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Efficiency Gains from Liberalizing Labor Mobility*

Frédéric Docquier†

IRES, Université Catholique de Louvain, Louvain-la-Neuve B-1348, Belgium
frederic.docquier@uclouvain.be

Joël Machado

IRES, Université Catholique de Louvain, Louvain-la-Neuve B-1348, Belgium
joel.machado@uclouvain.be

Khalid Sekkat‡

Université Libre de Bruxelles, Brussels B-1050, Belgium
ksekkat@ulb.ac.be

In this paper, we quantify the effect of a complete liberalization of cross-border migration on the world GDP and its distribution across regions. We build a general equilibrium model, endogenizing bilateral migration and income disparities between and within countries. Our calibration strategy uses data on effective and potential migration to identify total migration costs and visa costs by education level. Data on potential migration reveal that the number of people in the world who have a desire to migrate is around 400 million. This number is much smaller than that predicted in previous studies, and reflects the existence of high "incompressible" migration costs. In our benchmark framework, liberalizing migration increases the world GDP by 11.5–12.5 percent in the medium term. Our robustness analysis reveals that the gains are always limited, in the range of 7.0 percent (with schooling externalities) to 17.9 percent (if network effects are accounted for).

Keywords: Liberalization; migration; migration costs; migration policies

JEL classification: *F*22; *O*15; *O*24

I. Introduction

The debate on the links between migration, development, and inequality has recently been revived. Even though a complete liberalization of

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‡Also affiliated with the Economic Research Forum, Egypt.

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international migration is clearly not on the political agenda, it is worthwhile for economists and policymakers to estimate the effects that an abolition of visa costs could have on the world allocation of the labor force, the world production frontier (i.e., the world GDP), and income distribution across countries and regions. This is a complex task because it requires quantifying these visa restrictions (i.e., policy-induced costs borne by migrants to overcome the legal hurdles set by national authorities in destination and origin countries), and their impact on the size and structure of migration flows. There is no cross-country database measuring the size of migration costs and giving the breakdown of their private and legal parts. In this paper, we propose a backsolving calibration strategy, which consists of using original data on effective and desired migration by education level to identify total migration costs and visa costs as residuals of the migration technology.[1]

Our analysis is conducted for the year 2000. Comprehensive matrices of effective migration stocks were developed by Artuç *et al.* (2014). Based on the 2000 census round, this database identifies 111.6 million international migrants aged 25 and over; this represents about 3.5 percent of the world adult population (see Table A1 in the Appendix). As for desired migration, we aggregate four waves of the Gallup World Poll survey (Gallup, 2014; Esipova *et al.*, 2011). This unique and largely understudied survey allows us to identify the proportion and the characteristics of people who had not yet migrated and expressed a desire to leave their own country in the last decade (hereafter referred to as "desiring migrants"). About 290,000 adults from 142 countries were questioned about their desired migration and preferred country of destination. These countries are representative of about 97 percent of the world population.[2] In our benchmark scenario, we only focus on people who would permanently emigrate to another country if they were given the opportunity. We also consider alternative variants including temporary migration and network effects.

Table 1 documents the number of desiring and potential (effective + desiring) migrants in the benchmark scenario and before any general equilibrium feedback effect. For the year 2000, we identify 274.5 million desiring migrants aged 25 and over. Adding them to the effective migrants gives a total stock of 386.1 million potential migrants (i.e., 12.1 percent of the population). Most of these desiring migrants originate in poor countries and want to relocate to rich countries. The main regions of origin are Asia (30 percent of the total, including China and India),

[1] Sims (1990) developed the backsolving method to calibrate stochastic general equilibrium models. We also deal with exogenous processes as if they were endogenous, not to solve a model, but as a calibration device in a deterministic framework.

[2] For the remaining countries, we predict the aggregate proportion of desiring emigrants and its bilateral structure.

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Table 1. *Data on actual, desired, and potential migration by region*

	Emigration				Immigration			
Regions	Actual[a] ($\times 10^6$)	Desired[b] ($\times 10^6$)	Potential[c] ($\times 10^6$)	Potential[c,d] (percent)	Actual[a] ($\times 10^6$)	Desired[b] ($\times 10^6$)	Potential[c] ($\times 10^6$)	Potential[c,e] (percent)
WORLD	111.6	274.5	386.1	12.1	111.6	274.5	386.1	12.1
US	0.9	6.2	7.2	4.5	24.2	73.9	98.0	39.0
EU15	15.6	22.7	38.2	14.5	19.9	70.5	90.5	28.6
CANZ	1.5	2.2	3.6	12.8	8.6	44.7	53.3	68.3
GCC	0.6	0.5	1.1	12.3	5.7	23.3	29.0	78.5
MENA	9.1	21.9	31.0	22.7	5.6	5.8	11.4	9.8
SSA	10.5	45.8	56.3	24.9	8.7	9.7	18.4	9.8
CIS	19.1	15.0	34.1	19.4	16.7	1.9	18.7	11.7
CHIND	10.0	43.7	53.7	4.3	5.2	3.8	9.0	0.8
ASIA	20.0	65.4	85.4	14.9	9.0	21.2	30.2	5.8
LAC	15.5	38.6	54.1	20.5	2.6	8.9	11.5	5.2
OTHERS	8.7	12.7	21.5	21.6	5.3	10.8	16.1	17.1

Notes: [a]Stock of migrants aged 25 and over in 2000 (Source: Artuç *et al.*, 2014). [b]Stock of non-migrants aged 25 and over who would like to leave their country if they had the opportunity (Source: Gallup, 2014). [c]Potential migration = Actual migration + Desired migration. [d]Share of emigrants in the native labor force. [e]Share of immigrants in the labor force of the country of residence. Regions: US = United States; EU15 = 15 members of the 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.

sub-Saharan Africa (17 percent), Latin America (14 percent), and the Middle East and Northern Africa (8 percent). In terms of destinations, a vast majority want to emigrate to an OECD, high-income country (27 percent to the United States, 26 percent to Europe, and 16 percent to Canada, Australia, and New Zealand). Other important destinations are Japan, Singapore, Saudi Arabia, and the United Arab Emirates. Prospective migrants are slightly more educated than those left behind (i.e., there is a positive selection in emigration), but less educated than non-migrants in the host countries (i.e., there is a negative selection in immigration). However, positive selection in desired emigration is much smaller than in effective emigration.

The use of Gallup data allows us to approximate the number of adults who could respond to a complete abolition of visa restrictions. Existing studies of liberalization disregard or minimize the existence of private (or "incompressible") migration costs, and the endogeneity of migration decisions. Disregarding private migration costs and assuming that liberalization leads to wage equalization across countries, they predict that about 50 percent of the world population would live in a foreign country after a complete liberalization of migration. This is much greater than the potential migration stocks inferred from the Gallup survey data. In these studies,

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the rise in GDP would be in the range of 50–150 percent.[3] A summary of these predictions is provided in Clemens (2011): considering a common scenario with constant physical capital and no differences in the 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), and 96.5 percent in Moses and Letnes (2004). Less optimistic results are obtained when foreign workers are assumed to be less productive than natives.[4] Iregui (2005) is the only study accounting 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 finds that relocating people to equalize wages increases the world GDP by 67.0 percent. Hence, the semi-elasticity[5] of the world GDP to the share of international migrants in the world population ranges from 1.35 in Iregui (when education is accounted for) to 3.0 in Hamilton and Whalley. Interestingly, 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., 0.45 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), that is, a semi-elasticity of the world GDP to the share of migrants of 1.33, in line with Iregui (2005).[6] These optimistic studies suggest that migration barriers leave "trillion dollar bills on the sidewalk" (Pritchett, 2006; Clemens, 2011) and see efficiency as a decisive argument for a liberalization of cross-border migration.

[3] In comparison, removing the remaining barriers to trade and capital flows would generate small increases in world GDP ranging from 0.5 to 4 percent for trade, and from 0.1 to 1.7 percent for capital (Clemens, 2011).

[4] For example, Moses and Letnes (2004) have scenarios where workers from medium- and low-development regions are arbitrarily assumed to be respectively 1/3 and 1/5 as productive as natives in high-income countries. This limits efficiency gains to 9.6 percent.

[5] This is defined as the percentage of deviation in the world GDP divided by the change in the world proportion of migrants.

[6] More recent studies have investigated the economic impact of free-mobility agreements using stylized models with two regions (Iranzo and Peri, 2009; Klein and Ventura, 2009) or with a single "preferred" location for the new migrants (Kennan, 2013). They provide numerical illustrations that cannot be directly compared with those obtained under a full liberalization of global migration. Two other papers modeled migration as the outcome of a political economy or central planning problem (de la Croix and Docquier, 2009; Benhabib and Jovanovic, 2012) and provided theoretical and numerical predictions. Both used a stylized representation of the world (one developing region, or a two-region framework) and a simplistic treatment of moving costs (neglected, or calibrated using US interstate transportation costs).

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We quantify the effect of liberalization on the world economy using a model that endogenizes interdependences between migration decisions and economic performances. Efficiency gains are computed by taking into account, for the first time, people's desire to emigrate and the existence of high "incompressible" moving costs. This is a major improvement because the empirical literature on the determinants of migration has long emphasized the role of geographic and cultural distances. For example, psychological 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. They also explain why removing migration barriers in unattractive corridors (with high private costs) generates small migration flows, as illustrated by the German Green Card policy in the last decade.[7]

Our approach is to use a simple, abstract model, which highlights the major economic mechanisms underlying migration decisions and wage inequality, and then to confront the theory to the data. To the best of our knowledge, this paper is the first to provide a general equilibrium analysis of international labor mobility and income inequality across nations in a bilateral framework with (i) a large number of origin and destination countries, (ii) two levels of education, (iii) endogenous individual decisions to migrate, and (iv) monetary measures of incompressible moving costs and legal restrictions. Although the model is large (because of the number of countries included), the mechanisms are transparent. The model has only a few equations per country, uses consensual micro-foundations, and is 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 with this methodology in long-term macroeconomics.

Our quantitative analysis reveals striking results. As a starting point, we consider a benchmark framework similar to Iregui (2005). Accounting for incompressible migration costs in our benchmark framework divides the effect by 6 (i.e., +11.3 percent of world GDP), although our semi-elasticity of the world GDP to the share of international migrants is virtually identical to previous studies (we obtain a value of 1.33). Hence, the smallness of our efficiency gains is driven by the fact that we account for people's desire

[7] Germany aimed at attracting at least 20,000 specialists for its IT sector (mainly from India). This target was not met; by July 2003, fewer than 15,000 work permits had been issued (Kolb, 2005). The 2005 Immigration Act, which aimed at selecting and attracting talented workers, was also less successful than expected.

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to emigrate: the migration response to a liberalization is smaller than in previous studies. In the benchmark framework, general equilibrium effects are small: endogenizing wages and migration rates has a limited impact on the size of efficiency gains compared to a partial equilibrium model.

