The international platform of Ludwig-Maximilians University's Center for Economic Studies and the Ifo Institute

CESifo Working Papers

www.cesifo.org/wp

The Dynamic Implications of Liberalizing Global Migration

Marco Delogu
Frédéric Docquier
Joël Machado

CESIFO WORKING PAPER NO. 4596
CATEGORY 6: FISCAL POLICY, MACROECONOMICS AND GROWTH
JANUARY 2014

An electronic version of the paper may be downloaded
- *from the SSRN website: www.SSRN.com*
- *from the RePEc website: www.RePEc.org*
- *from the CESifo website: www.CESifo-group.org/wp*

CESifo
Center for Economic Studies & Ifo Institute

CESifo *Working Paper No. 4596*

The Dynamic Implications of Liberalizing Global Migration

Abstract

This paper quantitatively investigates the short- and long-run effects of liberalizing global migration on the world distribution of income. We develop and parametrize a dynamic model of the world economy with endogenous migration, fertility and education decisions. We identify bilateral migration costs and their legal component for each pair of countries and two classes of worker. Our analysis reveals that the effects of a liberalization on human capital accumulation, income and inequality are gradual and cumulative. In case of a complete liberalization, the world average level of GDP per worker increases by 20 percent in the short-run, and by more than 55 percent after 50 years. The world average index of inequality decreases and the liberalization path has stochastic dominance over the Baseline-As-Usual. These results are very robust to our identifying assumptions. We also analyze partial liberalization shocks: efficiency and inequality effects are roughly proportional to the "liberalization rate".

JEL-Code: O150, F220, F630, I240.

Keywords: migration, migration policy, liberalization, growth, human capital, fertility, inequality.

Marco Delogu
University of Luxembourg
162A Avenue de la Faïencerie
Luxembourg – 1511 Luxembourg
marco.delogu@uni.lu

Frédéric Docquier
IRES, Catholic University of Louvain
3 Place Montesquieu (bte L2.06.01)
Belgium – 1348 Louvain-la-Neuve
frederic.doxquier@uclouvain.be

Joël Machado
IRES, Catholic University of Louvain
3 Place Montesquieu (bte L2.06.01)
Belgium – 1348 Louvain-la-Neuve
joel.machado@uclouvain.be

This paper was presented at the IZA workshop on "Migration and Human Capital" (May 2013), the NORFACE conference in Nottingham (Sept. 2013) and seminars in Bari, Bonn, Geneva, Gothenburg and Nantes. We are grateful to Simone Bertoli, Bastien Chabé-Ferret, Guiseppe de Arcangelis, Gordon Hanson, Giovanni Peri, Hillel Rapoport and seminar participants for their comments and suggestions. The authors acknowledge CESifo sponsorship for the participation at the CESifo Economic Studies Conference on Migration held on December 2013 and financial support from the ARC convention on "Geographical Mobility of Factors" (convention 09/14-019).

1 Introduction

In this paper, we quantify the impact of liberalizing cross-border migration on the world average level of GDP per worker (referred to as the efficiency effect in the literature) and the world distribution of income (referred to as the inequality effect). The existing literature on liberalization disregards the effects of migration on human capital formation and demographic growth. For the first time, we use a dynamic model which accounts for education and fertility responses to changes in cross-border migration. Our quantitative analysis reveals that the long-run impact of liberalizing labor mobility exceeds by far the short-run impact. Liberalizing labor mobility reduces population growth and improves the skill structure of the world labor force. Its effects on the world distribution of income are gradual and cumulative.

The economic consequences of a liberalization of cross-border migration have been quantified in a limited set of studies. All of them use static models and, in most cases, assume that a complete liberalization would lead to wage equalization across countries. On average, these studies predict that (i) about 50 percent of the world population would live in a foreign country after a complete liberalization, and (ii) eliminating all restrictions to labor mobility would induce huge efficiency gains in the range of 50 to 150 percent of world GDP.[1] More precisely, in a scenario assuming there are no differences in inherent productivity of people (i.e. a Mexican worker migrating to the US is as productive as a US citizen), liberalization increases the world GDP by 147.3 percent in Hamilton and Whalley (1984), 122.0 percent in Klein and Ventura (2007), 96.5 percent in Moses and Letnes (2004). Less optimistic results are obtained when foreign workers are assumed to be less productive than natives. Iregui (2005) is the first to account for differences in workers' educational attainment (i.e. a low-skilled Mexican migrating to the US is as productive as a low-skilled US worker but less than the average American). Under the same set of hypotheses, she found that relocating people to equalize wages would increase the world GDP by 67.0 percent. In the latter study, the semi-elasticity of the world GDP to the share of international migrants in the world population is around 1.2. Note that Winters (2001) or Walmsley and Winters (2005) simulated the effect of an exogenous increase in developed countries' immigration quotas on both high-skilled and low-skilled migrants equivalent to 3 percent of the labor force (i.e. 0.5 percent of the world labor force). Using a global CGE model with two skill levels, they predicted a $150 billion increase in the world GDP (+0.6 percent), i.e. a semi-elasticity of the world GDP to the share of migrants of about 1.2 as in Iregui (2005). More recent studies have investigated the economic impact of free-mobility agreements using stylized models with two regions (Klein and Ventura, 2009; Iranzo and Peri, 2009) or with a single preferred location for the new migrants (Kennan, 2012). They provide numerical illustrations, which cannot be directly compared with those obtained under a full liberalization of global migration.

[1] A summary of these predictions is provided in Clemens (2011).

In these studies, private (or non-visa) migration costs are disregarded or modeled in a simplistic way. This is an important shortcoming as the empirical literature on the determinants of migration has long emphasized the role of geographic and cultural distances. For example, psychic and monetary moving costs explain why within-EU migration flows have been limited despite large income differences between EU member states and a free mobility agreement, or why large income disparities exist within countries. The first study accounting for the existence of "incompressible" moving costs is Docquier et al. (2012). They quantified the effect of liberalization on the world economy using a model jointly endogenizing migration decisions and economic performances. They use a "backsolving" calibration strategy which consists of using original data on effective and desired emigration by education level to identify total migration costs and visa costs as residuals of the migration technology. Data on desired migration are obtained 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 after a complete liberalization and obtain a semi-elasticity of the world GDP to the share of migrants of 1.15. This is in line with the existing studies accounting for skill differences across people (Iregui 2005, Winters 2001, Walmley and Winters, 2005). Hence, their relatively small efficiency effect is totally explained by the inclusion of incompressible migration costs, and not by the technological features of their model. When country-specific levels of total factor productivity are affected by human capital, the semi-elasticity falls and the efficiency effect of a liberalization can be much lower. The reason is that on average, 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). Almost all regions end up with a lower fraction of skilled workers among their workforce after a liberalization.

This paper develops a dynamic extension of the latter study and accounts for the role of effective migration and/or migration prospects on education and fertility decisions. Education and fertility are affected because the majority of new migrants move from South to North and assimilate in terms of fertility and children's education decisions.[2] Furthermore, increased emigration prospects stimulate incentives to acquire higher education in developing countries (See Mountford 1997, Stark et al. 1997, Beine et al. 2001 and 2008). Consequently, a liberalization gradually reduces population growth and improves the skill structure of the world labor force. These effects are cumulative and gradual so that the long-run impact of liberalizing labor mobility is likely to exceed the short-run impact. Similar mechanisms have been formalized in Mountford and Rapoport (2011), who developed a stylized model with

[2]Many studies on internal migration have found that it leads to convergence of fertility rates between migrants and urban natives. See among others, Lee and Pol (1993) or Bockeroff (1995). Convergence is also obtained in studies of international migration, including Stephen and Bean (1992) and Lindstrom and Giorguli Saucedo (2002) for women of Mexican origin living in the US. See also Chiswick and Miller (2012) and Fernandez and Fogli (2009).

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. For the first time, we incorporate these ingredients into a micro-founded macroeconomic model of the world economy including 195 receiving and sending countries, and then properly confront theory to data.

Our framework is 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. 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. Then we simulate the effects of a complete liberalization of migration from 2025 onwards and investigate its effect on the world distribution of income.

Our numerical experiments confirm that the effects of a liberalization on human capital accumulation, income and inequality are gradual and cumulative. A complete liberalization of labor mobility increases the proportion of international migrants from 3.2 to 21 percent in the short-run, and 18 in the long-run. In the short-run, the world average level of GDP per worker increases by only 20 percent and the semi-elasticity of GDP to migration (1.3) is slightly higher than that obtained in previous studies. The reasons are that the shock occurs in 2025 and new migration prospects increase the expected return to higher education. New migrants face a better environment to educate their offspring: liberalizing migration gradually stimulates the world proportion of college graduates. Fifty years after the shock, the world GDP per worker will exceed the level of the baseline-as-usual scenario by more than 50 percent. Hence, if large efficiency gains can be expected from a liberalization, they will be observed in the long-run and will impact the welfare of future generations. As for inequality, the Theil index gradually decreases in most scenarios. Again, the short-run effect is small (-1.5 percentage point) but the long-run effect is much larger (-8 percentage points). This does not imply that liberalizing migration is Pareto-improving. There are many winners and a few losers. However, we show that the liberalization path has stochastic dominance over the baseline-as-usual path; it has first-order dominance in partial equilibrium, and second-order dominance with endogenous wages. These results are very robust to our identifying strategy and to assumptions about the technological environment. Last but not least, we also consider partial liberalization shocks, i.e. a cut in legal migration restrictions by less than 100 percent. We show that the efficiency and inequality effects are roughly proportional to the "liberalization rate"; in other words, cutting legal moving costs by ϑ percent allows to realize slightly less than ϑ percent of the maximal gains from a complete liberalization.

The rest of this paper is organized as following. Section 2 describes the model and defines its competitive equilibrium. The parametrization of the model is presented in Section 3. Results are then commented in Section 4. Section 5 concludes.

2 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 born in country i and moving to country j), and how to allocate her/his resources between consumption, raising children, and providing basic education to a fraction of them.

After migration, the resident labor force of type s in country i is given by:

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

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 balances of high-skilled and low-skilled labor.

Each country produces a homogenous good and is characterized by a production technology which combines high-skilled and low-skilled labor. Young individuals can also supply labor in the informal economy, being considered as less productive than low-skilled workers.

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

$$U_{ki,t}^s = \ln v_{i,t}^s + \ln(1 - x_{ki,t}^s) - \ln \tau^s + \varepsilon_{ki,t}^s$$

where $\ln v_{i,t}^s \in \Re$ is the deterministic component of utility, $x_{ki,t}^s \in [0,1]$ measures total effort required to move from country k to country i (such that $x_{ii,t}^s = 0$), $\tau^s \geq 1$ 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, they differ across individuals but 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 ($\varepsilon^s_{ki,t}$) but know its distribution. They form expectations about the 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 (reflected in $\ln v^s_{i,t}$), 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. The decision depends on the institutional characteristics of the country and education level of the parents. This determines the indirect utility function $\ln v^s_{i,t}$.

These three stages are obviously connected. We thus solve this optimization problem backward.

