ki,00}^{h})v_{i,00}^{h}}{\pi_{i,00}\sum_{i=1}^{I}(1-x_{ki,00}^{l})v_{i,00}^{l}} - \frac{1-\pi_{i,00}}{\pi_{i,00}}$$

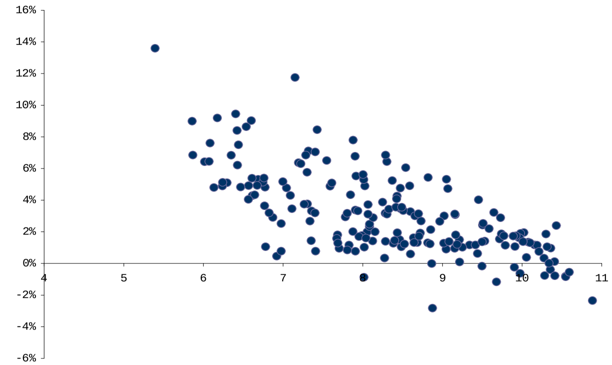
In the BAU, we assume that $\overline{\tau}_{k,t}$ is time invariant. The world proportion of college graduates will increase from 11.2 to 16.7 percent between 2000 and 2075 (see Table A.1 and Figure A.1.d). It will double in developing countries and increase by about one third in high-income countries. Combined with TFP growth, the rise in human capital increases GDP per worker from USD 11.3 to 48.8 thousand between 2000 and 2075 (see Table A.1). Spectacular increases are observed in emerging economies (China, India, Latin America) and, to a lesser extent, in the least developed countries.

Figure A1. Calibration of the BAU

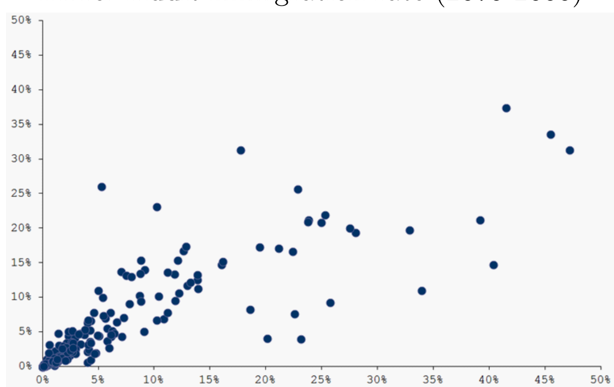
A.1.a. Wage ratio and human capital, 2000



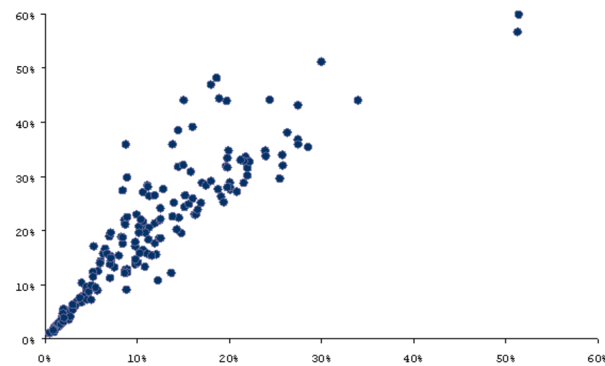
A.1.b. beta-convergence in TFP, 1975-2000



A.1.c. Adult immigration rate (2075-2000)



A.1.d. Share of college graduates (2075-2000)



Note. Figure A.1.a plots the log of the wage ratio between college graduates and the less educated (Y-axis) over the log of the skill ratio. The elasticity equals -0.301 (R^2=0.56). Figure A.1.b plots the average annual growth rate of TFP between 1975 and 2000 over the log of TFP in 1975. The convergence speed equals 1.5 percent per year (R^2=0.49). Figures A.1.c and A.1.d plot the immigration rates and shares of college graduates in the labor force in 2075 over its value in 2000. Immigration are stable in most countries, except in oil producing countries where they decrease due to convergence in TFP. On average, the proportion of college educated increases from 11.2 to 15.7 percent between 2000 and 2075.