In a second step, we conduct a large set of robustness checks. Very similar results (i.e., efficiency gains in the range of 10–12.5 percent) are obtained when we downgrade the education acquired in poor countries, account for temporary migration, allow effective migrants to relocate to their preferred destination, change the marginal utility of income, and account for congestion effects or the imperfect substitution between immigrants and natives on the labor market. In these scenarios, the semi-elasticity of the world GDP to the proportion of migrants in the world labor force varies between 1.2 and 1.4, in line with previous studies. More optimistic results (i.e., a 17.9 percent increase in the world GDP) are obtained when migration network externalities are factored in. On the contrary, efficiency gains fall to 7 percent when total factor productivity (TFP) is an increasing function of the proportion of college graduates in the country's labor force. Still, the effect of a complete liberalization on the world income is always limited, although our interpretation of the Gallup questions is likely to overestimate the importance of legal costs. Our results suggest that global efficiency gains have been overestimated in the existing literature.

The remainder of this paper is organized as follows. In Section II, we describe our benchmark model with endogenous migration and wages. We further present our identification strategy for the migration cost and the method used to disentangle its incompressible and legal components. We present our benchmark set of results in Section III. Then, in Section IV, we study the robustness of our results to the treatment of the Gallup data, to the marginal utility of income, to technological assumptions, and to the inclusion of network effects. We conclude in Section V.

II. Benchmark Model

Quantifying the effect of a liberalization requires modeling interdependences between migration decisions and economic performances.[8] We first develop a simple, abstract economic model, which highlights the major economic mechanisms underlying migration decisions and wage inequality in the short or medium term (i.e., over one generation). The model does not account for capital and trade. We discuss these assumptions and their implications in Section IV. We then confront the theory to the data. Our research steps include the identification of consensual analytical specifications for migration and production technologies, finding properly estimated

[8] A description of our simulation algorithm is provided in the Appendix.

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elasticities in the empirical literature, and identifying unobserved exogenous variables by forcing the model to match observations for the year 2000. Finally, we use Gallup survey data to identify the legal component of migration costs at the end of this section.

Theory

Our model distinguishes between two types of workers and J countries. The skill type s is equal to h for high-skilled workers (i.e., college graduates), to l for the less-educated or low-skilled, and to t when low-skilled and high-skilled workers are aggregated. We identify the condition under which migration to a destination country j is profitable for a type-s individual born in a given country i. This condition depends on migration costs and wage disparities between source and destination countries. We then describe the technology and endogenize wages. The combination of endogenous migration decisions and equilibrium wage rates determines the market allocation of the world population.

Migration Decisions. Because our model is static, we implicitly consider that individuals are one-period lived and decide either to stay in their home country or to emigrate permanently to another country. Migration flows are basically identical to migration stocks. Given the availability of new databases by education level, the determinants of the size and structure of international migration have been studied in a growing number of papers (Rosenzweig, 2008; Beine *et al.*, 2011a; Grogger and Hanson, 2011; Belot and Hatton, 2012; Bertoli and Fernández-Huertas Moraga, 2012, 2013; Razin and Wahba, 2015). They all use a random utility (or multinomial discrete choice) model, which fits the data and can be structurally estimated. Rosenzweig (2008) and Grogger and Hanson (2011), in particular, demonstrated that the linear utility specification fits the patterns of positive selection and sorting in the migration data well. To formalize migration decisions, we use the linear random utility framework and assume that the utility level of a type-s individual born in country i and staying in that country is given by

$$u_{ii,s} = \alpha(w_{i,s} + z_{i,s}) + \epsilon_{ii,s},$$

where α is the marginal utility of income, $w_{i,s}$ is the wage rate or marginal productivity of labor in country i, $z_{i,s}$ is an exogenous variable capturing non-wage income and amenities in the origin country (public goods and transfers minus taxes and non-monetary amenities), and $\varepsilon_{ii,s}$ is a random utility component. Although $\varepsilon_{ii,s}$ varies across individuals, individual subscripts are omitted for clarity.

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The utility obtained when the same person migrates to country j is given by

$$u_{ij,s} = \alpha(w_{j,s} + z_{j,s} - c_{ij,s}) + \varepsilon_{ij,s},$$

where $\varepsilon_{ij,s}$ is the random utility component and $c_{ij,s} \geq 0$ denotes the average moving costs borne by the migrant, such that $c_{ii,s} = 0\,\forall i, s$. These costs depend on factors such as geographic, cultural, and linguistic distances between origin and destination countries, and the immigration policy in the destination country. In our benchmark specification, they are treated as exogenous, while this assumption will be relaxed in the robustness analysis.

The random term $\varepsilon_{ij,s}$ is assumed to follow an independent and identically distributed (i.i.d.) extreme-value distribution. Bertoli and Fernández-Huertas Moraga (2012, 2013) and Ortega and Peri (2012) used more general distributions, allowing for a positive correlation in the realization of the shock across similar countries. In the empirical literature, generalizing the distribution of the random term is helpful to derive micro-founded gravity models accounting for multilateral resistance to migration. Augmenting the standard gravity model with appropriate fixed effects or correction terms improves the estimation of some key parameters (see Bertoli and Fernández-Huertas Moraga, 2012 and 2013). This is less an issue in our "non-estimation" paper because our backsolving identification strategy is such that we fit the data perfectly. Theoretically, accounting for spatial dependence in the random terms is also justified if migrants consider some destinations as strongly substitutable (e.g., Denmark and Sweden). However, we want to avoid arbitrarily choosing the nests of substitutable destinations and the within-nest correlation rate between the random terms. We believe using i.i.d. random terms is a neutral and reasonable assumption.

The probability that a type-s individual born in country i will move to country j is given by

$$\frac{L_{ij,s}}{N_{i,s}} = \Pr\left[u_{ij,s} = \max_k u_{ik,s}\right], \tag{1}$$

where $N_{i,s}$ is the native or natural population of type s from country i and $L_{ij,s}$ is the number of migrants from country i to country j. $L_{ii,s}$ denotes the number of non-migrants (individuals born in i and staying in i).

We use the McFadden theorem (McFadden, 1984): when the random terms $\epsilon_{ik,s}$ follow an extreme-value distribution of type I, the probability that a type-s individual born in country i will move to country j is given by the following logit expression

$$\Pr\left[u_{ij,s} = \max_k u_{ik,s}\right] = \frac{\exp[\alpha(w_{j,s} + z_{j,s} - c_{ij,s})]}{\sum_k \exp[\alpha(w_{k,s} + z_{k,s} - c_{ik,s})]}.$$

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Hence, the log-ratio of emigrants/stayers, $\ln(L_{ij,s}/L_{ii,s})$, is given by the following linear expression,

$$\ln\left[\frac{L_{ij,s}}{L_{ii,s}}\right] = \alpha(w_{j,s} - w_{i,s}) - x_{ij,s}, \tag{2}$$

where $x_{ij,s} \equiv \alpha(c_{ij,s} - z_{j,s} + z_{i,s})$ measures the cost of migration, net of the difference in amenities. Henceforth, we refer to $x_{ij,s}$ as net migration costs. Obviously, we have $x_{ii,s} = 0$.

Migration costs $c_{ij,s}$ vary across country pairs and education level. Indeed, migrants face significant legal barriers, social adjustment costs, financial burdens, and uncertainties while trying to reach their destination and settle there. We distinguish legal or visa costs, and private or assimilation costs. Private costs cover a wide range of hurdles faced by migrants in finding employment, housing, covering transportation costs, living far from one's community, deciphering foreign cultural norms, adjusting to a new linguistic and economic environment, etc. We denote private costs by $\underline{c}_{ij,s}$. Legal or visa costs represent policy-induced costs borne by the migrant to overcome the legal hurdles set by national authorities at destination and origin. We denote them by $b_{ij,s}$, implying $c_{ij,s} = \underline{c}_{ij,s} + b_{ij,s}$. We define incompressible net migration costs as

$$\underline{x}_{ij,s} \equiv \alpha(\underline{c}_{ij,s} - z_{j,s} + z_{i,s}).$$

Liberalizing labor mobility therefore means removing all legal migration costs and simulating the equilibrium allocation of labor when $x_{ij,s}$ falls to $\underline{x}_{ij,s}$. Note that an unconstrained and complete absorption of the additional immigrants is assumed in our model as in the existing literature. In the benchmark model, no externalities other than the effect on wages are considered. This assumption is obviously strong and might imply an overestimation of the efficiency gains. In Section IV, we consider the efficiency gains in the presence of additional externalities.

Production Function. Another strand of the literature has examined the impact of immigration on economic performance and welfare in destination countries (see recent works by Borjas, 2003, 2009; Card, 2009; Ottaviano and Peri, 2012). Empirical structural models are all derived from the profit maximization of representative firms characterized by a nested constant-elasticity-of-substitution (CES) production function with different stages: capital and labor, high-skilled and low-skilled labor, experience groups, and migrants and natives. We use a simplified version of this model without physical capital and without experience groups.

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Each country has a large number of homogeneous firms characterized by the same production function. The output in country i (Y_i) is produced using labor in efficiency units (Q_i)

$$Y_i = A_i Q_i, \tag{3}$$

where A_i reflects the level of TFP in country i. The world GDP or income level is written as $Y_W \equiv \sum_i Y_i$. The assumption that output is proportional to labor in efficiency units is equivalent to assuming a perfect mobility of capital across nations and a constant international interest rate.

Following the labor market and growth literatures (see, among others, Katz and Murphy, 1992; Card and Lemieux, 2001; Caselli and Coleman, 2006), we assume that labor in efficiency units (Q_i) is a nested CES function of highly educated workers ($Q_{i,h}$), and less-educated workers ($Q_{i,l}$):

$$Q_i = \left[\theta_{i,h} Q_{i,h}^{(\sigma-1)/\sigma} + \theta_{i,l} Q_{i,l}^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)}, \tag{4}$$

where $(\theta_{i,h}, \theta_{i,l})$ are the country-specific value share parameters of highly educated and less-educated workers (such that $\theta_{i,h} + \theta_{i,l} = 1$), and σ is the elasticity of substitution between the two groups of workers. In the benchmark model, we consider immigrants as perfect substitutes to natives (as in Borjas, 2009). This assumption will be relaxed in the robustness analysis.

Denoting the total labor force by $Q_{i,t} \equiv Q_{i,h} + Q_{i,l}$, the average income per worker ($y_i^w = Y_i/Q_{i,t}$) can be expressed as

$$y_i^w = A_i \left[\theta_{i,h} h_i^{(\sigma-1)/\sigma} + \theta_{i,l}(1-h_i)^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)}, \tag{5}$$

where $h_i = Q_{i,h}/Q_{i,t}$ measures the proportion of college graduates in the labor force.