2.1 Consumption, fertility and basic education

In the third stage, utility depends on the consumption level ($c^s_{j,t} \in \Re^+$), 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 $\theta \in [0,1]$ and $\lambda \in [0,1]$ are preference parameters for children and children's 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 a child's basic education cost 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 worker, $w^c_{i,t}$ is the wage rate for a child (reflecting country-specific, social and institutional norms towards child labor), and φ_i^s 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:

$$\frac{(1-\theta)\left[\phi w_{i,t}^s + q_{i,t}^s e_{i,t}^s - (1-q_{i,t}^s) w_{i,t}^c \varphi_i^s\right]}{c_{i,t}^s} - \frac{\theta}{n_{i,t}^s} = 0 \qquad (4)$$

$$\frac{(1-\theta)\, n_{i,t}^s \left[e_{i,t}^s + w_{i,t}^c \varphi_i^s\right]}{c_{i,t}^s} - \frac{\theta\lambda}{q_{i,t}^s} \geq 0 \qquad (5)$$

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

$$n_{i,t}^s = \frac{\theta w_{i,t}^s}{\phi w_{i,t}^s + q_{i,t}^s e_{i,t}^s - (1-q_{i,t}^s) w_{i,t}^c \varphi_i^s}$$

Assume first that (5) holds with equality (*interior solution*). Combining (4) and (5) gives the optimal fertility rate and investment in basic education:

$$n_{i,t}^s = \frac{\theta(1-\lambda) w_{i,t}^s}{\phi w_{i,t}^s - w_{i,t}^c \varphi_i^s} \qquad (6)$$

$$q_{i,t}^s = \frac{\lambda}{1-\lambda} \frac{\phi w_{i,t}^s - w_{i,t}^c \varphi_i^s}{e_{i,t}^s + w_{i,t}^c \varphi_i^s} \qquad (7)$$

The fertility rate decreases with the wage rate ($w_{i,t}^s$) and increases with child labor's income ($w_{i,t}^c$). Children's basic education increases with the wage rate ($w_{i,t}^s$), decreases with the education cost ($e_{i,t}^s$) and with child labor's income ($w_{i,t}^c$).

The condition for an interior solution writes as

$$w_{i,t}^s \leq \frac{(1-\lambda) e_{i,t}^s + w_{i,t}^c \varphi_i^s}{\phi\lambda} \qquad (8)$$

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

$$n_{i,t}^s = \frac{\theta w_{i,t}^s}{\phi w_{i,t}^s + e_{i,t}^s} \qquad (9)$$

Substituting the optimal levels of utility and basic education investment into (2) defines the optimal level of indirect utility, $\ln v_{i,t}^s$.

2.2 Migration

In the second stage, individuals discover their migration taste $\varepsilon^s_{ki,t}$, anticipate the distribution of $\ln v^s_{i,t}$ in all the 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. We normalize the scale parameter μ to unity in the distribution of random component of utility.

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

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

It follows that the ratio of bilateral migrants to stayers is then given by

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

2.3 Higher education

In the first stage, individuals do not know their migration type ($\varepsilon^s_{ki,t}$) 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

$$\ln \sum_{i=1}^I e^{\ln v^h_{i,t} + \ln(1 - x^h_{ki,t})} - \ln \tau = \ln \sum_{i=1}^I (1 - x^h_{ki,t}) v^h_{i,t} - \ln \tau$$

whereas the expected utility of a less educated worker amounts to

$$\ln \sum_{i=1}^{I} e^{\ln v_{i,t}^{l} + \ln(1-x_{ki,t}^{l})} = \ln \sum_{i=1}^{I} (1-x_{ki,t}^{l}) v_{i,t}^{l}$$

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

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

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

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

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

The average fertility rate in country i is given by

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

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 because $\pi_{i,t}$ is determined at time t.

2.5 Technology

We assume the following production function:

$$Y_{i,t} = A_{i,t} F\left(\ell_{i,t}^{h}, \ell_{i,t}^{l}\right) \tag{17}$$

where $A_{i,t}$ denotes total factor productivity and $F(.)$ features the substitutability between high-skilled and low-skilled workers. 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.

The wage rates are determined by the marginal productivity of labor :

$$w_{i,t}^{h} = A_{i,t} F_{h}^{'}\left(\ell_{i,t}^{h}, \ell_{i,t}^{l}\right) \tag{18}$$

$$w_{i,t}^{l} = A_{i,t} F_{l}^{'}\left(\ell_{i,t}^{h}, \ell_{i,t}^{l}\right) \tag{19}$$

$$w_{i,t}^{c} = \omega_{i,t} A_{i,t} F_{l}^{'}\left(\ell_{i,t}^{h}, \ell_{i,t}^{l}\right) \tag{20}$$

and we denote by $\sigma_{i,t} = w_{i,t}^{h}/w_{i,t}^{l}$ the wage ratio between high-skilled and low-skilled workers (one plus the skill premium).

In our numerical analysis, we will consider several variants of the production technology, with linear or CES specification for $F(.)$ and with exogenous or endogenous levels of total factor productivity.

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*[3] $\left\{A_{i,t}, e_{i,t}^{s}, \varphi_{i}^{s}, \overline{\tau}_{j,t}, \sigma_{i,t}, \omega_{i,t}\right\}_{\forall i,t}$*, a set of bilateral migration costs* $\left\{x_{ij,t}^{s}\right\}_{\forall i,j,t,s}$*, a functional form for $F(.)$, 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 endogenous variables* $\left\{w_{i,t}^{s}, \pi_{i,t}, z_{i,t}, h_{i,t}, n_{i,t}^{s}, q_{i,t}^{s}, N_{ij,t}^{s}, L_{i,t}^{s}\right\}_{\forall i,j,t,s}$ *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).*

We will parametrize a baseline intertemporal equilibrium for the world economy and simulate the effects of liberalization shocks.

[3] We will consider scenarios with endogenous wages ($\sigma_{i,t}$) and endogenous TFP ($A_{i,t}$).

2.7 World distribution of income

As a by-product of its competitive equilibrium, the model endogenizes the level of income inequality among the world citizens. We use the Theil index of inequality and compute it on adults' wage using the following expression:

$$T_t = \sum_{i \in I; s=l,h} SHW_{i,t}^s \ln \left(\frac{SHW_{i,t}^s}{SHN_{i,t}^s} \right)$$

where $SHW_{i,t}^s$ is the share of the world labor income earned by adults of type s living in country i at time t and $SHN_{i,t}^s$ is the share of the world adult population of the same class of individuals.

The advantage of the Theil is that it can easily be decomposed between the within-country and across-country components. This property allows to disentangle the sources of inequality:

$$\begin{aligned} T_t &= T_t^{within} + T_t^{across} \\ T_t^{within} &= \sum_{i \in I} SHW_{i,t} \sum_{i \in I; s=l,h} \frac{SHW_{i,t}^s}{SHW_{i,t}} \ln \left(\frac{SHW_{i,t}^s / SHW_{i,t}}{SHN_{i,t}^s / SHN_{i,t}} \right) \\ T_t^{across} &= \sum_{i \in I} SHW_{i,t} \ln \left(\frac{SHW_{i,t}}{SHN_{i,t}} \right) \end{aligned}$$

where $SHW_{i,t}$ and $SHN_{i,t}$ are the shares of country i in the world labor income and population (including college graduates and less educated workers).

Another criterion that can be used to characterize the effect of a liberalization on the world distribution of income is stochastic dominance. Let $\Phi(w)$ denote the cumulative distribution function of wages. Liberalization has first-order stochastic dominance over the BAU trajectory if

$$\Phi_{BAU}(w^{'}) - \Phi_{LIB}(w^{'}) \geq 0 \;\; \forall w^{'},$$

i.e. if the after-liberalization proportion of people earning less than w is lower than the BAU proportion, for all $w^{'}$.

The second-order stochastic dominance is a less demanding criterion. Liberalization has second-order dominance over the BAU trajectory if the area under Φ_{LIB} from $-\infty$ to $w^{'}$ is lower or equal to the area under Φ_{BAU} on the same interval, for all $w^{'}$. This implies that

$$\int_{-\infty}^{w^{'}} \left[\Phi_{BAU}(w) - \Phi_{LIB}(w) \right] dw \geq 0 \;\; \forall w^{'}.$$

We analyze stochastic dominance using the discrete approximation of the world distribution of income (with 2 times 195 groups of workers) generated by our model.

3 Parametrization

The model is calibrated assuming that one period represents 25 years. Our parametrization strategy is designed to match the evolution of the world economy between 1975 and 2000 and to fit the demographic projections of the United Nations for agents aged 25+ for the period 2000-2075 (United Nations, 2011). The calibration is done under three technological scenarios presented in Section 3.1. The values of preference parameters and the time path of country characteristics are then discussed in Section 3.2. The underlying Baseline-As-Usual or before-shock trajectory (BAU) is discussed in Section 3.3. Finally, we identify migration barriers that would be removed in case of a complete liberalization of cross-border migration in Section 3.4.

3.1 Technological environment

Cross-border migration impacts the size and structure of the labor force in origin and destination countries. Hence, it is likely to affect the levels of total factor productivity and wages in origin and destination countries. We calibrate the model to fit GDP and skill premium data in 1975 and 2000. Then we predict benchmark levels for the total factor productivity and wages under three technological variants and simulate the effect of a liberalization from 2025 onwards. This section presents our data sources and the three technological scenarios.

Data on the size and education structure of the resident labor force in 1975 and 2000 ($L^s_{i,t}$) are obtained from Docquier, Lowell and Marfouk (2009) and Defoort (2008). Data on GDP in USD in 1975 and 2000 are obtained for the World Development Indicators (2010). Combining these sources, we can compute the average labor income in each country (equivalent to GDP per worker) and the proportion of college graduates in the labor force. We can also 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 around the year 2000 in Hendricks (2004). 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 is not available, we predict the wage ratio using a log-linear function of the skill ratio in the resident labor force.[4] We then compute the wage of high-skilled and low-skilled workers in 1975 and 2000 using our country-specific estimates for the average wage, the wage ratio and the proportion of college graduates.

To identify total factor productivity and to predict wage levels after 2000, we need to specify the analytical form of the production function. We use three variants of the technological environment.

[4] A simple OLS regression gives $\ln \sigma_{i,00} = 0.25 - 0.31 \ln \frac{h_{i,00}}{1-h_{i,00}}$ with R^2=0.57.

Scenario 1 - The first variant assumes that $F(.)$ in (17) is a linear function of high-skilled and low-skilled labor, and that total factor productivity $A_{i,t}$ grows at a constant and homogenous rate of 1.5 percent per year (i.e. 45 percent per period) in all the countries. We have

$$\begin{aligned} F\left(\ell_{i,t}^h, \ell_{i,t}^l\right) &= \sigma_i \ell_{i,t}^h + \ell_{i,t}^l \\ A_{i,t} &= A_{i,t-1}(1+0.015)^{25} \end{aligned}$$

with σ_i fixed at its level in 2000, and $A_{i,2000}$ calibrated as a residual of (17). This first scenario can be considered as a partial equilibrium scenario in which the levels of total factor productivity and wages are not affected by migration shocks.

Scenario 2 - The second variant assumes that $F(.)$ is a CES combination of high-skilled and low-skilled labor:

$$F\left(\ell_{i,t}^h, \ell_{i,t}^l\right) = \left[s_{i,0}\left(\ell_{i,t}^h\right)^{\frac{s_1-1}{s_1}} + (1-s_{i,0})\left(\ell_{i,t}^l\right)^{\frac{s_1-1}{s_1}}\right]^{\frac{s_1}{s_1-1}}$$

where $s_{i,0}$ is a country-specific parameter affecting the relative productivity of high-skilled workers and s_1 denotes the structural elasticity of substitution. $s_{i,0}$ is calibrated as to match the the wage ratio σ_i observed in 2000 in each country while we set $s_1 = 3.0$ as in Docquier et al. (2012). The wage ratios observed in 2000 are thus matched by construction.