Table A1. Regional predictions in the BAU

	Pop.25+ (in mil.)				College graduates (as %)				Children per adult				GDP per worker (in thous.)			
	2000	2025	2050	2075	2000	2025	2050	2075	2000	2025	2050	2075	2000	2025	2050	2075
World	3,180	4,956	6,722	7,874	11.2	11.2	13.1	15.7	1.56	1.36	1.17	1.17	11.3	18.2	30.1	48.8
HIGH	694	913	1,131	1,334	30.1	32.2	36.2	39.8	1.24	1.16	1.10	1.11	30.4	43.9	65.8	99.2
DEV	2,486	4,043	5,591	6,541	5.9	6.5	8.4	10.8	1.65	1.40	1.19	1.19	6.0	12.4	22.9	38.5
LOW	248	474	721	892	2.5	2.7	3.6	4.6	1.95	1.54	1.25	1.25	2.2	5.5	10.9	18.4
LDC	250	480	733	906	2.1	2.4	3.2	4.2	1.97	1.56	1.26	1.26	2.1	5.3	10.7	18.2
SIDS	25	40	53	58	9.8	10.9	14.8	19.0	1.81	1.46	1.22	1.21	10.9	16.9	27.4	43.9
EU27	337	412	469	502	19.3	21.3	24.4	27.6	1.21	1.11	1.04	1.04	23.8	33.7	49.8	73.6
USA	184	251	337	443	51.3	53.3	55.7	56.6	1.19	1.17	1.16	1.16	43.1	63.9	94.8	139.5
CANZ	36	51	68	86	43.6	45.9	50.5	52.8	1.22	1.15	1.12	1.12	31.9	40.3	55.4	78.6
CIS	173	211	236	241	17.7	19.0	21.7	24.8	1.24	1.13	1.04	1.04	9.7	15.5	24.5	37.8
INDIA	482	874	1,284	1,559	4.7	5.2	6.8	8.8	1.82	1.47	1.21	1.21	4.1	11.2	23.4	40.8
CHINA	759	974	1,125	1,171	2.6	2.7	3.1	3.6	1.29	1.16	1.04	1.04	5.4	12.0	21.6	34.7
ASIA	561	968	1,381	1,648	10.2	10.0	11.9	14.4	1.75	1.45	1.21	1.21	10.5	16.2	26.7	42.6
GCC	14	33	57	80	12.8	12.0	15.7	20.3	1.88	1.51	1.25	1.24	28.6	37.7	56.6	85.8
MENA	132	271	422	517	7.8	8.5	11.8	16.1	2.13	1.63	1.29	1.28	7.8	10.6	16.6	25.9
SSA	225	431	660	821	3.1	3.1	4.0	5.1	1.92	1.53	1.25	1.25	3.5	6.7	12.4	20.4
LAC	251	443	637	755	11.4	12.9	17.6	23.4	1.83	1.49	1.22	1.21	11.0	22.1	41.9	73.5

Note. Pop 25+ is the population aged 25 and over in million (proxy for the labor force). College graduates (as %) is the percentage of high-skilled adults 25+ in the labor force. Children per adult is the number of children per resident. GDP per worker is total GDP divided by the labor force in thousands of USD. We use the following abbreviations for country groups: HIGH = high-income countries, DEV = developing countries, LOW = low-income countries, LDC = least developed countries, SIDS = small islands developing states, EU27 = 27 members of European Union, USA = United States, CANZ = Canada, Australia and New Zealand, CIS = Commonwealth of Independent States (ex-Soviet Union), GCC = countries of the Gulf Cooperation Council, MENA = Middle East and Northern Africa, ASIA = other Asian countries (not included in the MENA or GCC), SSA = Sub-Saharan Africa, LAC = Latin American and Caribbean countries.

B. The liberalization variant

Once the BAU is calibrated, we can simulate two migration shocks, a complete repatriation of people ($x^s_{ij,t} = 1 \; \forall s, j \neq i$) or a complete liberalization of international migration, i.e. $x^s_{ij,t} = \underline{x}^s_{ij,t} \; \forall s, j \neq i$ where $\underline{x}^s_{ij,t}$ stands for incompressible migration costs after policy restrictions have been removed. We assume the shock happens in 2025 and is permanent.