Firms maximize profits. The equilibrium wage rate for type-s workers in country i is equal to the marginal productivity of labor:

$$w_{i,s} = A_i \frac{\partial Q_i}{\partial Q_{i,s}} = \theta_{i,s} A_i \left(\frac{Q_i}{Q_{i,s}}\right)^{1/\sigma}. \tag{6}$$

From these profit maximization conditions, it is straightforward to show that total output equals total income: $Y_i = w_{i,h} Q_{i,h} + w_{i,l} Q_{i,l}$. The wage ratio of college graduates to the less educated is given by

$$\frac{w_{i,h}}{w_{i,l}} = \frac{\theta_{i,h}}{\theta_{i,l}} \left(\frac{Q_{i,l}}{Q_{i,h}}\right)^{1/\sigma}. \tag{7}$$

It follows that the income per worker is increasing in the proportion of college graduates ($\partial y_i^w/\partial h_i > 0$) in country i if and only if the wage ratio

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$w_{i,h}/w_{i,l}$ exceeds one. This condition is reasonably satisfied in all countries. The country-specific effect of liberalizing labor mobility on the income per worker is positive (resp. negative) if the change in the proportion of college graduates is positive (resp. negative).

Equilibrium Allocation. In each country, the type-s resident labor force ($Q_{i,s}$) is the sum of national stayers and immigrants, whereas the native or natural labor force ($N_{i,s}$) is the sum of national stayers and emigrants. Given the notations above, we have

$$Q_{i,s} \equiv \sum_{k \in J} L_{ki,s} \tag{8}$$

$$N_{i,s} \equiv \sum_{k \in J} L_{ik,s}. \tag{9}$$

Hence, the world equilibrium allocation of labor can be defined as follows.

Definition 1. *For a given distribution of the native population* $\{N_{i,s}\}_{\forall i,s}$*, of TFP values* $\{A_i\}_{\forall i}$*, and bilateral structure of net migration costs* $\{x_{ij,s}\}_{\forall i,j,s}$*, a competitive equilibrium is an allocation of labor* $\{L_{ij,s}\}_{\forall i,j,s}$ *and vector of wages* $\{w_{i,s}\}_{\forall i,s}$ *satisfying (i) aggregate constraints* (8) *and* (9)*, (ii) utility maximization conditions* (2)*, and (iii) profit maximization conditions* (6) *for all* i*,* j*, and* s*.*

An equilibrium allocation of labor is characterized by a system of $2 \times J \times (J+1)$ equations, that is, $2 \times J \times (J-1)$ bilateral log-ratio of migrants to stayers, $2 \times J$ wage rates, and $2 \times J$ aggregation constraints. In the next subsections, we use data for 195 countries (developed and developing independent territories) and explain how we parametrize our system of 76,440 simultaneous equations. Once properly calibrated, this model can be used to conduct a large variety of numerical experiments.

Comparative Static Analysis. The main concern of our analysis is efficiency and therefore the main variable of interest is the world (denoted W) income per worker, y_W^w. However, redistributive effects across regions are also considered. At the regional level, alternative income measures allow us to evaluate the effects of liberalization on the different types of agents (i.e., migrants and stayers). Besides the income per worker y_i^w (i.e., the average income of workers employed in a given country), we analyze the effect of liberalization on income per natural y_i^n (i.e., the average income of national workers born in a given country), and income per remaining stayer y_i^r (i.e., the average income of natives staying in their country of birth). The latter variable includes remittances sent by expatriates. In theory, the amount of

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remittances should depend on the emigrant-to-stayer ratio, income differences between origin and destination countries, and immigration policy at destination (see Docquier *et al.*, 2012a). For simplicity, we assume here that remittances are proportional to expatriates' total income.

The income variables of interest are defined as

$$Y_i^w = \sum_{j \in W, s} L_{ji,s} w_{i,s}; \qquad y_i^w = \frac{Y_i^w}{Q_{i,t}} \tag{10a}$$

$$Y_i^n = \sum_{j \in W, s} L_{ij,s} w_{j,s}; \qquad y_i^n = \frac{Y_i^n}{\sum_{s=l,h} N_{i,s}} \tag{10b}$$

$$Y_i^r = \sum_{s} L_{ii,s} w_{i,s} + \tau_i \sum_{j \neq i, s} L_{ij,s} w_{j,s}; \qquad y_i^r = \frac{Y_i^r}{\sum_s L_{ii,s}}, \tag{10c}$$

where τ_i is the exogenous propensity to remit income to country i.

At the margin, the effect of a change in the allocation of labor (i.e., a set of $dQ_{i,s}\ \forall i, s$ such that $\sum_{i \in W} dQ_{i,s} = 0\ \forall s$) on the world average income per worker (dy_W^w) is given by

$$dy_W^w = \sum_{s, i \in W} \left(y_i^w + Q_{i,t} \frac{dy_i^w}{dh_i} \frac{dh_i}{dQ_{i,s}} \right) \frac{dQ_{i,s}}{Q_{W,t}}. \tag{11}$$

Equation (11) highlights the two mechanisms at play when migration increases. The first term between brackets reflects the gain in income induced by the relocation of workers from low-wage to high-wage countries. The second term captures the general equilibrium effect on the average income per worker in the origin and destination countries. The effect on the income per worker depends on the change in the distribution of human capital across the world ($dh_i\ \forall i$). Hence, there is a possibility that the world average income per worker increases, while the income per worker decreases in all regions; this happens if the gains experienced by new migrants exceed the losses for non-migrants. A similar comparative static exercise is performed for income per natural and income per stayer in the Appendix.

Parametrization

Given the availability of migration data, we calibrate our model on the year 2000 and distinguish between 195 countries. In this section, we explain how we identify the common, country-specific, and bilateral parameters of our model. A description of our data sources and summary statistics by region can be found in the Appendix (see Table A1).

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To calibrate the production technology, we proceed in three steps. First, we combine several data sources to assess the size and skill structure of each country's labor force ($Q_{i,s}\ \forall i, s$). Second, in order to compute the quantity of labor in efficiency units ($Q_i\ \forall i$), we need to specify the value of σ, the elasticity of substitution between high-skilled and low-skilled workers. There is a large group of influential papers that propose specific estimated values. Johnson (1970) and Murphy *et al.* (1998) estimate values for σ around 1.30 (1.34 and 1.36, respectively). Ciccone and Peri (2005) and Krusell *et al.* (2000) estimate values around 1.50 (1.50 and 1.66, respectively), and Ottaviano and Peri (2012) estimate a value close to 2. Angrist (1995) recommends a value above 2 to explain the trends in the college premium on the Palestinian labor market. In our calibration, the parameter σ is set to 3 and is common to all countries.[9] The parameter $\theta_{i,h}$ is calibrated using the wage ratio between college graduates and the less educated using equation (7). The country-specific wage ratio is obtained using data on returns to schooling and average years of education. Finally, combining GDP data in US dollars (USD) from the World Development Indicators ($Y_i\ \forall i$) and labor in efficiency units ($Q_i\ \forall i$), it is straightforward to identify the TFP level, A_i, for each country i as a residual of equation (3). Then, the wage rate for type-s workers in country i ($w_{i,s}\ \forall i, s$) can be easily computed using equation (6). The calibrated wage rates are perfectly compatible with data on GDP, data on the size and education structure of the labor force, the consensual CES production technology, and the distribution of skill premia across countries.

As for the migration technology, the marginal utility of income, α, is estimated by Grogger and Hanson (2011). For the sorting equations, they obtain the values of 0.026 and 0.060 when using pre-tax wage data from the World Development Indicators and the Luxembourg Income Study, respectively. When post-tax wage data are used, α increases to 0.103. In our benchmark model, we use 0.026. Other values are considered in the robustness analysis in Section IV. Combining bilateral migration stocks and labor force data gives estimates for the log-ratio of migrants to stayers, $\ln(L_{ij,s}/L_{ii,s})$, for the 195×195 country pairs. We have no data on migration costs, but we can identify them using a backsolving calibration strategy as in Sims (1990). Using migration data and the wage rate proxies described above, we compute $x_{ij,s}$ as a residual of equation (2):

$$x_{ij,s} = \alpha(w_{j,s} - w_{i,s}) - \ln\left(\frac{L_{ij,s}}{L_{ii,s}}\right).$$

[9] The results are robust to the choice of σ as shown in the earlier version of this paper (Docquier *et al.*, 2012b)

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We have $x_{ii,s} = 0\,\forall i, s$, and for the pairs of countries with zero immigrants ($L_{ij,s} = 0$), we set $x_{ij,s}$ to an arbitrarily large value. Using this backsolving strategy, our identified net migration costs are perfectly compatible with bilateral migration and income data observed in 2000, and with the widespread random utility model of migration.

As far as remittances are concerned, the exogenous propensity to remit, τ_i (remittances divided by emigrants' aggregate income), is calibrated so as to match the amount of remittances observed in the 2000 equilibrium. This propensity to remit is used to compute the level of income per stayer ($y_i^r\ \forall i$).

Identifying Visa Costs

To the best of our knowledge, no comprehensive database on visa costs and legal migration restrictions has been available so far. Again, we use the backsolving strategy and identify legal costs as residuals of the migration equation (2) in which effective migration stocks are replaced by potential migration stocks (i.e., the sum of effective and desiring bilateral migrants). In order to estimate potential migration stocks, we rely on the Gallup World Poll survey. For each country of origin and education level, it identifies the proportion of non-migrants expressing a desire to emigrate to another country. In our benchmark scenario, we only focus on people who want to emigrate permanently. In the robustness check, we account for temporary migration, assuming two possible levels for the average duration of their stay abroad. The survey includes the following two relevant questions on intentions to emigrate permanently.

Q1 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?
Q2 To which country would you like to move?

These questions were asked in 142 countries. By the year 2000, these countries represented 97.4 percent of the worldwide population aged 25 and over covered in our full set of 195 countries. In line with the effective migration data, we only consider respondents aged 25 and over, and distinguish between individuals with a college education and the less educated.[10]

[10] However, the skill structure of the Gallup database is different from the one in Artuç *et al.* (2014), in which a high-skilled individual is anyone who has at least one year of college education. Using the Gallup survey classification, we define high-skilled individuals as those who have completed four years of education after high school and/or earned a

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Interpretation of the Questions. In the Gallup reports, question Q1 is seen as capturing migration aspirations rather than intentions. We consider that "having the opportunity" is interpreted by the respondents as the complete absence of policy restrictions to movement. Our interpretation is likely to overestimate the importance of legal costs and thereby the effect of a complete liberalization. Indeed, for some people, it is likely that "having the opportunity" means obtaining a visa, a job offer, or being able to pay for private migration costs. Even though they reply positively to the question, these respondents would not be able to emigrate in the absence of policy restrictions due to other constraints (e.g., financial constraints, lack of networks, etc.). Furthermore, some people who mention a desire to leave might end up emigrating, even in the absence of changes to mobility restrictions. For example, about 1/7 of would-be migrants report that they plan to emigrate during the next 12 months. However, potential overestimation is not a major issue here given that it backs up the idea that efficiency gains have been overestimated in the existing literature. Bilateral desired migration stocks are constructed in two steps. More details about our adjustment method and its implications can be found in the Online Appendix.