When $F(.)$ is specified, total factor productivity in 2000 can be calibrated as a residual of (17) and is assumed to evolve as in Scenario 1. In this second scenario, a liberalization affects the skill premium and wage inequality in origin and destination countries.

Scenario 3 - In the third variant, we come back to the linear specification for $F(.)$ but assume that total factor productivity is a concave function of the proportion of college graduates in the resident labor force. Again, $A_{i,2000}$ is calibrated as a residual of (17) and for subsequent years, we have:

$$A_{i,t} = A_{i,t-1}(1+0.015)^{25}\left(\frac{h_{i,t}}{\overset{\circ}{h}_{i,t}}\right)^{s_2}$$

where s_2 denotes the elasticity of total factor productivity to human capital and $\overset{\circ}{h}_{i,t}$ corresponds to the proportion of college graduates observed at year t for the reference Scenario 1. Again, for the sake of comparison, we use the same elasticity as in Docquier et al. (2012): $s_2 = 0.32$. In this scenario, a liberalization affects total factor productivity. Accounting for such schooling externalities played an important role in Docquier et al. (2012). New migrants being more educated than natives left behind (positive selection in emigration) and less educated than workers in destination countries (negative selection in immigration), a liberalization reduced the proportion of college graduatues and total factor productivity in almost all the regions. Results are less obvious in our framework because education decisions are endogenous.

3.2 Preference parameters

We now discuss the calibration of preference parameters and country-specific variables affecting fertility, education and migration decisions.

Structural parameters (θ, λ, ϕ) - 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 Gosseries (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 Gosseries (2009) used 0.578. We use $(\theta, \lambda, \phi) = (0.3, 0.6, 0.15)$. In a robustness analysis, we will decrease parameters θ and λ by 0.1.

Variables affecting fertility and basic education $(w^c_{i,75}, e^h_{i,75}, e^l_{i,75})$ - First, we combine data on the resident and native labor forces to identify average education and fertility outcome variables. We use data on the native labor force in 2000 $(N^s_{i,00})$ from Docquier, Lowell and Marfouk (2009) and data on the resident labor force in 1975 $(L^s_{i,75})$ from Defoort to identify the average fertility rate as $n_{i,75} = N_{i,00}/L_{i,75}$. Aggregating natives with secondary and tertiary education in 2000, we obtain $q_{i,75}N_{i,00}$, and identify the proportion of children who received basic education in 1975 $(q_{i,75})$. Then, using the proportion of college educated natives among adults with basic education, $\pi_{i,00} = N^h_{i,00}/(q_{i,75}N_{i,00})$, we identify the proportion of educated among the native adult population, $z_{i,00} = \pi_{i,00}q_{i,75}$.

Second, we calibrate country characteristics to match the average education and fertility outcomes and reasonable behavioral differences between high-skilled and low-skilled individuals. We assume that (i) high-skilled parents educate all their children $(q^h_{i,75} = 1)$, (ii) high-skilled parents have a fixed number of children $\overline{n}^h_{i,75}$ close to the replacement rate, and (iii) for cultural reasons, child labor is only envisaged in low-skilled families $(\varphi^l_i = 1$ and $\varphi^h_i = 0)$. Using data on $n_{i,75}$ and $h_{i,75}$, we identify $n^l_{i,75}$ as the residual of (13). As for the choice of $\overline{n}^h_{i,75}$, 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, $n^h_{i,t}/n^l_{i,t}$, equals 0.605, and the correlation between country-specific fertility differentials and the proportion of college graduates is so low (0.14) that the fertility differential can be considered to be independent of the level of development. We iterated on $\overline{n}^h_{i,75}$ and chose its level in such a way that the world average level of $n^h_{i,t}/n^l_{i,t}$ equals 0.605. This requires a value of 1.025 (i.e. the high-skilled fertility rate roughly equals the demographic replacement rate). We calibrate $w^c_{i,75}$ 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 the BAU and in line with the demographic transition, 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 labor force 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 in United Nations (2011) (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 the 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 $\varepsilon^l_{i,75} \equiv e^l_{i,75}/w^h_{i,75}$. On the BAU trajectory, we assume that $\varepsilon^s_{i,t} = \varepsilon^s_{i,75}$ are time invariant for all s and t.

Bilateral migration costs ($x^s_{ki,00}$) - We use the data set in Docquier et al. (2012b), which 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. As optimal fertility and education decisions have been identified, we can compute the optimal level of the deterministic component of utility, $\ln v^s_{i,t}$ $\forall i,t$. Bilateral migration costs $(1-x^s_{ki,00})$ can be 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.

Higher education technology ($\overline{\tau}_{k,t}$) - 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 $\ln \sum_{i=1}^{I}(1-x^s_{ki,00})v^s_{i,00}$. The upper bound of the higher education cost $\overline{\tau}_{k,00}$ can then be obtained as a residual of (12). This gives

$$\overline{\tau}_{k,00} = \frac{\sum_{i=1}^{I}(1-x^h_{ki,00})v^h_{i,00}}{\pi_{i,00}\sum_{i=1}^{I}(1-x^l_{ki,00})v^l_{i,00}} - \frac{1-\pi_{i,00}}{\pi_{i,00}}$$

On the BAU trajectory, we assume that $\overline{\tau}_{k,t}$ is time invariant.

Validation - As far as we can, we use all the degrees of freedom of the data to identify the needed parameters and country characteristics. Hence, our model cannot produce a test of its assumptions. In order to establish the relevance of our identification method, we examine whether our identified country-specific parameters exhibit realistic correlations with observations for related variables that are not matched by our model or viewed as traditional determinants in the empirical literature. Correlation rates are presented in Table 1.

The first column shows that the calibrated relative income of children is negatively correlated with development, the quality of institutions, the level of public expenditure per student in secondary education, and positively correlated with the share of the population living in rural areas. More importantly, the correlation with the proportion of economically active children is large (59 percent). Variable $\omega_{i,75}$ captures well parents' incentives to rely on child labor. The second column shows that the calibrated cost of basic education decreases with development and increases with the share of population living in urban area, where access to schooling is uneasy. Finally, the effort required to acquire higher education is negatively correlated with development, the quality of institutions, the level of public expenditure per student in secondary and tertiary education, and positively correlated with the share of the population living in rural areas.

Table 1. Correlation between identified country characteristics and data

	ω_i	ε_i^l	$\overline{\tau}_i$
GNI per capita[a]	-0.51	-0.27	-0.60
Government effectiveness[b]	-0.48	-0.07	-0.49
Political stability[b]	-0.33	-0.12	-0.45
Share of rural population[a]	0.44	0.36	0.60
Economically active children (percentage of 7-14)[a]	0.59	0.30	0.58
Public education expend. per student (secondary level)[a]	-0.59	0.00	-0.50
Public education expend. per student (tertiary level)[a]	-0.13	-0.10	-0.15

Data sources. [a] World Development Indicators (2010), [b] Kauffmann, Kraay and Mastruzzi (2009)

3.3 BAU trajectory

Figure 1 gives the 2000-2075 trajectory generated by our BAU assumptions under the three technological scenarios.

Demographic forecasts are very stable across scenarios. Remember that we adjust $\omega_{i,t}$ in the years 2025, 2050, and 2075 to fit the population projections in United Nations (2011). Our population growth rates are compatible with the realization of the demographic transition in poor countries. As shown on Figure 1.e, the world average fertility rate decreases from 1.56 in 2000 to 1.17 in 2075. Figure 1.b shows that the world population size increases from 8 to 17 billion (18 billion in Scenario 2). The gradual fall in $\omega_{i,t}$ induces higher parental investment in basic education, which later translates into higher investment in tertiary education. Consequently, the proportion of college graduates in the world labor force gradually increases from 11.2

percent in 2000 to 16 percent. As shown on Figure 1.c, small differences are observed across scenarios, except in Scenario 2, where the increase in the proportion of college graduates is visibly lower. In the latter scenario, the rise in human capital is slowed down by the negative impact that it has on the skill premium, thereby reducing incentives to educate.

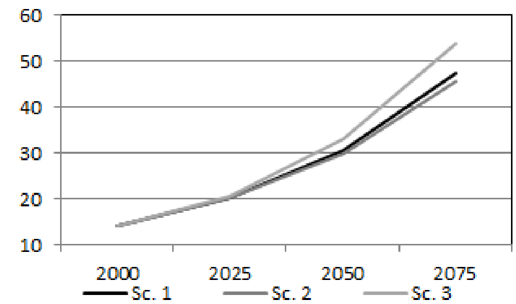
Exogenous TFP growth and increased human capital boost GDP per worker. On Figure 1.a, the average level of GDP per worker increases from about $14,200 in 2000 to $47,000 in 2075 under Scenarios 1 and 2. On average, the annual growth of GDP per worker amounts to 1.6 percent. Economic growth is larger if total factor productivity increases with human capital. In Scenario 3, the average level of GDP per worker reaches $53,900 (an average annual growth rate of 1.8 percent).

In all the scenarios, we predict that the world migration rate will be very stable over time (see Figure 1.d). Despite the fact that the population in the South increases compared to the North, our BAU does not involve drastic changes in immigration rates to the North. In the United States, the immigration rate increases from 13.2 to 14 percent; in CANZ, it decreases from 24.3 to 21.8; in the GCC it is divided by two because of large demographic growth in this region. The rise is more pronounced in the EU27 (from 6.6 to 10.8 percent).

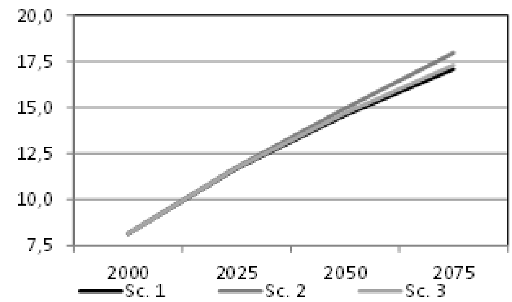
As far as income inequality is concerned, Bourguignon and Morrisson (2002) and Pritchett (1997) documented that inequality in the world distribution of income worsened between the industrial revolution and World War I (the Theil index increased from 0.52 to 0.80), and has grown much more slowly since then. In the early 19th century most inequality was due to differences within countries; later, it was due to differences across countries (accounting for about two-thirds of inequality). Sala-I-Martin (2006) found a Theil index of 0.78 in 2000 and identified a significant decrease in inequality indices during the 1990's (due to the take-off in China, India and other major globalizers). Our calibrated Theil index is around 0.4 in 2000. This is much lower than the value obtained in Bourguignon and Morrisson (2002) and Sala-I-Martin (2006) for two main reasons. First, our Theil index is only based on wages earned by employed adults (this explains why our across-country index amounts to 0.32 instead of 0.52 in Sala-I-Martin's study). Second, it does not account for inequality between individuals living in a given country and sharing identical educational attainment; this explains why our within-country index amounts to 0.05 instead of 0.26 in Sala-I-Martin's study.