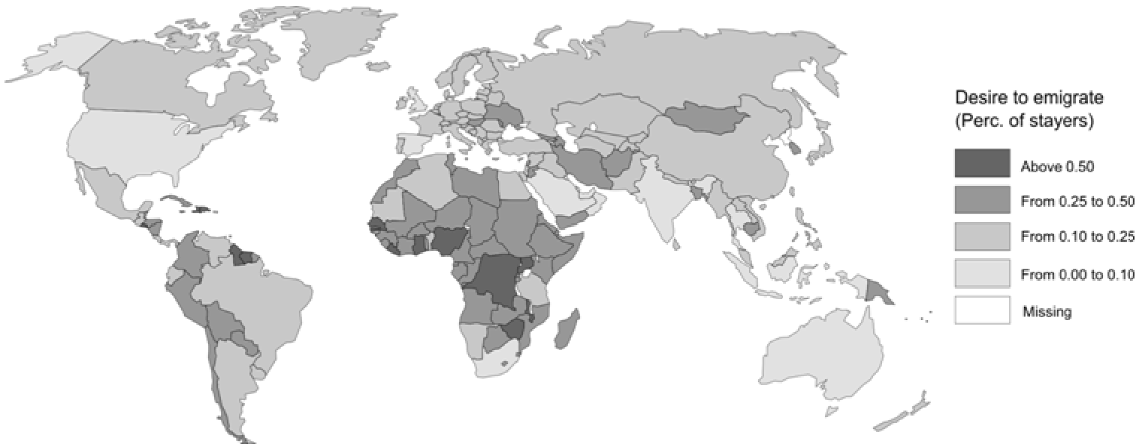
To identify incompressible migration costs, we use the backsolving strategy and identify legal costs as residual of the migration technology (11) in which effective migration stocks are replaced by desired migration stocks. In order to estimate the desired migration stocks, we follow Docquier et al. (2012a) and rely on the Gallup World Survey. This survey was organized between 2007 and 2009. It is based on phone and face-to-face interviews with 260.000 adults (1.000-3.000 per country), aged 15+, in a total of 135 countries (representing about 93 percent of the world's adult population). Two questions are of interest for our analysis: "Ideally, if you had the opportunity, would you like to move permanently to another country, or would you prefer to continue living in this country?", and "To which country would you like to move?". We consider that "having the opportunity" is interpreted by the respondents as the complete absence of policy restrictions to movement. For each pair of countries and skill group, we compute the number of would-be migrants and add them to the number of effective migrants.

The Gallup 2007 Survey reveals that nearly 700 million adults would like to permanently emigrate to another country if they could (see Esipova et al., 2011). As shown on Figure A.2.a, most of these would-be migrants originate from poor countries and in particular from sub-Saharan Africa. The proportion of stayers who express aspirations to emigrate varies between one third and one half in the poorest countries. Stayers with higher education are the most likely to express a desire to emigrate although positive selection in desired migration is much smaller than in effective migration. Figure A.2.b shows that the average skill ratio of desires to emigrate is around 1.5 in low-income countries while the same ratio computed for effective migration ranges between 10 and 20. Two-thirds of these potential migrants named the United States as the top desired destination; other important destinations are Canada, European countries and Saudi Arabia.

Assuming that respondents do not internalize general equilibrium effects generated by the migration of other stayers in the world (i.e. the $\ln v^s_{i,t}$'s are fixed to their baseline values), we can identify incompressible migration costs in 2000 ($\underline{x}^s_{ij,00}$) as residuals of (11). In our liberalization experiment, we assume $x^s_{ij,t} = \underline{x}^s_{ij,00}$ from 2025 on.

Figure A2. Size and education structure of desired migration in 2007

A.2.a. Average desire to emigrate



A.2.b. College graduates to less educated ratio of desires to emigrate

Source: Gallup World Poll Survey, described in Esipova et al. (2011)