Average Desire to Emigrate. Our first step consists of using answers to Q1 to compute the aggregate proportion of individuals who express a desire to permanently leave their country, whatever their preferred country of destination. For each country of origin, we aggregate individual answers to Q1 and weight each observation by the relevant Gallup sample weight. These weights are designed to match the demographic characteristics of the total weighted sample of respondents with the latest estimates of the demographic characteristics of the adult population available for the country. To compute the aggregate desire to emigrate, we divide the weighted number of respondents who answered Q1 positively by the total number of respondents to the same question.

We aggregate the first four waves of the Gallup survey (i.e., the years 2007–2010) and consider that these four waves represent a single period of observation that is not too far from our base year 2000. Combining waves allows us to limit the number of missing cells and to increase the accuracy of our estimates. The survey covers 287,410 respondents (i.e., an average of 2,024 observations per country). However, in some cases, the number of respondents is small and the raw data need to be adjusted (e.g., in Burundi, only one college graduate was interviewed and expressed a desire to emigrate). We construct reliability rates for each country of origin and

four-year college degree (see the Online Appendix for further details on this issue). Because the propensity to emigrate increases with education, we might overestimate the desire to migrate of both high-skilled and low-skilled individuals.

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education level, based on the absolute number of respondents (at least 50 to be fully reliable) and the relative coverage of the Gallup sample (at least 0.01 percent of the country's whole adult population to be fully reliable). We also predict potential (i.e., desired + effective) emigration rates using a third-order polynomial function of the effective emigration rates. Our adjusted desire to emigrate is a reliability-weighted average of the raw and predicted emigration rates. For the 53 countries that are not included in the Gallup survey (i.e., a reliability rate equal to zero), the emigration rate is fully predicted. It is worth noticing that the latter imputed data only account for 2 percent of the total number of desiring migrants. In our benchmark, we assume that desired emigration rates apply to the non-migrant population ($L_{ii,s}\ \forall j \neq i, s$). As a robustness, we also consider a scenario in which each effective migrant can relocate to another destination.

Bilateral Structure. In the second step, we use answers to Q2 to disaggregate the number of desiring migrants by country of destination. Several issues had to be solved to compute the bilateral shares. First, given the large response rate to Q2, we ignore those who did not answer Q2 for the computation of the bilateral shares. Second, a few respondents answered Q2 and mentioned a preferred destination without answering Q1. We considered that they answered "Yes" to Q1. Third, we split five aggregate categories of destination countries proportionally to the distribution of the stated desire to emigrate to countries belonging to the same country group. Finally, for the 53 countries that are not covered in the Gallup survey, we imputed the bilateral shares of a similar country belonging to the same region, with a similar level of development and a common colonizer. More details about our imputation matches can be found in the Online Appendix.

Legal Migration Costs. Adding desiring migrants from the Gallup survey to effective migrants, we obtain potential migration stocks and compute the allocation of labor that would be observed in the absence of migration barriers: $L^p_{ij,s} = L_{ij,s} + d_{ij,s} L_{ii,s}\ \forall j \neq i, s$. In the benchmark, we do not allow effective migrants to relocate. This assumption will be relaxed at the beginning of Section IV. Assuming that respondents do not internalize general equilibrium effects generated by the migration of other stayers in the world (i.e., wages are fixed to their baseline values), we can identify incompressible migration costs ($\underline{x}_{ij,s}$) as residuals of the migration technology,

$$\underline{x}_{ij,s} = \alpha(w_{j,s} - w_{i,s}) - \ln\left(\frac{L^p_{ij,s}}{L^p_{ii,s}}\right).$$

Migration barriers can be quantified either in USD ($b_{ij,s} \equiv (x_{ij,s} - \underline{x}_{ij,s})/\alpha$), or as a proportion of net migration costs ($\beta_{ij,s} \equiv b_{ij,s}/x_{ij,s}$). The

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interpretation of $\beta_{ij,s}$ should not be pushed too far because $x_{ij,s}$ includes disparities in amenities and does not measure total migration costs per se. Net migration costs are even negative for some small corridors involving a poor origin country ($x_{ij,s} < 0$), or become negative after liberalization ($\underline{x}_{ij,s} < 0$) in a few cases.[11] In the case of a full liberalization, 39 percent of high-skilled and 41 percent of low-skilled corridors would benefit from a decrease in migration costs. Focusing on corridors with $\beta_{ij,s} \in [0, 1]$, migration barriers represent 3.2 and 5.4 percent, on average, of net migration costs for high-skilled and low-skilled workers, respectively.

However, legal restrictions are relatively more important for large corridors. For low-skilled migrants, policy barriers represent almost 14 percent of net migration costs for the 10 (and 19 percent for the 100) largest corridors (e.g., 18 percent for Turkey–Germany and Bangladesh–India, and 26 percent for Mexico–US). As for college graduates, legal barriers represent a lower proportion of net migration costs, on average. However, for the main corridors, the policy barriers are still important; that is, about 20 percent of the net costs for the 10 main corridors, seven of which have the US as the destination country (e.g., 25 and 21 percent for India–US and Mexico–US, respectively). This proportion falls to 19 percent for the 100 largest corridors. Even though policy-induced restrictions are important for large corridors, incompressible migration costs still represent an important fraction of total migration costs.

III. Benchmark Results

In this section, we use the benchmark model to simulate the effects of a complete liberalization of labor mobility ($x_{ij,s} \rightarrow \underline{x}_{ij,s}\ \forall ij, s$) and to provide results for 11 regions. Throughout the rest of the paper, we use the following abbreviations: US = United States; EU15 = 15 initial members of the 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; and OTHERS = remaining countries. The results for selected countries are provided in Table A2 in the Appendix. Our model is static and our results should be considered as medium-term effects, as in the majority of existing papers. More optimistic results could be achieved in the long run because

[11] Twenty corridors exhibit negative net migration costs for college-educated workers. The majority of these corridors are between small developing island states and the US (eight corridors), Canada (five corridors), and the UK (two corridors). The remaining corridors are Suriname–the Netherlands, Kuwait–Occupied Palestinian Territory (O.P.T.), Oman–O.P.T., Qatar–O.P.T., and Bahrain–Philippines.

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Table 2. *Effect of a complete liberalization on migration rates and composition of the labor force (deviation in percentage points from the baseline)*

	Immigration rates[a]			Emigration rates[b]			Share of college graduates[c]		
Regions	Partial eq.	CES	Downgrading	Partial eq.	CES	Downgrading	Partial eq.	CES	Downgrading
WORLD	8.6	8.5	8.4	8.6	8.5	8.4	0.0	0.0	0.0
US	25.8	24.8	24.6	3.9	3.9	3.9	−11.7	−10.5	−10.8
EU15	21.2	21.2	21.2	8.6	8.5	8.4	−1.4	−1.5	−2.0
CANZ	44.0	43.5	43.4	7.6	7.5	7.5	−11.5	−10.2	−10.7
GCC	38.1	38.0	38.0	5.4	5.3	5.3	−4.5	−3.4	−2.7
MENA	5.5	5.5	5.5	16.0	15.8	15.7	−0.3	−0.5	−0.4
SSA	5.9	5.9	5.9	20.2	19.8	19.7	0.0	−0.1	0.0
CIS	2.0	2.0	2.0	8.5	8.5	8.5	−0.8	−0.9	−0.7
CHIND	0.3	0.3	0.3	3.5	3.4	3.4	−0.3	−0.3	−0.2
ASIA	4.2	4.2	4.2	11.4	11.2	11.2	−0.8	−0.9	−0.7
LAC	4.2	4.2	4.2	14.6	14.2	14.1	−0.1	−0.3	−0.2
OTHERS	11.6	11.5	11.5	12.8	12.7	12.6	1.4	1.0	1.1

Notes: [a]Share of immigrants in the labor force of the country of residence. [b]Share of emigrants in the native labor force. [c]Share of college graduates in the resident labor force. Regions: US = United States; EU15 = 15 members of the 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.

new migrants can accumulate financial assets and human capital (Klein and Ventura, 2009).

Partial Equilibrium Effects

Focusing first on partial equilibrium results with exogenous wages, we reproduce the Gallup desired migration flows reported in Table 1. Liberalizing labor mobility increases the world stock of migrants by 246.1 percent, from 111.6 million to 386.1 million individuals. The change is stronger for low-skilled workers (+284.2 percent) than for high-skilled workers (+136.6 percent). Typical migration destinations (such as the US, EU15, CANZ, and GCC) experience a greater rise in immigration than in emigration, as reflected by the relatively higher potential immigration stock compared to the potential emigration stock. However, the highest immigration rates are observed in CANZ (68.3 percent) and GCC (78.5 percent).

Table 2 shows the effect of a liberalization on the proportion of immigrants, emigrants, and high-skilled workers in the labor force. The worldwide fraction of workers living outside their country of birth increases by 8.6 percentage points (from 3.5 percent to 12.1 percent). The immigration rate (measured as the stock of immigrants relative to the labor force) increases by 25.8 percentage points in the US, while in EU15 this figure

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Table 3. *Effect of a complete liberalization on income (percentage of deviation from the baseline)*

	Income per worker			Income per natural			Income per stayer		
Regions	Partial eq. (1)	CES (2)	Downgrading (3)	Partial eq. (4)	CES (5)	Downgrading (6)	Partial eq. (7)	CES (8)	Downgrading (9)
WORLD	11.9	11.3	11.2	11.9	11.3	11.2	3.4	3.3	3.5
US	−5.6	−5.7	−6.0	−1.2	−0.3	0.0	0.2	1.2	1.4
EU15	−0.6	−0.7	−0.9	0.1	0.0	0.1	−0.4	−0.4	−0.4
CANZ	−2.8	−3.4	−3.6	0.1	0.6	1.0	0.0	0.7	1.1
GCC	−6.5	−5.4	−4.4	−1.6	−1.9	−1.8	−0.3	−0.6	−0.4
MENA	1.1	0.7	1.1	29.6	28.9	28.9	9.9	9.5	10.0
SSA	7.0	6.7	7.1	102.7	94.5	94.9	28.5	26.1	27.8
CIS	−0.1	−0.2	−0.1	15.3	15.3	14.6	1.6	1.5	1.6
CHIND	−0.3	−0.4	−0.3	15.9	14.8	14.5	6.1	5.6	5.9
ASIA	2.6	2.3	2.3	15.9	15.1	15.0	3.7	3.2	3.4
LAC	1.3	0.8	1.0	16.8	14.7	14.2	4.6	3.9	4.1
OTHERS	17.9	17.2	17.0	16.0	15.7	15.3	4.1	3.9	3.9

Notes: US = United States, EU15 = 15 members of the 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.

increases by 21.2 percentage points. On the contrary, developing regions register the highest increase in their emigration rate (as measured by the stock of emigrants relative to the size of the native labor force). The latter rises by 20.2 percentage points in SSA and by 16.0 percentage points in MENA.