Figure 1. World average values on the BAU path

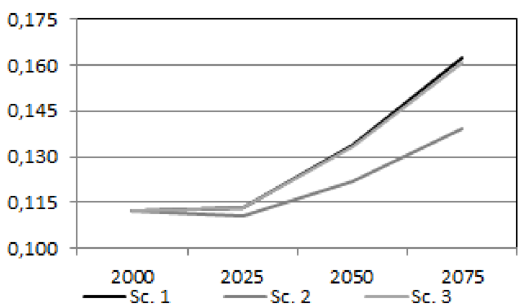
1.a. GDP per worker (x1,000)



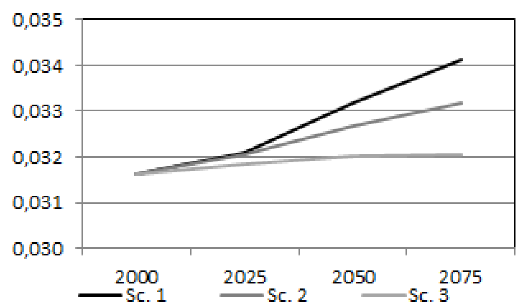
1.b. Population (x1,000,000,000)



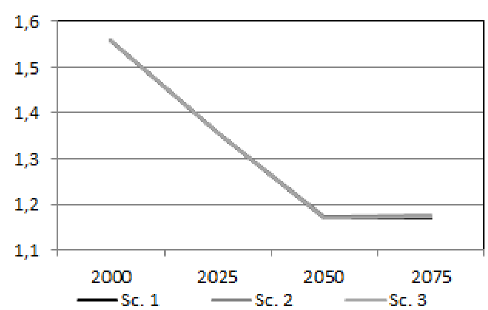
1.c. Proportion of college graduates



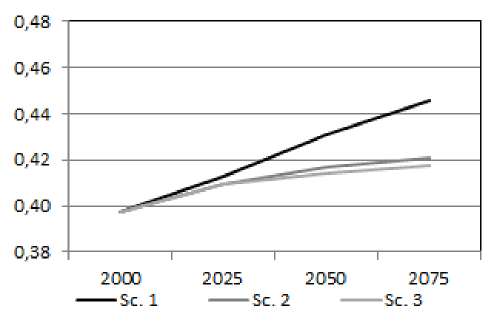
1.d. Proportion of immigrants



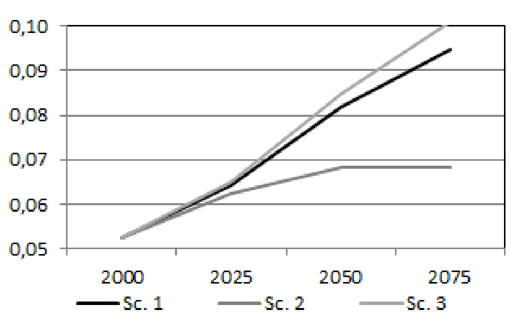
1.e. Fertility rate



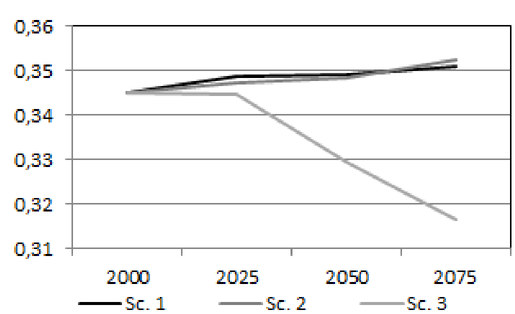
1.f. Theil index of inequality



1.g. Within-country inequality



1.h. Across-country inequality



On the BAU path, our Theil index is fairly stable over time across scenarios: it increases from 0.40 to 0.44 in partial equilibrium and from 0.40 to 0.42 in Scenarios 2 and 3 (see Figure 1.f). In Scenario 2, the global rise in educational attainment has a depressing effect on skill premia and wage inequality within countries (see Figure 1.g). In Scenario 3, the across-country inequality index decreases because human capital increases at a faster pace in developing countries.

3.4 Liberalization shock

Once the BAU is calibrated, we can simulate the effect of 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. The shock occurs in 2025 and is assumed to be permanent.

In order to identify incompressible migration costs, we use a 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. (2012) 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.[5] 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 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 fourth 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.

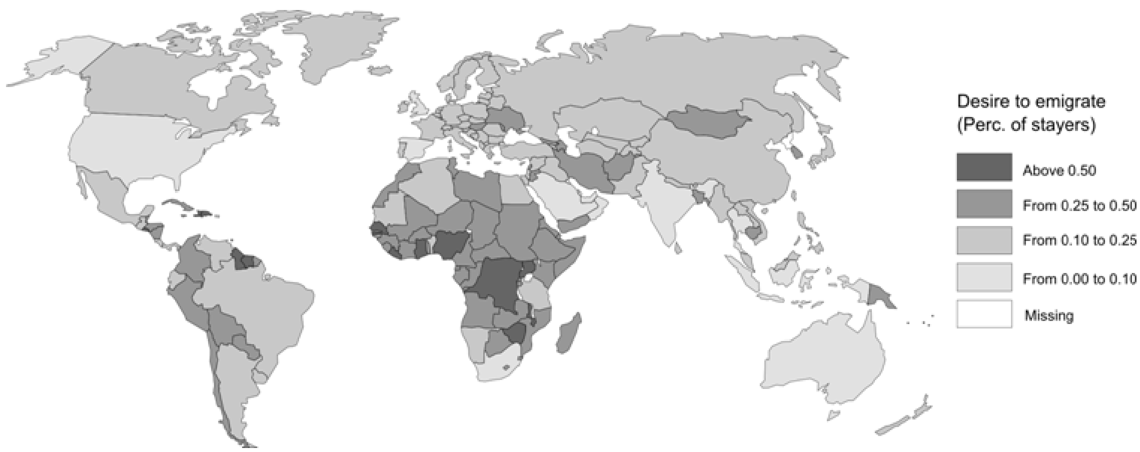
Figure 2.b shows that the average skill ratio of desires to emigrate is around 1.5 in low-income countries while the same ratio computed for effective migration ranges between 10 and 20. Two-thirds of these potential migrants named the United States as the top desired destination; other important destinations are Canada, European countries and Saudi Arabia.

[5] Docquier et al. (2012) provide a discussion on the interpretation of the survey question.

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 onwards.

Figure 2. Size and education structure of desired migration in 2007

2.a. Average desire to emigrate



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

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

4 Effects of a liberalization

We first simulate the effect a complete liberalization of cross-border migration assuming that the shock occurs in 2025. We compute the deviation from the BAU trajectory under the three technological scenarios and over 3 periods of 25 years (2025, 2050, 2075). Figure 3 depicts the effect obtained for the key indicators of the world economy. Section 4.1 focuses on the efficiency response to a liberalization. The changes in the world distribution of income and welfare are investigated in Section 4.2. The robustness of the results to some identifying assumptions is assessed in Section 4.3. Section 4.4 presents results from partial liberalization experiments. Finally, some caveats of our exercise are discussed in Section 4.5. Country-specific results and regional effects are discussed in the Appendix.

4.1 Efficiency

As stated in the introduction, the effect of a liberalization on the world production frontier (i.e. the world GDP per worker) has been studied in static frameworks. Our dynamic model allows to compare the short-run and long-run effects of removing migration restrictions. Differences between short-run and long-run effects arise because migration gradually affects the size and educational structure of the world population.

Figure 3.d shows that liberalizing labor mobility increases the proportion of international migrants by about 17 percent in the short-run under all scenarios. This is slightly above the effect obtained in Docquier et al. (2012) for the year 2000 (+15 percent). The difference is due to the fact that the liberalization shock occurs in 2025, a year in which the population in developing countries is relatively larger than in 2000. The long-run effect on migration is slightly lower (15 percent) than the short-run one because the population living in developing countries gradually falls over time compared with the BAU trajectory.

A key finding of our analysis is that removing migration barriers stimulates acquisition of human capital. There are three reasons for this. First, in line with the "brain gain" literature (Mountford 1997, Stark et al. 1997, Beine et al. 2001 and 2008), new emigration prospects stimulate the expected return to education; the fraction of young adults acquiring higher education increases as from the year 2025 (i.e. in the short-run). As shown on Figure 3.c, the short-run impact on the proportion of college graduates varies between 1.9 and 2.5 percentage points in all the scenarios. Second, wherever they live, newly educated parents have higher propensities to educate their children. Third, newcomers in rich countries, educated or not, face a better environment (lower education costs, no child labor) for educating their offspring. The latter two effects are dynamic by nature. Enrolment in basic education increases as from 2025, and the pool of young adults who can access the higher education system is larger as from 2050 (i.e. in the long-run). Consequently, the rise in educational attainment is cumulative. In 2075, the world proportion of college graduates increases by about 6.5 percentage points in all the scenarios. In parallel, the world average fertility rate and the world population size decrease gradually.

The effect on the world production frontier is depicted on Figure 3.a. In the short-run, the rise in GDP per worker amounts to 23 percent under Scenarios 1 and 2, and the semi-elasticity of the world GDP to migration equals 1.3. This is slightly superior to the 1.2 semi-elasticity obtained in Docquier et al. (2012), Iregui (2005), Winters (2001) or Walmsley and Winters (2005) because we now account for higher incentives to acquire higher education. As shown in the robustness section (see Section 4.3), simulating the model without this brain gain effect (i.e. with constant π_i) reduces the semi-elasticity to 1.12 (see Section 4.3) in line with previous studies. Under Scenario 3, the short-run rise in GDP falls to 18 percent and the semi-elasticity reaches 1.1. The reason is that new migrants are usually more educated than natives left behind (positive selection in emigration) but less educated than workers in destination countries (negative selection in immigration). Increasing migration tends to lower the proportion of college graduates in almost all regions. This effect was drastic in Docquier et al. (2012); it is much less severe here because of the positive response in human capital investments. In the Appendix, we show that a decrease in the proportion of college graduates is observed in the major industrialized destination regions (see Table A1). It is not the case in developing regions where the incentive mechanism is stronger.

Given the gradual education responses, the long-run gains from liberalizing cross-border migration exceed by far the short-run effects. By 2050, the increase in GDP per worker amounts to 42.7, 41.1 and 35.0 percent under Scenarios 1, 2 and 3, respectively. By 2075, the impact reaches 56.5, 54.1 and 50.0 percent. We thus argue that if large gains can be expected from a liberalization, they will be observed in the long-run and will affect the welfare of future generations.

4.2 Inequality

Our analysis of inequality is uniquely based on labor income, the only determinant of utility affected by the shock. Figure 3.f shows that the Theil index is always lower under the liberalization scenarios with respect to the BAU. In order to understand the underlying mechanisms, the components of the Theil index are decomposed for two sets of countries: high-income countries (labeled as rich) and developing countries (labeled as poor). The within-country and across-country components of the Theil index thus become:

$$\begin{aligned} T^{within} &= SHW_{poor}T^{within}_{poor} + SHW_{rich}T^{within}_{rich} \\ T^{across} &= SHW_{poor}T^{across}_{poor} + SHW_{rich}T^{across}_{rich} + T_{(poor,rich)} \end{aligned}$$

where (SHW_{poor}, SHW_{rich}) are the labor income shares in developing and high-income countries, $(T^{within}_{poor}, T^{within}_{rich})$ are the within-country components of the Theil index computed for developing and high-income countries, $(T^{across}_{poor}, T^{across}_{rich})$ are the across-country components of the Theil index computed for developing and high-income countries, and $T_{(poor,rich)}$ is the inequality measure between developing and high-income countries (as if each group was a single entity).

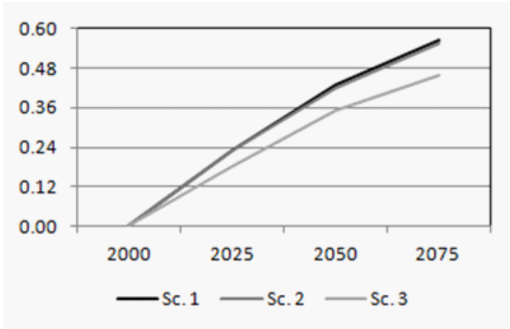
Table 2 disentangles the changes in the Theil index obtained for 2025 and 2075 under Scenario 1. Similar effects are obtained in Scenarios 2 and 3. Liberalizing labor mobility reduces the average level of inequality in the world (as measured by the Theil Index). A decomposition of the Theil index allows to highlight the mechanisms at work. The within component decreases in all the scenarios (see Figure 3.g). The reason is that within-country inequality levels are much higher in developing countries ($T_{poor}^{within} > T_{rich}^{within}$). The liberalization induces people to move from poor (high-inequality) to rich (low-inequality) countries, thereby reducing the income share of developing countries. The average level of within-country inequality therefore decreases, even though the within-country component slightly increases in both sets of countries. The across component also decreases in all the scenarios for similar reasons (see Figure 3.h). The across-country inequality levels are much higher in developing countries ($T_{poor}^{across} > T_{rich}^{across}$) and the income share of these countries decreases after a liberalization. In addition, the level of T_{rich}^{across} decreases due to the negative selection in immigration to the richest destination countries. This explains why the world average level of inequality across countries (T^{across}) decreases despite a rising gap between rich and poor countries ($T_{(poor,rich)}$).

Table 2. Explaining the effect on inequality in 2025 and 2075 (Scenario 1)

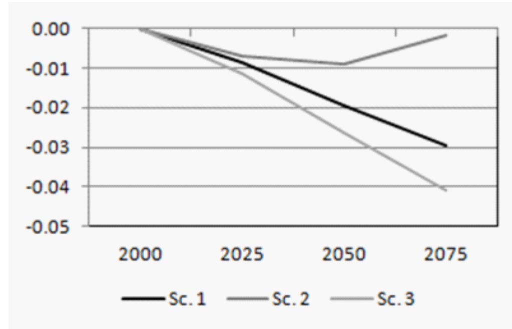
	BAU 2025 (Levels)	Lib 2025 (Deviation)	BAU 2075 (Levels)	Lib 2075 (Deviation)
SHW_{poor}	0.493	-0.129	0.507	-0.262
SHW_{rich}	0.507	+0.129	0.493	+0.262
T_{poor}^{within}	0.102	+0.001	0.154	-0.005
T_{rich}^{within}	0.028	+0.001	0.034	+0.005
T^{within}	0.064	-0.009	0.095	-0.029
T_{poor}^{across}	0.140	+0.004	0.172	+0.007
T_{rich}^{across}	0.042	-0.013	0.363	-0.016
$T_{(poor,rich)}$	0.258	+0.013	0.246	-0.005
T^{across}	0.349	-0.006	0.351	-0.051
T	0.413	-0.015	0.446	-0.080

Figure 3. Effect of a liberalization on world average values

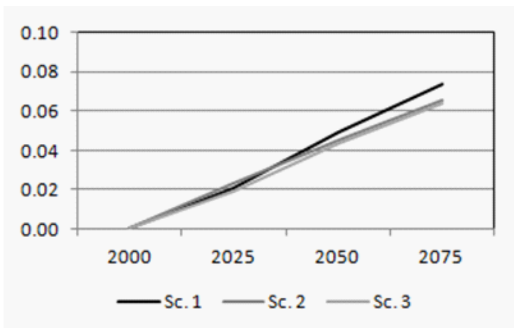
3.a. GDP per worker (Percentage of deviation)



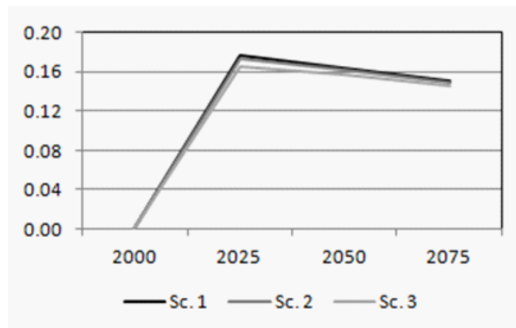
3.b. Population (Percentage of deviation)



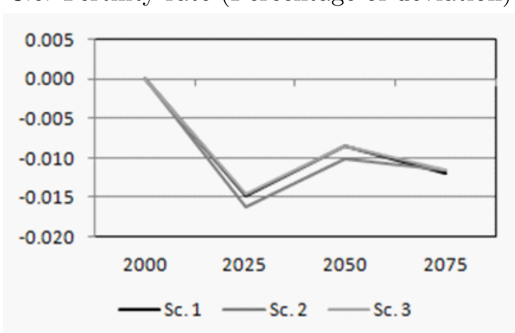
3.c. Proportion of college graduates (Deviation)



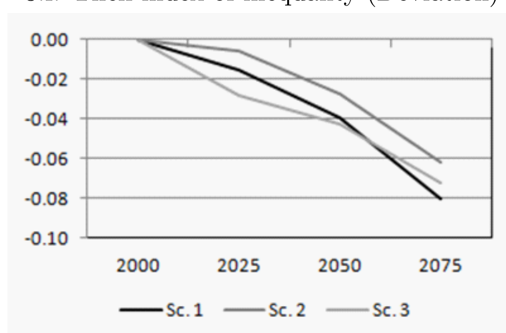
3.d. Proportion of immigrants (Deviation)



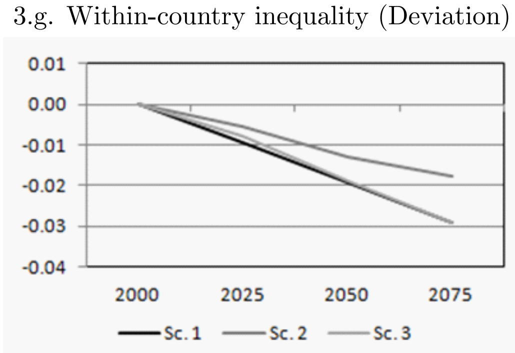
3.e. Fertility rate (Percentage of deviation)



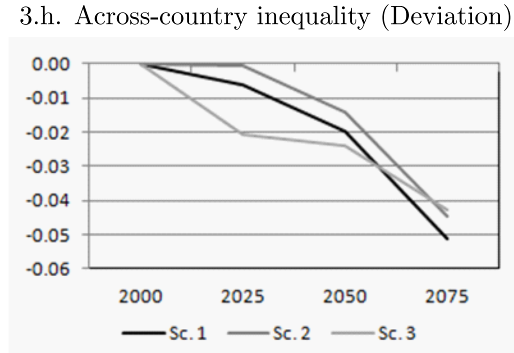
3.f. Theil index of inequality (Deviation)



3.g. Within-country inequality (Deviation)



3.h. Across-country inequality (Deviation)



This does not mean that liberalizing labor mobility is Pareto-improving. Detailed results by country and by region presented in the Appendix show that there might be winners and losers. Although liberalization stimulates the world proportion of college graduates, new migrants tend to be more educated than those left behind (positive selection in emigration) and less educated than workers in host countries. The effect on human capital is country-specific: in the short-run, the proportion of college graduates increases in 116 countries, and decreases in the other 79 countries. By 2075, it increases in 123 countries and decreases in the 72 other. The latter group includes the major industrialized destinations (Canada, the United States, Australia, the United Kingdom, etc.) and a few low-income countries where emigration is large. A decrease in GDP per worker is observed in these countries.

What matters for welfare is the effect of liberalization on the wage level of non-migrants. In the partial equilibrium scenario (Scenario 1), liberalization has first-order stochastic dominance over the BAU trajectory. Under the CES technology (Scenario 2), low skilled wages decrease in countries where human capital decreases, and high skilled wages decrease in other countries. In the presence of schooling externalities (Scenario 3), all wages are reduced in countries where human capital decreases. In scenarios 2 and 3, there are winners and losers after liberalization and we loose the first-order stochastic dominance property. However, the liberalization path has second-order stochastic dominance over the BAU.[6]

4.3 Robustness

In this section, we evaluate the robustness of some identifying assumptions. The endogeneity of education decisions has strong implications for our results. We thus assess whether our efficiency and inequality impacts are robust to the inclusion of a "brain gain" mechanism and parameters affecting education decisions. We simulate the model using the technological environment defined in Scenario 1 (partial equilibrium) and the four following variants:

- Constant $\pi_{i,t}$ (no brain gain)
- Constant $\omega_{i,t}$ (no demographic transition)
- An altruism parameter, θ, equal to 0.2 (instead of 0.3 in the benchmark)
- A preference for basic education, λ, equal to 0.5 (instead of 0.6 in the benchmark)

Qualitatively, our results are robust to the identifying assumptions, as shown on Figure 4. The effects on the world average level of GDP per worker are very stable

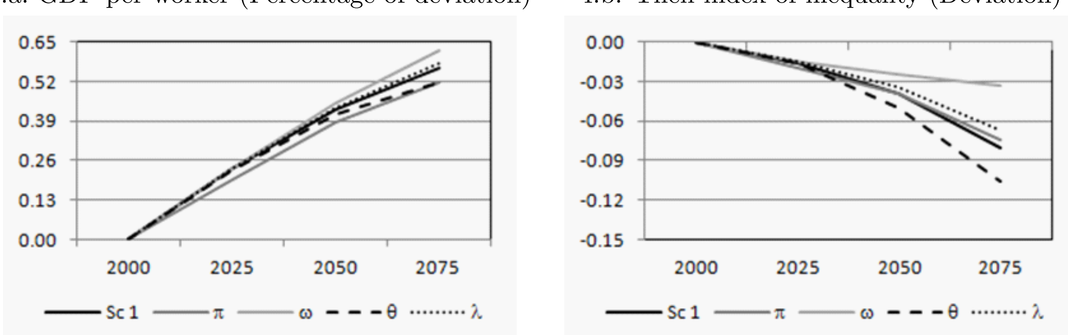
[6] In the case of Scenario 3, we should say "virtually has second-order stochastic dominance" because the size of the lowest class of income increases in 2050 and 2075. This however only concerns a very small fraction of the world population.

across scenarios, as shown on Figure 4.a. The effects on inequality are qualitatively robust but quantitatively more sensitive to the choice of θ and to variables governing basic education decisions ($\omega_{i,t}$). In a world with constant fertility per country, the inequality response would be smaller.

Eliminating the brain gain effect by fixing π at its benchmark value reduces the proportion of college graduates: the efficiency gains fall by approximately 3.6 and 4.7 percentage points in the short and long run respectively. Keeping child wage rates constant ($\omega_{i,t}$) affects efficiency gains marginally in the short run but increases them by 5.7 percentage points in the long run. This change affects the parents' "quantity-quality" trade off in their fertility decisions. A higher $\omega_{i,t}$ implies that children earn a higher income; this increases the opportunity cost of basic education and induces lower enrolment rates with basic education. A lower altruism parameter (θ) reduces the average fertility rate close to 1 in the long run as compared to 1.17 in Scenario 1. It also decreases the education cost of high-skilled workers; this leads to a higher proportion of skilled workers in the BAU (21.3 percent compared to 16.3 percent for Scenario 1). Given the lower fertility and higher education rate under this scenario, liberalization has a lower potential impact and efficiency gains are marginally lower in the short run. In the long run, they amount to 51.6 percent compared to 56.5 percent in Scenario 1. Finally, decreasing the preference parameter for education increases fertility and decreases education in the BAU. Liberalizing migration under this assumption therefore leaves room for potentially stronger changes in fertility and education behavior and implies slightly higher efficiency gains (+1.6 percentage points in the long run).