As shown in Section II, the skill composition of additional migration flows is crucial for the effects on the average income. In the partial equilibrium framework, we disregard changes in wage rates and highlight the benefits from simply relocating desiring migrants (i.e., the first component of equation (11)). However, the average resident worker's education level varies if the proportion of educated workers among arriving immigrants differs from that of the residing population. As shown in Table 2, liberalizing cross-border migration reduces the proportion of college graduates in almost all regions. The reason is that new migrants are generally more educated than natives left behind (positive selection in emigration), but less educated than workers in destination countries (negative selection in immigration). All regions, except for OTHERS, end up with a lower fraction of skilled workers in their workforce. The latter region includes some developed countries, such as Norway, which explains why it attracts more high-skilled workers than it loses.

The evolution of the three different income variables presented in equations (10a), (10b), and (10c) is provided in Table 3. These three income

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measures capture heterogeneous realities, thereby highlighting the consequences of liberalization for different groups of workers. Column 1 in Table 3 shows the percentage deviation of income per worker at the regional level. The relocation of labor to more productive regions implies an 11.9 percent increase in world income. In the US and EU15, the income per worker decreases by 5.6 percent and 0.6 percent, respectively, while it is reduced by 6.5 percent in GCC. The regions benefiting from a higher income per worker are SSA (+7.0 percent), MENA (+1.1 percent), ASIA (+2.6 percent), and LAC (+1.3 percent). Even though there is positive selection among the emigrants from most of these regions, their average income per worker increases primarily due to a relocation at the intra-regional level. Many workers move to countries paying higher wages within the same region (e.g., 650,000 additional workers move from Malawi to South Africa and 450,000 move from Indonesia to Japan).

Column 4 reports the evolution of income per natural. In the absence of migration restrictions, workers typically relocate to countries where wages are higher, implying a higher income per natural in most regions. The latter more than doubles for natives from SSA and increases between 15 and 30 percent in the rest of the developing regions. However, the potential increase in income is less important for individuals born in developed countries. Income per natural decreases for the US and GCC, in particular. These are very high income regions but a certain number of individuals still want to emigrate, capturing motivations that are different from the pure potential increase in wages (e.g., amenities, personal aspirations, etc.).

Column 7 shows the effect on the income per stayer. Because wages are assumed constant in this scenario, the income per stayer is only affected by the change in skill distribution among non-migrants, and the effect of remittances received (in particular, for developing countries). A first observation is that the variation in income per stayer for traditional destination regions is close to 0. It is slightly positive for the US (+0.2 percent), neutral for CANZ, and negative for the EU15 (−0.4 percent) and GCC (−0.3 percent). Because these regions do not receive large amounts of remittances, this is a consequence of the change in their workers' skill distribution. Emigration in the US is negatively selected, while positive selection characterizes the desired emigration from the EU15 and GCC. Thus, the stayers' average skill level increases in the US, but decreases in the two other regions.

General Equilibrium Effects

Similar results are obtained when general equilibrium effects are accounted for. At the world level, migration stocks increase somewhat less (+241.1 percent) than in partial equilibrium (+246.1 percent). The immigration

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rate decreases slightly in destination countries, while the emigration rate is marginally reduced in the origin regions. When wages are endogenous, the wage rate received by a worker depends on the change in the skill distribution, as shown in equation (11) (i.e., the relative skill distribution of immigrants relative to stayers). Immigrants lower the wage rate of stayers belonging to the same education group, and increase the income of substitutable workers, while the reverse holds for emigrants.[12]

The world GDP per worker increases by 11.3 percent, instead of 11.9 percent in the partial equilibrium case (Table 3). Compared to the partial equilibrium scenario, traditional immigration countries experience a marginally stronger decrease in GDP per worker, while origin regions are more adversely affected.

As far as income per natural is concerned, the only regions experiencing a loss are GCC (-1.9 percent) and the US (-0.3 percent). Both regions suffer from a drop in their proportion of college-educated workers. Interestingly, the proportion of college graduates drops by 10.2 percentage points in CANZ, while income per natural still increases. The emigration of CANZ workers to countries where wage rates are higher compensates for the loss induced by the lower proportion of college graduates at home (e.g., approximately 400,000 workers move from CANZ to the US). However, the effect is much stronger for natives from sending countries because they are the ones who move to countries paying higher wages. Natives from SSA and MENA benefit from an average increase in their income of 94.5 and 28.9 percent, respectively. The gains are close to 15 percent in LAC, ASIA, and CIS. These improvements are slightly below the gains observed in the partial equilibrium case. Wages at destination are reduced compared to the benchmark case. At the same time, prospective immigrants anticipate general equilibrium effects perfectly. Because wages at destination decrease for the main groups of migrants, emigration rates are marginally smaller than in partial equilibrium.

On average, non-migrants in immigration destinations (i.e., stayers) benefit from a slight improvement in their income because of the immigration surplus induced by complementary workers (US $+1.2$ percent and CANZ $+0.7$ percent). In the case of the US and CANZ, the income per stayer increases more than in the partial equilibrium scenario, implying that the skill distribution of the arriving immigrants complements that of the stayers. EU15 stayers experience a slight decrease in their average income. This is caused by the positive selection among European emigrants, which reduces the average skill level and income of the stayers. The source regions continue to benefit from improved revenues particularly because of

[12] Using the framework of di Giovanni *et al.* (2014), host countries could experience welfare gains because migration increases the market size and number of varieties at destination.

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the remittances sent back by the diasporas established abroad. The main beneficiaries are stayers in SSA (+26.1 percent), MENA (+9.5 percent), and CHIND (+5.6 percent).

From the combination of the three different income measures, it can be concluded that the main beneficiaries of a liberalization of mobility restrictions are new emigrants. In developing countries, remittances sent to stayers more than cover their revenue loss caused by the positive selection in emigration, at least under the assumption that migrants' propensity to remit is constant. Finally, the income measures focusing on the people (income per natural and per stayer) contrast sharply with the results focusing on the geographical dimension (income per worker).

Downgrading of Education

Our basic specification assumes that there is an equivalence between national and foreign degrees in terms of quality. It is widely documented that many immigrants with higher education tend to find jobs in occupations typically staffed by less-educated natives (see Mattoo *et al.*, 2008). Highly educated immigrants trained in developing countries, in particular, are likely to be less productive in high-skill jobs than natives with similar educational degrees. Evidence of such heterogeneity in the quality of education is provided by Coulombe and Tremblay (2009), who have estimated the relative productivity of migrants and natives in Canada. As explained in the Appendix, our downgrading correction consists of multiplying the number of college graduates originating from a given country by the relative productivity index computed for that country, and considering the remaining fraction as less-educated workers. For example, each college graduate from Angola is considered as a combination of 0.73 of an actual college-educated worker and 0.27 of a less-educated worker.

The application of the downgrading of education to the CES case with general equilibrium effects provides a first robustness check on the distribution of skills. Accounting for differences in educational quality reduces the number of high-skilled workers by approximately 34 million (e.g., a decrease of 9.5 percent of the college-educated workforce at the world level). The number of additional college-educated migrants is reduced by 5.5 million at the world level, compared to the benchmark case, while the number of low-skilled workers increases by the same amount. Table 2 shows that the downgrading of education only marginally changes the immigration and emigration rates in most regions.

The lower number of high-skilled workers in the world implies a lower number of high-skilled potential migrants, while the number of low-skilled potential migrants increases. This leads to a slightly smaller effect on income per worker at the world level, which increases by 11.2 percent (instead of 11.3 percent in the CES benchmark). The decrease in income per

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worker is amplified in almost all developed countries that attract most of the college-educated emigrants (US, EU15, and CANZ). In these countries, the proportion of high-skilled workers decreases more than in the benchmark case (see Table 2). However, the proportion of high-skilled workers decreases less in developing countries.

Moreover, the population of developed regions is relatively more educated. The rise in low-skilled migration increases the wage premia of the relatively more educated native workforce. This also explains why the income per stayer increases slightly more in the downgrading scenario in almost all regions. Hence, our results are very robust to downgrading.

IV. Robustness Analysis

In this section, we assess the robustness of our results to various identifying and technological assumptions. We first use alternative interpretations of the Gallup data. We then evaluate the robustness of our results to the level of the marginal utility of income, and to the inclusion of technological spillover effects. We also allow desired migration to be amplified by network effects. For each modification in the benchmark model or in the parametrization strategy, we update the identification of unobserved exogenous variables and simulate the effect of a complete liberalization of labor mobility. Other general caveats are discussed at the end of the section.

Measurement of Potential Migration

In the benchmark scenario, we computed the stock of potential migrants (i.e., effective + desiring migrants) and its bilateral structure, assuming that effective migrants do not relocate to another destination, and disregarding desired temporary migration. As a robustness check, we construct three variants of the potential migration stock and apply them to the CES case.

First, we use the same size and structure of desired migration, but consider that effective migrants do relocate proportionally to the bilateral structure of desired migration. This scenario is labeled "Relocation". Because desired migration is much more concentrated in high-income countries than effective migration, we expect efficiency gains to be greater in this scenario. Columns 1 and 5 in Table A3 in the Appendix show that the number of potential migrants drastically increases in the EU15 and CANZ in this scenario. In contrast, migration between developing regions decreases.

Second, we use the Gallup World Poll survey and identify the proportion of non-migrants expressing a desire to emigrate temporarily or permanently to another country. We use answers to Q1' and Q2' on temporary migration, which are formulated as for Q1 and Q2 for permanent migration except that the term "permanently" is replaced by "temporarily". We apply the same adjustments and imputation as for permanent migration, as

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Table 4. *Robustness 1: interpretation of Gallup questions, CES case (percentage of deviation from the baseline)*

	Income per worker			Income per natural			Income per stayer		
Regions	Relocation	Temp.15	Temp.30	Relocation	Temp.15	Temp.30	Relocation	Temp.15	Temp.30
WORLD	12.4	12.0	12.7	12.4	12.0	12.7	3.6	3.4	3.5
US	−6.8	−6.1	−6.5	0.0	−0.5	−0.7	1.5	1.3	1.4
EU15	−0.5	−0.7	−0.8	−0.4	0.0	0.0	−0.4	−0.5	−0.6
CANZ	−3.8	−3.4	−3.5	−0.2	0.6	0.6	0.9	0.7	0.8
GCC	−5.9	−5.5	−5.5	0.3	−1.9	−2.0	−0.5	−0.6	−0.6
MENA	−1.3	0.8	0.9	31.8	29.6	30.2	10.1	9.7	9.9
SSA	6.7	7.0	7.4	106.2	99.5	104.6	27.3	28.2	30.3
CIS	−0.6	−0.3	−0.3	26.6	16.4	17.5	2.3	1.6	1.7
CHIND	−0.3	−0.5	−0.5	15.4	16.4	18.0	5.9	6.2	6.7
ASIA	2.5	2.5	2.6	16.3	15.9	16.6	3.6	3.3	3.3
LAC	1.1	0.8	0.8	12.8	15.9	17.2	3.8	4.3	4.8
OTHERS	21.9	18.6	20.0	18.7	16.6	17.5	4.4	4.1	4.4

Notes: US = United States; EU15 = 15 members of the 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.

explained in the Online Appendix. There is a large overlap between those who answered Q1 and Q1' positively. By default, we consider these to be potential permanent migrants. However, some individuals declared that they would like to emigrate temporarily but not permanently. We now include the latter in the set of potential migrants and consider two scenarios about the duration of temporary migration: we assume temporary migrants stay for 15 or 30 percent of a whole career in the destination country (i.e., about 6 or 12 years), and we use the same bilateral structure as for permanent migration.[13] As shown in Table A3, the number of potential migrants increases from 386.1 to 407.0 million under the "Temp.15" variant, and to 428.0 million under the "Temp.30" variant.

Table 4 shows the effect of a complete liberalization of migration in these three alternative scenarios. Efficiency gains reach 12.4 percent in the "Relocation" case, as more migrants move to high income regions. The income per worker decreases in the US, CANZ, and GCC because of an amplification of the negative selection among immigrants. The drop in the income per worker is lower in origin regions, with the exception of MENA, where the income per worker decreases by 1.3 percent (compared to a previous increase of 0.7 percent). This could be due to a stronger positive selection among MENA emigrants towards developed regions, and a higher

[13] For simplicity, we assume temporary migrants are "mitosic": 15 (or 30) percent of them move abroad, while the remaining 85 (or 70) percent stay put.

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Table 5. *Robustness 2: marginal utility of income, CES case (percentage of deviation from the baseline)*

	Income per worker			Income per natural			Income per stayer		
Regions	α=0.060	α=0.103	α=0.300	α=0.060	α=0.103	α=0.300	α=0.060	α=0.103	α=0.300
WORLD	11.0	10.7	9.8	11.0	10.7	9.8	3.1	2.8	2.3
US	−5.0	−4.3	−2.8	−0.4	−0.6	−1.0	1.0	1.0	0.8
EU15	−0.8	−0.8	−0.8	0.0	0.0	−0.1	−0.5	−0.5	−0.6
CANZ	−2.8	−2.4	−1.6	0.4	0.3	0.0	0.5	0.4	0.3
GCC	−4.2	−3.4	−2.1	−1.7	−1.7	−1.6	−0.4	−0.3	−0.1
MENA	0.5	0.4	0.2	28.8	28.5	27.2	9.3	9.0	8.5
SSA	6.4	6.2	6.0	91.8	89.2	81.4	25.1	24.1	21.5
CIS	−0.3	−0.4	−0.6	15.3	15.4	15.4	1.4	1.4	1.2
CHIND	−0.5	−0.5	−0.6	14.4	14.0	12.9	5.5	5.3	4.7
ASIA	2.1	2.0	1.7	14.9	14.5	13.4	3.0	2.8	2.2
LAC	0.4	0.1	−0.4	14.0	13.4	11.6	3.4	3.0	2.2
OTHERS	16.8	16.4	15.8	15.7	15.6	15.0	3.7	3.5	3.1

Notes: US = United States; EU15 = 15 members of the 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.

negative selection among immigrants, in particular towards Middle East countries. In comparison to the benchmark, income per natural decreases more in LAC, EU15, and CANZ. In the last two cases, this can be explained by the wage effects caused by an intensification of the negative selection among immigrants, while a higher positive selection among LAC migrants is observed (e.g., LAC workers now leaving LAC for the US or EU15). This also explains why LAC is the only region suffering from a lower income per stayer compared to the CES benchmark case.

Accounting for temporary migration has the primary effect of increasing the scale of migration. Because the bilateral distribution of the benchmark is applied to a higher stock of potential migrants, regional results only slightly change quantitatively while remaining qualitatively robust. The average income per worker increases by 12 percent and 12.7 percent, respectively, under the assumption that a temporary migrant is equivalent to 0.15 or 0.30 permanent migrant.

Marginal Utility of Income

In this section, we assess the sensitivity of our results to the level of the marginal utility of income. In our benchmark model, we use $\alpha = 0.026$. We now consider the CES case for three alternative values, $\alpha = (0.060; 0.103; 0.300)$. Table 5 shows that the effect of a complete liberalization of migration in these three scenarios is quite robust. The larger

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the marginal utility of income, the lower the effect of a liberalization on the average income per worker.

In the CES framework, wages at destination decrease for the main groups of desiring migrants. Hence, as the marginal utility of income increases, the number of additional emigrants and the efficiency gains from liberalizing migration decrease when wages are endogenous. Under $\alpha = 0.060$, the GDP per worker increases by 11 percent, while $\alpha = 0.30$ reduces the gain to 9.8 percent. Similarly, the results for income per natural and income per stayer are qualitatively robust while quantitatively only marginally affected.

Technological Spillovers

Our benchmark model relies on simple technological assumptions and a simplistic treatment of labor market interactions between immigrants and natives. The efficiency gains from liberalizing labor mobility are likely to be affected if TFP is endogenized, or if immigrants and natives are not perfect substitutes on the labor markets. Here, we consider three technological variants.

Congestion. In the benchmark framework, we assumed an unconstrained absorption capacity by the receiving countries, as is done in the rest of the literature. However, the existence of a fixed factor in production (such as land) can cause aggregate decreasing returns. In general, congestion effects can be modeled by assuming that TFP is also a function of the aggregate quantity of factors. Our first extension consists in endogenizing the TFP level as follows:

$$A_t = a_i (Q_{i,t})^{-\phi}.$$

In this expression, the crowding effect of the labor force size on land, assuming a share of land in production of 0.03 in rich countries (see Ciccone and Hall, 1996) would imply $\phi = 0.03$. The scale factor, a_i, can be calibrated as a residual of the TFP equation.

Imperfect Substitution between Immigrants and Natives. The benchmark 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 (Card, 2009; Manacorda *et al.*, 2012; Ottaviano and Peri, 2012).[14] In our second extension, immigrants and natives within the same

[14] There are various reasons to believe that native and immigrant workers might differ in several aspects relevant to the labor market. First, immigrants have skills, motivations, and tastes that might set them apart from natives. Second, in manual and intellectual work, they

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skill/education category are allowed to be imperfect substitutes within a CES structure. We use the following specification:

$$Q_{i,s} = \left[\theta_{i,n} L_{ii,s}^{(\delta-1)/\delta} + \theta_{i,m}\left(\sum_j L_{ji,s}\right)^{(\delta-1)/\delta}\right]^{\delta/(\delta-1)},$$

Here, $L_{ii,s}$ is the number of type-s native workers and $\Sigma L_{ji,s}$ is the number of type-s immigrant workers who are present in the country; δ is the elasticity of substitution between natives and immigrants in group s; parameters $(\theta_{i,n}, \theta_{i,m})$ capture the firm's preference parameters for natives and immigrants (such that $\theta_{i,n} + \theta_{i,m} = 1$). There is a debate in the literature on the estimates of the elasticity of substitution between natives and immigrants. We use $\sigma = 20$, in line with Card (2009) and Ottaviano and Peri (2012), and calibrate $\theta_{i,n}$ to equalize wages before the liberalization shock. The latter hypothesis ensures that our results are fully comparable to those in the benchmark model, and allows us to isolate the effect of imperfect substitution.

Schooling Externalities. In the third extension, we consider the possibility of a positive schooling externality on TFP.[15] In the spirit of Lucas (1988), we now assume that the TFP level is increasing in schooling intensity,

$$A_i = a_i' \left(\frac{Q_{i,h}}{Q_{i,t}}\right)^{0.32}, \tag{12}$$

where a_i' captures the part of TFP independent from the human capital externality, and $Q_{i,h}/Q_{i,t}$ is the proportion of college graduates in the domestic labor force.

We acknowledge that, in the existing literature, there is still a certain level of disagreement between those who find substantial schooling externalities and those who do not.[16] We want the schooling externality to be

might have culture-specific skills and limitations (e.g., limited knowledge of the language or culture of the host country), which create comparative advantages in some tasks and disadvantages in others. Third, even in the absence of a comparative advantage, immigrants tend to be concentrated in different occupations than natives because of migration networks or historical accidents (e.g., Iranzo and Peri, 2009). New immigrants, in particular, tend to cluster disproportionately in those sectors or occupations in which previous migrant cohorts are already over-represented.

[15] Recent evidence of a schooling externality has been identified at the country level (Benhabib and Spiegel, 2005; Vandenbussche *et al.*, 2006; Cohen and Soto, 2007), or at the metropolitan level (Acemoglu and Angrist, 2000; Moretti, 2004a, 2004b; Ciccone and Peri, 2006; Iranzo and Peri, 2009)

[16] Acemoglu and Angrist (2000) find an elasticity close to zero, Iranzo and Peri (2009) suggest using 0.44, while Moretti (2004a, 2004b) finds values between 0.75 and 1.00. De la Croix and Docquier (2012) use an elasticity of 0.277.

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Table 6. *Robustness 3: technological externalities (percentage of deviation from the baseline)*

	Income per worker			Income per natural			Income per stayer		
Regions	Congestion	Nested CES	Schooling	Congestion	Nested CES	Schooling	Congestion	Nested CES	Schooling
WORLD	10.7	10.1	7.0	10.7	10.1	7.0	3.0	3.5	−0.3
US	−6.4	−6.3	−12.1	−1.0	0.6	−7.1	0.4	2.2	−5.9
EU15	−1.2	−1.7	−2.7	−0.6	0.2	−2.3	−0.9	0.7	−2.4
CANZ	−5.5	−5.3	−10.2	−1.4	3.3	−6.5	−1.5	4.5	−6.9
GCC	−8.3	−6.6	−5.2	−4.3	1.9	−2.0	−3.1	4.0	−0.5
MENA	1.1	0.4	−3.0	27.7	25.7	24.5	9.5	8.9	5.5
SSA	7.0	5.9	4.3	93.1	84.3	84.7	26.1	24.1	22.0
CIS	0.0	−0.2	−1.5	15.1	13.1	12.7	1.7	1.5	0.1
CHIND	−0.3	−0.4	−3.0	14.4	13.1	10.5	5.6	5.1	2.5
ASIA	2.4	1.4	−0.8	14.7	13.2	11.0	3.3	2.9	0.1
LAC	1.2	0.1	0.4	14.4	12.0	11.1	4.2	3.5	2.8
OTHERS	16.1	15.4	20.1	15.1	13.4	14.3	3.7	4.3	4.3

Notes: US = United States, EU15 = 15 members of the 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.

compatible with the TFP levels calibrated in the second part of Section II. Hence, we identify the TFP levels of our 195 countries between 1980 and 2005 (one observation every five years), collect human capital data over the same period (Defoort, 2008), and use dynamic regression results, which can be found in the Appendix of the earlier version of the paper (Docquier *et al.*, 2012b). TFP growth is regressed on its lagged value and the log of the proportion of college graduates in the labor force. Controlling for year- and country-fixed effects, we find an elasticity of TFP to human capital equal to 0.17 in the short run and to 0.32 in the long run, and we recalibrate a_i' in order to match the GDP data.