Figure 4. Robustness analysis

4.a. GDP per worker (Percentage of deviation) 4.b. Theil index of inequality (Deviation)



As for inequality, Figure 4.b shows that a liberalization reduces the Theil index in all the robustness checks. Short-run effects are small and almost identical across scenarios. The magnitude of the long-run effect is affected by our identifying assumptions. Under the variant with constant π or with $\lambda = 0.5$, the long-run effects are almost identical to Scenario 1. A smaller decrease in inequality is obtained when $\omega_{i,t}$ is constant. The reason is that a liberalization has a lower potential for increasing the proportion of college graduates in this scenario; and college graduates are those who have the highest propensity to move, i.e. to relocate in less unequal and richer countries. The reverse explanation holds in the scenario with a lower value for θ.

4.4 Partial liberalization experiments

In the previous sections, we simulated the effect of a complete liberalization of international migration (i.e. a 100 percent cut in legal/visa moving costs: $x^s_{ij,t} \longrightarrow \underline{x}^s_{ij,t}$ $\forall s, j \neq i$) on the world economy. A global liberalization shock is clearly not at the agenda of international institutions and policy-makers in destination countries. We consider our numerical analysis as a thought experiment defining the potential efficiency gains and redistributive implications of globalizing the world labor market, and compare them to those obtained in the existing literature.

We now consider partial liberalization variants in which legal costs are reduced by ϑ percent, where ϑ is capturing the liberalization rate. We still consider that these shocks are global, i.e. they have the same magnitude for all the country pairs and educational groups:

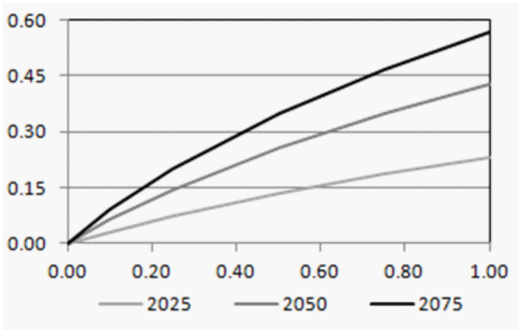
$$x^s_{ij,t} \longrightarrow x^s_{ij,t} - \vartheta \left(x^s_{ij,t} - \underline{x}^s_{ij,t} \right) \quad \forall s, j \neq i$$

We provide results for ϑ equal to 0.00 (BAU), 0.10, 0.25, 0.50, 0.75 and 1.00 (complete liberalization). As before, we assume that the shock happens in 2025 and is permanent. Figure 5 highlights the impact of partial liberalization shocks on GDP per worker, the world proportion of migrants, the semi-elasticity of GDP to migration, and the Theil index. We simulate the shock under the technological environment of Scenario 1. The intensity of the shock is measured on the horizontal axis, and each curve corresponds to a time period.

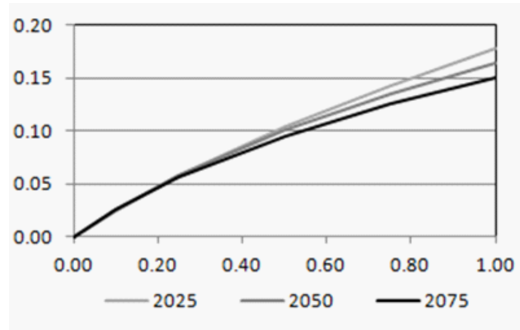
Figures 5.a and 5.d show that responses in GDP per worker and inequality are slightly concave in the liberalization rate. The effects are almost proportional to the cut in legal moving costs, whatever the period of analysis. Figure 5.b reveals that the same patterns emerge for the world migration rate. Although the model has non linearities, the semi-elasticity of the world GDP to the world migration rate is very stable across scenarios (see Figure 5.c). The short-run elasticity is similar to that obtained in Winters (2001), Iregui (2005), Walmsley and Winters (2005) and Docquier et al. (2012): it varies between 1.29 and 1.30. As time passes by, this elasticity increases given the endogeneity of education decisions. However, it does not change with the liberalization rate ϑ: it varies between 2.5 and 2.6 in 2050 and between 3.5 and 3.7 in 2075. Cutting legal moving costs by ϑ percent allows to realize slightly less than ϑ percent of the maximal gains from a complete liberalization.

Figure 5. Results for partial liberalization shocks

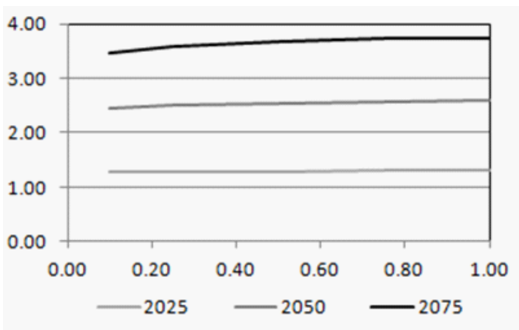
5.a. GDP per worker (Percentage of deviation)



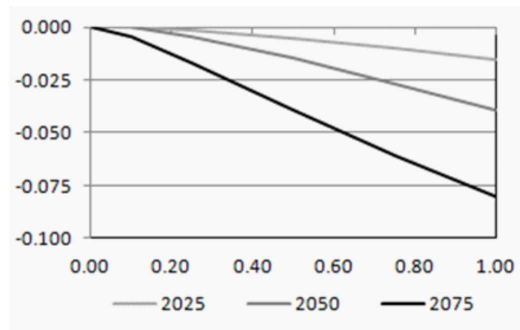
5.b. Proportion of immigrants (Deviation)



5.c. Semi-elasticity of GDP to migration (Level)



5.d. Theil index of inequality (Deviation)



4.5 Caveats

Our model is a partial representation of the actual world economy. It includes the same mechanisms as in previous studies and extends them by endogenizing the education and fertility responses to a liberalization.

Although we showed that our results are robust to the identifying assumptions, the literature has emphasized other migration-induced effects that are not captured by our model. The difficulty is that existing studies have not provided a precise assessment of their elasticities. Are our results robust to these missing ingredients? We discuss here the potential effects of refined labor market interactions between migrants and natives, trade, capital movements, congestion effects, network externalities, and remittances.

Labor market interactions - Our model assumes that natives and immigrants with identical levels of education are perfect substitutes in the production function. Recent literature has shown that there might be some complementarity between natives and foreign workers. Estimates of the elasticity of substitution have been provided in the literature. Accounting for complementarity and adjusting the preference parameter for immigrant workers in production to match native/migrant wage disparities, Docquier et al. (2012) obtained lower effects from liberalization. This is because the productivity of migrants is usually lower than that of native workers.

Movements of goods and capital - Accounting for movements of goods and capital is also likely to affect the efficiency gains from liberalizing labor mobility. Accounting for trade, classical trade theories predict that trade and migration are perfect substitutes. In such a context, increasing migration flows would have no effect on wages. More realistically, trade and migration are likely to be imperfect substitutes because countries produce differentiated goods or migration induces trade-creation effects. By excluding trade responses, we ignore uncertain effects related to the substitution or complementarity between trade and migration. If substitution forces dominate, they should decrease the efficiency gains of liberalization.

Assuming that output is proportional to labor in efficiency units, we disregard capital accumulation. Our model represents a globalized economy in which capital follows people. In an economy without capital movement, increasing migration would reduce capital and income per worker at destination and increase them at origin. The existing literature has shown that lower efficiency gains would be obtained in the short-run if physical capital is immobile across nations. However, the world quantity of physical capital is likely to gradually increase because new South-North migrants can save more (Kennan, 2012). This increases the long-run efficiency gains and reinforces our results.

Network externalities - Network externalities could stimulate the gains from liberalizing labor mobility. First, if migrants facilitate transfers of technologies across countries, liberalization could generate higher efficiency gains than what we predict. Such technological externalities have not been clearly identified in the literature and are difficult to assess. Second, it is likely that established networks of migrants reduce private moving costs for new potential migrants. Docquier et al. (2012) accounted for this effect and used the US elasticity of private migration cost to network size. Globally, efficiency gains could be multiplied by 1.45 if this elasticity was constant over time and applied to all destination countries.

Congestion effects - An additional aggregate effect of immigration may stem from its impact on the aggregate scale of production. On the one hand, the existence of a fixed factor in production (such as land) would cause aggregate decreasing returns. In general, congestion effects can be modeled by assuming that the TFP is also a function of the aggregate scale of production. Docquier et al. (2012), showed that congestion effects are likely to be small if the elasticity of total factor productivity to the size of the labor force is calibrated using the share of land income in GDP (as advocated by Ciccone and Hall, 1986).

Remittances - Finally, our model disregards remittances that migrants send back to their home country. The average ratio of remittances to GDP is low (3 percent); and 135 countries exhibit a lower ratio than the mean. However, this ratio is much higher in some countries (36 percent in Tonga, 34 in Lesotho, 29 in Bosnia, 22 in Jordan, 20 in Samoa, 17 in West Bank and Gaza, 16 in Albania, 15 in Haiti, Yemen and Cape Verde). In many of these countries, the after-liberalization ratio of emigrants to stayers will be four to six times larger than in the BAU. This can make a huge difference in the size of remittances. Hence, acounting for remittances is likely to affect the size of our effects. It is however difficult to include remittances for different reasons.

First, the literature has emphasized different motives to remit (altruism, exchange of services, risk diversification, reimbursement of loan, etc.) and the weights of these motives vary across countries or country pairs. Second, there is no consensus about who remits more and who receives more (college graduates or less educated): survey data collected in Bollard et al. (2011) show that the correlation between the amount remitted and the level of education of the remiter is also country-specific. Third, in a fully micro-founded model, individuals should anticipate remittances in their migration and education decisions, and the amount remitted would itself depend on the size of migration flows: the properties of our model would be much more complex although the literature has not identified robust and general effects of remittances on education decisions and other types of investment. In other words, there is no perfect way to include remittances in the model and parametrize remittance patterns.

Although we acknowledge the fact that remittances can affect the size of our efficiency gain (through their impact on education, fertility and migration), we assume that these efficiency effects are of second-order importance and focus on the inequality effects. This means that we compute the inequality index considering that remittances have no effect on education, fertility and migration. Our model provides values for the pre-transfer wages. In 2000, we can easily compute the aggregate labor income of all emigrants from any country i ($EMW_{i,00}$), the sum of wages in country i ($Y_{i,00}$) and calibrate the propensity to remit of emigrants (r_i) which fits the observed ratio of remittances to GDP ($REM_{i,00}$) in 2000. This gives $r_i = REM_{i,00}Y_{i,00}/EMW_{i,00}$. Then we simulate (for Scenario 1) the income distribution after liberalization and in all subsequent periods, assuming that r_i is constant (high-remittance variant) or that the elasticity of r_i to the emigrant/stayer ratio equals -0.5 (low-remittance variant): we obtain a new ratio of remittances to GDP, $REM_{i,t} = r_{i,t}EMW_{i,t}/Y_{i,t}$. Using a constant proportion to remit in the BAU, remittances increase from 1.3 % in 2000 to 1.7 % in 2075 of the wage mass in developing countries. Results are depicted on Figure 6.

Figure 6. Remittances and the inequality effect of liberalization

6.a. Remittance/GDP in poor countries (Deviation) 6.b. Across-country Theil index (Deviation)

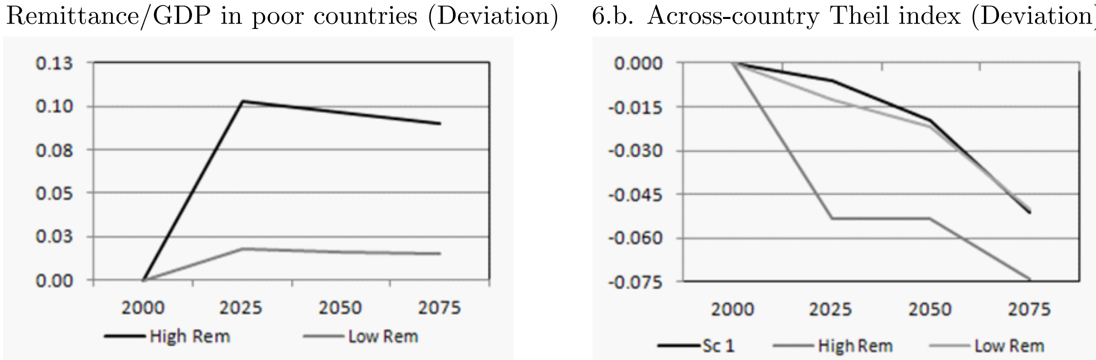


Figure 6.a provides the changes in the remittances/GDP ratio in developing countries, expressed in percentage point of deviation from the baseline. Under constant

propensity to remit, the liberalization strongly increases the remittances/GDP ratio in developing countries by 10 percentage points in 2025 and by 9 in 2075. The amount received by each stayer would be multiplied by 5 on average. As shown on Figure 6.b, the decrease in the across-component of the after-remittance Theil index ('High Rem' curve) would be much more pronounced than in the before-remittance index ('Scen 1' curve on Figure 4.h).[7] If the propensity to remit is elastic to the emigrant-to-stayer ratio, the remittances/GDP ratio increases by about 3 percentage points in all the years, and the amount received by each recipient is multiplied by two. The decrease in the after-remittance Theil index ('Low Rem' curve) would then be almost identical to that obtained for the the before-remittance index. In conclusion, the fall in inequality induced by a liberalization is accentuated by remittances if and only if the propensity to remit of emigrants is sufficiently inelastic to the emigrant-to-stayer ratio.

5 Conclusion

This paper studies the effect of liberalizing global migration on the world distribution of income. For the first time, we use a dynamic framework, which accounts for education and fertility responses to migration shocks. We show that liberalization increases the world GDP per worker and reduces inequality and extreme poverty. The effects on human capital accumulation, income and inequality are gradual and cumulative. Under a complete liberalization scenario, the world average level of GDP per worker increases by only 20 percent in the short-run, and by more than 55 percent after 50 years. The main reason is that new migrants moving from developing to developed countries face a better environment (lower education costs, no child labor) for providing basic education to their children and decreasing their fertility. This increases the pool of young adults who will be eligible for higher education in the future generation. Some of them will invest in college education and will have a greater propensity to provide education to their own offspring. Gradually, liberalization increases the world proportion of college educated and reduces population growth. These mechanisms are robust to our identifying assumptions and are also valid in the case of a partial liberalization, provided that the cut in migration restrictions is global (i.e. identical for all the country pairs and educational groups).

Liberalizing labor mobility also reduces inequality. When people move from poor (high-inequality) to rich (low-inequality) countries, the income and demographic shares of developing countries fall. This reduces the within-country component of the Theil index. In addition, liberalization decreases the average level of GDP per worker in receiving (developed) countries, and increases it in the sending (developing) countries. The latter effect arises because new emigration prospects stimulate the expected

[7] We do not compute the within-component of the Theil index to avoid introducing assumptions about the distribution of remittances in the recipient country.

return to education and raise the fraction of young adults acquiring higher education in developing countries. Globally, the liberalization path has stochastic dominance over the baseline-as-usual; we obtain first-order dominance in partial equilibrium and second-order dominance in general equilibrium. Liberalizing labor mobility reduces extreme poverty in the world.

In sum, we demonstrate that the long-run gain from liberalizing cross-border migration exceeds by far the short-run effect, and its magnitude is in line with what was found in previous studies. However the mechanism and the distribution of the gains are different. What drives the gains is the human capital response to the migration shock, rather than the magnitude of the shock. The main winners are future generations of people originating from poor countries. This makes it difficult to find redistributive policies to compensate the losers, i.e. the current generations of low-skilled nationals residing in high-income countries.

References

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

[2] Beine, M. & F. Docquier & H. Rapoport (2001). Brain Drain and Economic Growth: Theory and Evidence. Journal of Development Economics 64 (1): 275–89.

[3] Beine, M. & F. Docquier & H. Rapoport (2008). Brain Drain and Human Capital Formation in Developing Countries: Winners and Losers. Economic Journal 118 (528): 631–52.

[4] Bollard, A. & D. McKenzie & M. Morten & H. Rapoport (2011). Remittances and the brain drain revisited: the microdata show that more educated migrants remit more. World Bank Economic Review 25 (1): 132–156.

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

[6] Brockeroff, M. (1995). Fertility and Family-planning in African Cities: the Impact of Female Migration. Journal of Biosocial Science 27 (3): 347-358.

[7] Ciccone, A. & R.E. Hall (1996). Productivity and the Density of Economic Activity. American Economic Review 86 (1): 54-70.

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

[9] Chiswick, B.R. & P.W. Miller (2012). Negative and Positive Assimilation, Skill Transferability, and Linguistic Distance. Journal of Human Capital 6 (1): 35-55

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

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

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

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

[14] de Palma, A. & K. Kilani (2007). Invariance of conditional maximum utility. Journal of Economic Theory 132: 137-146.

[15] Docquier, F. & B.L. Lowell & A. Marfouk (2009). A gendered assessment of highly skilled emigration. Population and Development Review, 35 (2): 297-322.

[16] Docquier, F. & J. Machado & K. Sekkat (2012). Efficiency gains from liberalizing labor mobility. IRES Discussion Paper 2012-023.

[17] Docquier, F. & T. Müller & J. Naval (2013). Informality and long-run growth. IRES Discussion Paper 2013-xxx.

[18] Docquier, F. & Ç. Ozden & Ch. Parsons & E. Artuc (2012b). A Global Assessment of Human Capital Mobility: the Role of non-OECD Destinations. IRES Discussion Paper 2012-022.

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

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

[21] Fernández, R. & A. Fogli (2009). Culture: An Empirical Investigation of Beliefs, Work, and Fertility. American Economic Journal: Macroeconomics 1 (1): 146-77.

[22] Hamilton, B. & J. Whalley (1984). Efficiency and Distributional Implications of Global Restrictions on Labour Mobility. Journal of Development Economics 14 (1): 61-75.

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

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

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

[26] Iranzo, S. & G. Peri (2009). Migration and trade: Theory with an application to the Eastern-Western European integration. Journal of International Economics 79 (1): 1-19.

[27] Iregui, A.M. (2005). Efficiency Gains from the Elimination of Global Restrictions on Labour Mobility. In: G.J. Borjas and J. Crisp, Poverty, International Migration and Asylum, 211-238. New York: Palgrave Macmillan.

[28] Kaufmann, D. & A. Kraay & M. Mastruzzi (2009). Governance Matters VIII: Aggregate and Individual Governance Indicators, 1996-2008. World Bank Policy Research Working Paper No. 4978.

[29] Kennan, J. (2013). Open Borders. Review of Economic Dynamics, 16 (2): L1-L13.

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

[31] Klein, P. & G. Ventura (2007). TFP Differences and the Aggregate Effects of Labor Mobility in the Long Run. The B.E. Journal of Macroeconomics, 7 (1): Article 10.

[32] Klein, P. & G. Ventura (2009). Productivity differences and the dynamic effects of labor movements. Journal of Monetary Economics, 56 (8): 1059-1073.

[33] Kremer, M. & D. Chen (1999). Income-distribution dynamics with endogenous fertility. American Economic Review 89 (2): 155-160.

[34] Lee, B.S. & L.G. Pol (1993). The Influence of Rural-UrbanMigration on Migrants Fertility in Korea, Mexico and Cameroon. Population Research and Policy Review 12(1) : 3-26.

[35] Lindstrom, D.P. & S. Giorguli Saucedo (2002). The Short- and Long-Term Effects of U.S. Migration Experience on Mexican Women's Fertility. Social Forces 80 (4): 1341-1368.

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

[37] Mountford, A. (1997). Can a Brain Drain Be Good for Growth in the Source Economy? Journal of Development Economics 53 (2): 287–303.

[38] Mountford, A. & H. Rapoport (2011). The brain drain and the world distribution of income. Journal of Development Economics 95 (1): 4-17.

[39] Moses, J.W. & B. Letnes (2004). The Economic Costs to International Labor Restrictions: Revisiting the Empirical Discussion. World Development 32 (10): 1609-1626.

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

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

[42] Stark, O. & Ch. Helmenstein & A. Prskawetz (1997). A Brain Gain with a Brain Drain. Economics Letters 55 (2): 227–34.

[43] Stephen, E.H. & F.D. Bean (1992). Assimilation, Disruption and the Fertility of Mexican-origin Women in the United States. International Migration Review 26 (1): 67-88.

[44] United Nations (2011), Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2010 Revision: Highlights and Advance Tables. Working Paper No. ESA/P/WP.220.

[45] Walmsley, T.L. & L.A. Winters (2005). Relaxing the Restrictions on the Temporary Movement of Natural Persons: A Simulation Analysis. Journal of Economic Integration, December, 20 (4).

[46] Winters, L.A. (2001). Assessing the Efficiency Gain from Further Liberalization: A Comment. In: P. Suave & A. Subramanian (eds) Efficiency, Equity and Legitimacy: The Multilateral Trading System at the Millenium. Chicago: Chicago University Press. 106-113.

[47] World Bank (2010). World Development Indicators. The World Bank: Washington DC.

6 Appendix - Results by country/region

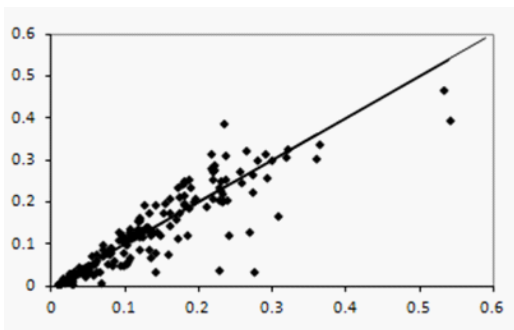
We provide here a few country-specific results that help understanding the mechanisms at work in our model.

Human capital - Figure A.1 focuses on country-specific changes in the proportion of college graduates. The BAU levels are represented on the horizontal axis and the after-liberalization levels are represented on the vertical axis. Results are provided for Scenario 1 and for the robustness variant with no incentive or "brain-gain" channel (i.e. constant π).