Results. Table 6 shows the effect of a complete liberalization of migration for the three technological variants. At the world level, the rise in GDP per worker is only marginally affected by the congestion effect (+10.7 percent) and the imperfect substitution between natives and immigrants (+10.1 percent). The congestion effect decreases efficiency gains in the traditional source countries, while it slightly benefits non-migrants in origin countries. However, given that wages in the main destination countries are reduced, changes in income per natural are smaller in the main sending regions. Imperfect substitution between natives and immigrants reduces the income per worker in all regions, but particularly in traditional destinations, which already have relatively important migrant stocks. However, non-migrant natives, who are now complementary to immigrants, benefit from immigration, as shown by a higher increase in the income per stayer in developed

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regions. Thus, natives from traditional destination countries tend to benefit from higher incomes, while the gains for emigrants are reduced, as shown by relatively lower improvements of income per natural in developing regions. Schooling externalities reduce the average efficiency gain to 7 percent. The positive selection in emigration in most origin countries and the negative selection in immigration in the destination countries explain why efficiency gains are lower relative to the benchmark in all regions (except in OTHERS). Given equation (11), we expect stronger crowding-out effects on non-migrants' income levels in this scenario, in particular in migrant-receiving countries. The schooling externality is particularly harmful for natives and non-migrants in the main receiving countries, which emphasizes the impact of negative selection among immigrants in these regions.

Migration Networks

Our benchmark specification assumes that private migration costs are exogenous. However, the assumption of exogenous incompressible migration costs is questionable. The critical role of diasporas on migration patterns has been clearly recognized in the sociology, demography, and economics literatures, and extensively analyzed over the last 20 years (e.g., Boyd, 1989). Many authors have shown that established migrant networks play an important role in the migration decisions of current would-be migrants. Relying on network information, newcomers can reach relatively better and safer decisions in the case of uncertainty and imperfect information. They might also more easily decipher foreign cultural norms, adjust to the new linguistic and cultural environment, or overcome legal entry barriers through sponsorship by immediate family members and other relatives (Massey *et al.*, 1993; Carrington *et al.*, 1996; Pedersen *et al.*, 2008; Beine *et al.*, 2011a).

In this section, we account for network externalities and allow private migration costs to be compressed when the size of the bilateral diaspora increases. Network externalities have been disregarded in the existing literature on liberalization, and we expect them to reinforce the gains.

The size of global network externalities has been estimated by Beine *et al.* (2011a), who find that the diasporas are by far the most important determinant of flow size, explaining over 70 percent of the observed variability. They obtain semi-elasticities of bilateral migration costs to the size of the total diaspora at destination, $\partial c_{ij,s}/\partial \ln(1 + L_{ij,T})$, of 0.625 for college graduates and 0.778 for the less educated. However, these elasticities sum up the effects on legal and private migration costs.

In a subsequent paper, Beine *et al.* (2011b) disentangle the relative importance of the two channels using US immigration data by metropolitan area and country of origin. Assuming that both effects are governed by the

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same log-linear functional forms, they obtain semi-elasticities of visa costs to network size, $\partial b_{ij,s}/\partial \ln(1 + L_{ij,T})$, of 0.229 for college graduates and 0.383 for the less educated. When the functional homogeneity assumption is relaxed, the semi-elasticity reaches an average of 0.577 (they do not provide estimates by education level). Although this value only characterizes the immigration policy of the US, we use it for all countries. We subtract the visa effect from the total semi-elasticities and endogenize incompressible migration costs ($\underline{x}_{ij,s}$) as follows:

$$\underline{x}_{ij,l}^{\text{new}} = \underline{x}_{ij,l}^{\text{base}} - 0.20 \cdot \ln\left(\frac{1 + L_{ij,T}^{\text{new}}}{1 + L_{ij,T}^{\text{base}}}\right)$$

$$\underline{x}_{ij,h}^{\text{new}} = \underline{x}_{ij,h}^{\text{base}} - 0.05 \cdot \ln\left(\frac{1 + L_{ij,T}^{\text{new}}}{1 + L_{ij,T}^{\text{base}}}\right).$$

Adding network effects increases potential migration by slightly more than 200 million individuals, out of whom 50 million come from Africa (including SSA and MENA), 90 million from Asia (including ASIA and CHIND), and 25 million from LAC (see Table A4). These additional migrants would concentrate mainly in the EU15 (+43 million), Asia (+39 million), and the US (+32 million).

The effect of a complete liberalization of migration with network effects is presented in Table 7. In the partial equilibrium framework, accounting for diasporas on incompressible migration costs further increases the income per worker (+17.9 percent compared to +11.9 percent), as more workers are relocated to higher productivity regions. The main destination countries experience higher immigration inflows and suffer from a slightly stronger decrease in the income per worker. However, the sending countries experience an evolution in the income per worker, which is more favorable than in the benchmark case. Compared to the latter, more workers leave countries located in regions such as MENA, LAC, or ASIA, benefiting from the existing diasporas in high-income countries. Similarly, the rise in income per natural is particularly amplified for individuals from developing regions as more individuals benefit from lower migration costs. The average income per stayer increases by 7.6 percent at the world level (instead of 3.4 percent in the absence of network effects), while, in all regions, non-movers also experience a higher revenue. In developing regions, remittances sent by emigrants increase the income of non-migrants, while in receiving countries, selection effects are reduced because of a proportionally higher increase in low-skilled migration (which is more sensitive to the network effect).

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Table 7. *Robustness 4: adding network effects (percentage of deviation from the baseline)*

	Income per worker			Income per natural			Income per stayer		
Regions	Partial eq.	CES	Techn. extern.	Partial eq.	CES	Techn. extern.	Partial eq.	CES	Techn. extern.
WORLD	17.9	17.4	7.8	17.9	17.4	7.8	7.6	7.0	2.3
US	−9.0	−7.7	−17.1	0.1	−0.3	−9.0	2.7	2.5	−6.2
EU15	−1.4	−1.5	−8.3	−1.8	−1.7	−7.1	0.1	0.0	−3.2
CANZ	−6.6	−5.5	−20.5	1.3	0.6	−10.1	2.5	2.0	−8.4
GCC	−11.2	−8.3	−12.3	−4.6	−4.7	−3.5	0.8	0.8	3.7
MENA	3.4	2.7	−1.8	41.4	41.4	27.9	18.5	17.8	12.2
SSA	17.2	16.6	13.7	171.5	166.9	130.1	66.7	63.9	55.6
CIS	0.1	0.0	0.5	24.2	24.3	16.5	3.4	3.3	3.2
CHIND	−0.3	−0.4	−2.5	26.1	25.0	14.9	10.6	10.1	5.5
ASIA	7.0	6.6	−0.1	23.4	23.0	12.0	6.9	6.3	2.5
LAC	1.9	1.0	1.0	19.7	18.8	9.5	9.0	8.0	7.7
OTHERS	27.7	27.3	18.3	21.6	21.5	12.5	6.3	6.0	5.6

Notes: US = United States; EU15 = 15 members of the 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.

Endogenizing wages changes the results only slightly. However, if all the technological externalities mentioned previously are considered, the impact of a liberalization is dampened. In all regions, the technological externalities tend to reinforce the decrease in the skill ratio. Congestion effects are amplified by the higher migration stocks, while schooling externalities reinforce the impact of the negative selection of emigrants. Hence, these externalities reduce the wage rates in most regions, thereby limiting the positive effect of network externalities.

Summary and Caveats

Accounting for incompressible private migration costs reduces the efficiency gains from liberalizing labor mobility. The effect ranges between 7 and 18 percent of the GDP in the medium term. Our semi-elasticity of the world GDP to the share of migrants in the world population varies between 0.6 and 1.5 (Figure 1). This semi-elasticity crucially depends on the TFP levels of the sending and receiving countries. Desiring migrants typically move from developing to developed countries. In most scenarios, we obtain a semi-elasticity in the range of 1.2–1.4, in line with previous studies. Its level increases to 1.5 if effective migrants can relocate to richer countries. In contrast, when schooling externalities are important, it falls to 0.8. When the three technological externalities are combined with the

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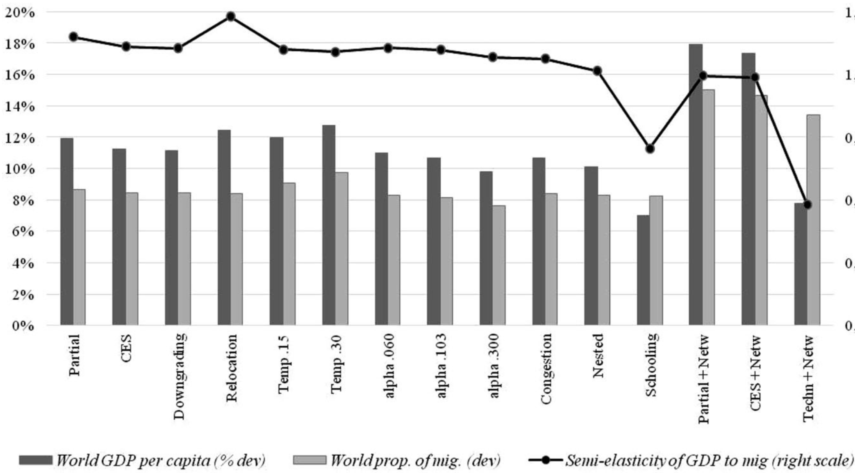

Fig. 1. Semi-elasticity of the world GDP to migration after a complete liberalization
Notes: The semi-elasticity is defined as the percentage of deviation in the world GDP divided by the change in the world proportion of migrants.

network effect, the semi-elasticity decreases to 0.6. Still, our results should not be considered as too pessimistic for the following reasons.

First, assuming that output is proportional to labor in efficiency units in equation (3), we have a model without slowly accumulating factors in mind. It might represent a globalized economy in which capital follows people.[17] Under constant physical capital stock in each country, increased migration would reduce the income per worker in the richest immigration countries and lower the efficiency gains from liberalization in the medium term, as demonstrated in existing studies. Things can be different in the long run because people relocating to richer countries can accumulate more financial assets and human capital (e.g., Klein and Ventura, 2009). However, in line with the majority of papers in this literature, we focus on the medium-term impact.