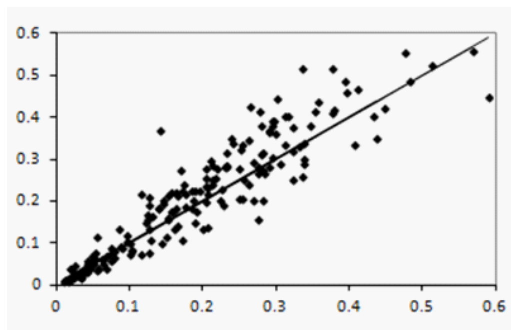
Figure A.1. Changes in the proportion of college graduates

(BAU levels on the horizontal axis & After-liberalization levels on the vertical axis)

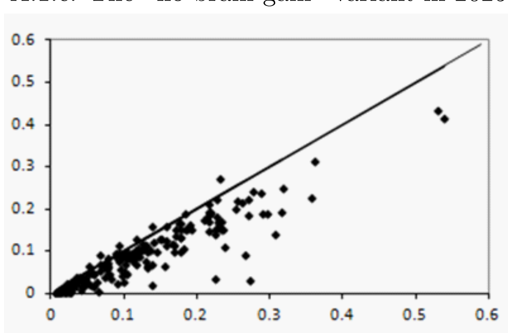
A.1.a. Scenario 1 in 2025



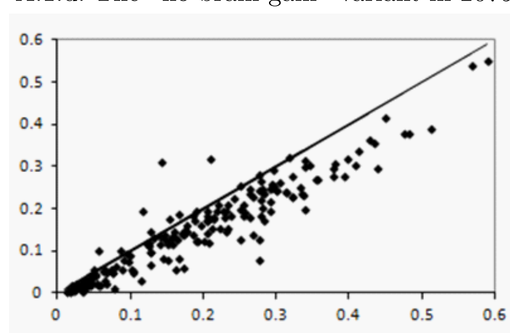
A.1.b. Scenario 1 in 2075



A.1.c. The "no brain-gain" variant in 2025



A.1.d. The "no brain-gain" variant in 2075



In 2025, the world average proportion of college graduates increases by 2.1 percentage points under Scenario 1. This is partly mitigated by the fact new migrants tend to be more educated than those left behind (positive selection in emigration) and less educated than workers in host countries, on average. Figure A.1.a shows that liberalizing labor mobility increases the proportion of college graduates in 116 countries, and decreases it in the other 79 countries. The latter group includes the major industrialized destinations (e.g. -14 percentage points in Canada, -6.4 in the United States, –2.0 in Australia, -0.7 in the United Kingdom) and a few low-income countries of the world (in sub-Saharan Africa, many high-skilled migrants leave countries such as Djibouti, Gabon, Comoros, Cote d'Ivoire, Zimbabwe, etc.). By 2075, the world average proportion of educated increases by 7.3 percentage points. Figure A.1.b shows that the proportion of college graduates increases in 123 countries and decreases in the other 72 countries. The selection effect thus mitigates the benefits from higher human capital accumulation. In particular, under Scenario 3 (schooling externalities on total factor productivity), smaller gains in GDP are obtained.

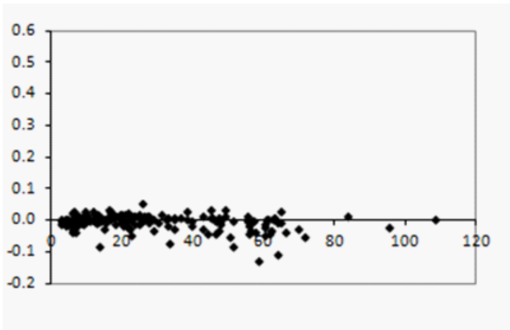
In the robustness variant without incentive or brain-gain effect, the proportion of college graduates does not change in 2025 and increases by 4.8 percentage points only in 2075. In 2025 (and 2075, respectively), the proportion of college graduates increases in 19 (21, respectively) countries and decreases in the 176 (174, respectively) remaining countries.

Wages - Figure A.2 represents the percentage deviation in wages induced by a liberalization (vertical axis) over the BAU level (horizontal axis). Obviously, country-specific wage rates are constant in the partial equilibrium scenario (Scenario 1). Results are thus only provided for Scenario 2 (CES production function) and Scenario 3 (schooling externalities on total factor productivity), and for college graduates and the less educated. Under Scenario 2, low-skilled wages increase and high-skilled wage decrease with the proportion of college graduates in the labor force. The selection mechanism is such that liberalizing labor mobility increases the proportion of college graduates in 116 countries and decreases it in the other 79 countries by 2025. Hence, low-skilled wages increase in 116 countries and decrease in 79 countries. By 2075, the proportion of college graduates increases in 123 countries only, and decreases in the other 72 countries. Hence, low-skilled wages increase in 123 countries and decrease in 72 countries. The reverse is obtained for high-skilled wages. As apparent from figures A.2.a and A.2.b for 2025 (A.2.c and A.2.d for 2075), the relative changes are more pronounced for college graduates than for the less educated, and more pronounced in 2075 than in 2025. Under Scenario 3, all wage levels increase with the proportion of college graduates in the labor force. Wages increase in 116 countries in 2025, and 123 countries in 2075. The effects are more pronounced in 2075 than in 2025. In the short-run, losses in the major industrialized countries and poor countries are on average more important than gains incurred in middle income countries (see Figures A.2.e and A.2.f). In the long-run, losses and gains are comparable (see Figures A.2.g and A.2.h).

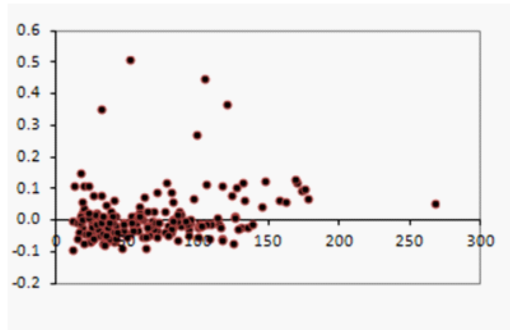
Figure A.2. Changes in wages

(BAU levels on the horizontal axis &
percentage deviations from BAU levels on the vertical axis)

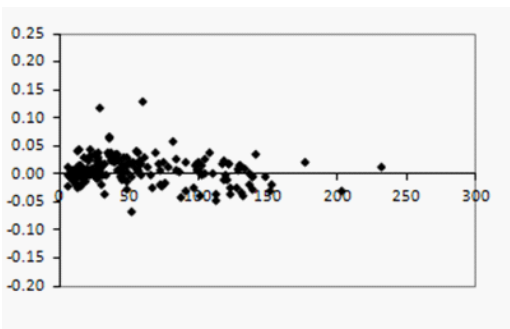
A.2.a. Scenario 2 in 2025 - Less educated



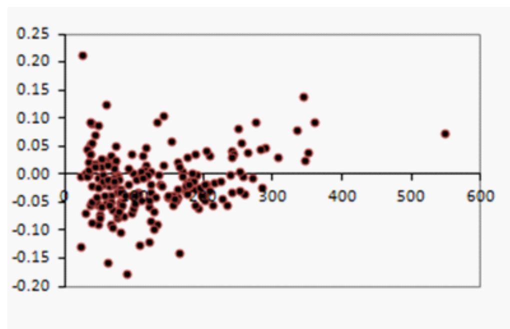
A.2.b. Scenario 2 in 2025 - College graduates



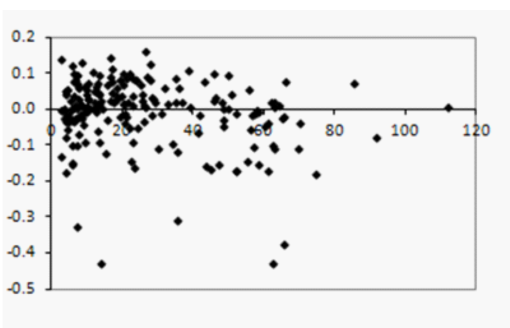
A.2.c. Scenario 2 in 2075 - Less educated



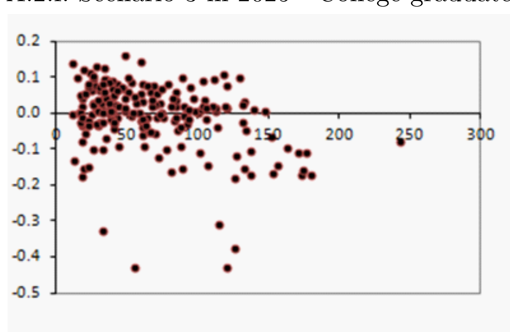
A.2.d. Scenario 2 in 2075 - College graduates



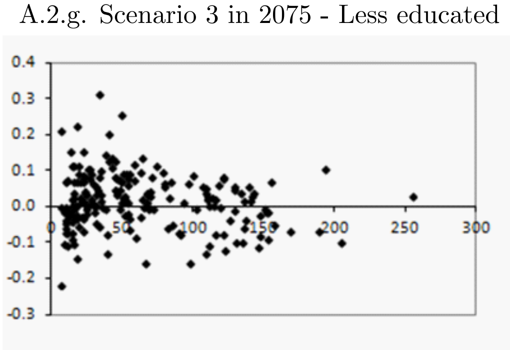
A.2.e. Scenario 3 in 2025 - Less educated



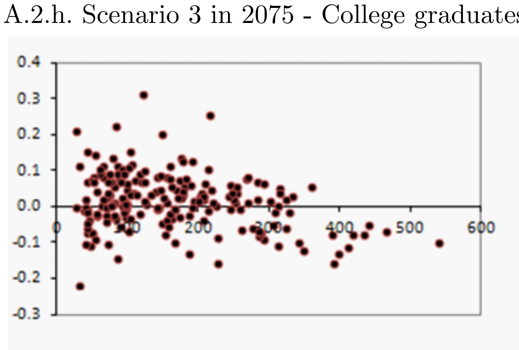
A.2.f. Scenario 3 in 2025 - College graduates



A.2.g. Scenario 3 in 2075 - Less educated



A.2.h. Scenario 3 in 2075 - College graduates



Regional effects - Finally, Table A.1 gives the impact on regional level of GDP per worker in 2025 and 2075. Due to negative selection in immigration, a decrease in GDP per worker is observed in the major industrialized destinations regions (the United States, Canada, Australia and New Zealand, and the countries of the Guld Cooperation Council). The effect persists 50 years after the shock, although it is gradually mitigated by the world increase in educational attainment. The EU27 region is both an immigration and emigration region; the global effect is positive and increases over time. The level of GDP per worker increases in most sending regions except China and India. This is induced by the initial brain gain effect and the resulting rise in basic education.

Table A.1. Effect of liberalization on GDP per worker per region

(Percentage deviation from the BAU)

	2025				2075			
	Sc. 1	Sc. 2	Sc. 3	Sc. 4	Sc. 1	Sc. 2	Sc. 3	Sc. 4
WORLD	23.2	23.0	18.1	12.9	56.5	55.7	46.0	22.7
USA	-3.4	-1.3	-7.0	-3.0	-0.4	-0.1	-1.2	-0.5
EU27	5.3	4.9	6.8	3.6	10.2	8.8	13.0	5.4
CANZ	-2.5	-0.8	-9.1	-2.7	-2.6	-0.7	-9.2	-3.5
GCC	-6.8	-5.5	-17.7	-4.9	-6.2	-3.7	-12.4	-4.4
MENA	15.8	14.7	15.7	12.2	21.5	20.3	17.5	15.4
SSA	18.8	18.4	13.9	5.6	45.9	43.5	42.2	7.1
CIS	4.0	1.7	12.6	3.6	5.0	1.6	13.9	6.6
ASIA	20.1	18.4	7.3	8.3	46.3	45.1	34.1	12.1
CHIND	-0.4	-0.3	0.8	-0.1	-0.2	-0.4	0.8	0.7
LAC	4.4	3.6	6.0	4.6	8.3	6.8	9.1	9.6
OTHERS	36.6	35.3	42.7	25.3	63.7	59.6	69.6	34.7

Regions: USA = United States, EU27 = 27 members of European Union; CANZ = Canada, Australia and New Zealand; GCC = countries of the Gulf Cooperation Council; MENA = Middle East and Northern Africa; SSA = Sub-Saharan Africa; CIS = Commonwealth of Independent States (ex-Soviet Union); CHIND = China and India; ASIA = Rest of Asia; LAC = Latin American and Caribbean countries; OTHERS = other countries.