Second, defenders of trade could also object that trade and migration are closely related. In the Heckscher–Ohlin tradition, trade and migration are perfect substitutes: increasing migration flows has no effect on wages.

[17] Indeed, the assumptions that (i) output is produced using physical capital and labor in efficiency units, (ii) production is represented by a constant-returns-to-scale (CRS) Cobb–Douglas function, (iii) physical capital is mobile across firms and nations, and (iv) each single firm and each single country are too small to affect the international interest rate would lead to the same linear specification. The returns to physical capital would be equalized across firms and countries, thereby implicitly defining the equilibrium capital-to-labor ratio in the economy. Plugging this arbitrage condition into the production function, a firm's output becomes a linear function of labor in efficiency units.

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More realistically, trade and migration are likely to be imperfect substitutes because countries produce differentiated goods or migration induces trade-creation effects (e.g., Gould, 1994; Head and Ries, 1998; Rauch and Trindade, 2002; Rauch and Casella, 2003; Combes *et al.*, 2005). In a model with firm heterogeneity and love of variety, di Giovanni *et al.* (2014) have shown that the trade response to migration is driven by the fact that migration modifies the number of varieties produced at origin and destination. 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.

V. Conclusion

In this paper, we endogenize bilateral migration and income inequality across countries in a general equilibrium model of the world economy with skill heterogeneity, private migration costs, and immigration restrictions. The model is calibrated using a unique database on labor force characteristics, bilateral migration stocks by education level, and economic variables. Furthermore, we estimate and break down migration costs using an original backsolving strategy. The model is then used to simulate a complete liberalization of labor mobility. Taking incompressible migration costs into account reduces efficiency gains resulting from our simulation in the range of 7–18 percent of the world GDP, with a focal effect around 12 percent of the world GDP. These numbers are much lower than those reported in the literature, although we might overestimate the effect of visa costs. The main reason is that existing studies overestimate, by far, the number of potential migrants.

On the one hand, additional technological extensions, such as endogenous TFP and more realistic labor interactions between natives and immigrants amplifying general equilibrium effects, further reduce the gains. Positive selection in emigration and negative selection in immigration, in particular, reinforce the negative impact for both origin and destination regions. On the other hand, the consideration of the network effects induced by existing diasporas on incompressible migration costs accelerates the distribution of workers among higher productivity countries.

Obviously, political economy issues arise because liberalization induces income losses for stayers in high-income immigration-receiving countries. Addressing these issues is beyond the scope of this paper.[18] The model could also be extended with endogenous education and population size in order to investigate long-run effects. Furthermore, it could be used to

[18] A politically sustainable mechanism, encouraging rich countries to host more immigrants, is discussed in de la Croix and Docquier (2009).

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predict the effect of TFP and preference shocks on future migration flows. These extensions are left for future research.

Appendix

Comparative Static Analysis

Here, we complement the comparative static analysis of Section II. The regional income per worker takes into account redistribution effects, which are not reflected by changes in the world production frontier. Denoting regional aggregate variables by subscript R, the change in regional income per worker is

$$dy_R^w = \sum_{\substack{i \in R \\ s=l,h}} \left(y_i^w - y_R^w + Q_{i,t} \frac{dy_i^w}{dh_i} \frac{dh_i}{dQ_{i,s}} \right) \frac{dQ_{i,s}}{Q_{R,t}}. \tag{A1}$$

The term in brackets represents the change in regional income. Two effects are simultaneously at play: a reallocation of workers from low-wage to high-wage countries and an impact on the wage rates of stayers, weighted by the workforce size of each country. It must be stressed that regional averages might hide different realities at the country level, given the aggregation of regional population and production. Therefore, the average income per worker at the regional level can increase, even if the proportion of high-skilled workers decreases. To illustrate this, suppose that a part of the regional population moves from a low-income country to a higher-income country located in the same region. The regional population remains constant while the total production increases. Even if some high-educated workers leave the region, the average income can increase if a sufficiently large number of workers reallocate to (or arrive in) the more productive countries.

The effect on the average regional income per natural is

$$dy_R^n = \sum_{\substack{i \in R \\ j \in W \\ s=l,h}} w_{j,s} \frac{dL_{ij,s}}{N_R} + \sum_{\substack{i' \in W \\ j' \in W \\ s'=l,h}} \left(\sum_{\substack{i \in R \\ j \in W \\ s=l,h}} \frac{dw_{j,s}}{dL_{i'j',s'}} L_{ij,s} \right) \frac{dL_{i'j',s'}}{N_R}, \tag{A2}$$

with $\sum_{j' \in W} dL_{i'j',s} = 0 \, \forall i', s'$. Only the distributional effect on the wages of natives is taken into account, given that the number of natives from a certain region is constant. The first term accounts for the reallocation of workers born in region R. For $j \in R$, the reallocation takes place inside the region (e.g., a Korean worker moving to Japan), while for $j \notin R$ the worker leaves the region (e.g., a Korean worker migrating to the US). The second term incorporates the general equilibrium effects induced by labor

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mobility on the wages across the world (e.g., a Korean worker living in the US can experience a change in income as a result of the arrival of additional Indian and Brazilian migrants in the US).

Denoting stayers in region R by

$$S_{R,t} = \sum_{\substack{i \in R \\ s=l,h}} L_{ii,s},$$

we can write the effect on the average regional income per stayer as

$$\begin{aligned} dy_R^r = & \sum_{\substack{i \in R \\ s=l,h}} w_{i,s} \frac{dL_{ii,s}}{S_R} \\ & + \sum_{\substack{i' \in W,\, j' \in W \\ s'=l,h}} \left[\Big(\sum_{\substack{i \in R \\ s=l,h}} \frac{dw_{i,s}}{dL_{i'j',s}} L_{ii,s} \Big) \frac{dL_{i'j',s}}{S_R} - y_R^r \frac{dS_R}{S_R} \right] \\ & + \sum_{\substack{i' \in W,\, j' \in W \\ s'=l,h}} \left[\sum_{\substack{i \in R,\, j \neq i \\ s=l,h}} \tau_i \Big(\frac{dL_{ij,s}}{dL_{i'j',s'}} w_{j,s} + L_{ij,s} \frac{dw_{j,s}}{dL_{i'j',s}} \Big) \right] \frac{dL_{i'j',s}}{S_R}. \end{aligned} \quad \text{(A3)}$$

The average income per stayer depends on the changes in the number of non-movers in region R. Furthermore, labor mobility can affect the wage rates (both inside and outside region R) and thereby also the amount of money remitted by emigrants to stayers in the source country (general equilibrium effects).

Simulation Algorithm

The calibrated model can now be used to simulate a liberalization of labor mobility. Each experiment requires simulating a system of 76,440 simultaneous equations. We use a Gauss–Seidel "shooting" algorithm. Each iteration I starts with a set of $2\times$ 38,025 guesses for $\widehat{\ell}_{ij,s}^{I} (\equiv L_{ij,s}/L_{ii,s})$ for $s = h, l$. For each set of guesses, we compute the size and structure of the labor force and wage rates in each country. We then use the utility-maximization condition to compute the solution for $\overline{\ell}_{ij,s}^{I}$. The next iteration then starts with a new set of guesses, $\widetilde{\ell}_{ij,s}^{I+1} = \eta \widetilde{\ell}_{ij,s}^{I} + (1-\eta)\overline{\ell}_{ij,s}^{I}$, where $1-\eta$ is the correction factor. The algorithm stops when the sum of errors (in absolute value) falls below a convergence threshold: $\sum_{i,j,s} |\widetilde{\ell}_{ij,s}^{I} - \overline{\ell}_{ij,s}^{I}| < \varepsilon$. The parameter η regulates the convergence speed towards the new equilibrium and could take any value between 0 and 1. By setting it to η=0.95, we choose a slow convergence process toward the new equilibrium.

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Modeling migration decisions and endogenous TFP amplifies the general equilibrium effects (dh) emphasized in equation (11). It also modifies the dynamic properties of the model and could give rise to multiple equilibria. Indeed, if TFP is exogenous, the emigration of college graduates increases high-skill wages at origin, dampening incentives to leave for other educated workers. In contrast, if TFP is endogenous, the brain drain reduces TFP and might reduce high-skill wages at origin, inducing strategic complementarities in emigration decisions. De la Croix and Docquier (2012) have derived the conditions under which interactions between migration and income give rise to multiple equilibria. Our iterative algorithm, which converges slowly to the new equilibrium (given the choice of η=0.95), is likely to capture the local effect of the shock. Thereby, it prevents the possibility of switches to other equilibria. However, using alternative values for η, we have not identified any cases of jumps toward other trajectories in our numerical experiments. Furthermore, multiplicity would not be a serious problem here, given that it mainly concerns small states that represent less than 1 percent of the world GDP (as shown in de la Croix and Docquier, 2012).

Data Sources

Income Data (Y_i $\forall i$). Data on total GDP in USD in 2000 are obtained from the World Development Indicators. Columns 1 and 2 in Table A1 give the regional distribution of the world GDP and the regional level of GDP per worker.

Labor Force Data ($Q_{i,s}$ $\forall i, s$). The size of the working-age labor force (i.e., the population aged 25 and over) is provided by the United Nations. Labor force data are then split across skill groups using international indicators of education attainment. Here, we follow Docquier *et al.* (2009) and combine different datasets documenting the proportion of college graduates in the population aged 25 and over. They use de la Fuente and Doménech (2006) for OECD countries and Barro and Lee (2001) for non-OECD countries. For countries where Barro and Lee's measures are missing, they use rescaled proportions from Cohen and Soto (2007). In the remaining countries, where both Barro–Lee and Cohen–Soto data are missing (about 70 countries in 2000), they apply the proportion of college graduates of the neighboring country with the closest enrollment rate in secondary/tertiary education, or the closest GDP per worker. Columns 3 and 4 in Table A1 give the regional distribution of the total labor force and the share of college-educated workers.

Within-Country Wage Inequality ($w_{i,h}/w_{i,l}$). The country-specific wage ratio is obtained using data on returns to schooling and average years of

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Table A1. *Data on income, labor force, and actual migration by region*

Regions	Income[a]		Labor force[b]		Immigration[b]		Emigration[b]	
	$\times 10^9$ (1)	Per worker (2)	$\times 10^6$ (3)	College as %[c] (4)	$\times 10^6$ (5)	As %[c] (6)	$\times 10^6$ (7)	As %[d] (8)
WORLD	45,195.7	14,207.6	3,181.1	11.2	111.6	3.5	111.6	3.5
US	9,579.3	52,133.3	183.7	51.3	24.2	13.1	0.9	0.6
EU15	8,814.7	32,895.8	268.0	21.2	19.9	7.4	15.6	5.9
CANZ	1,381.2	38,857.6	35.5	43.6	8.6	24.3	1.5	5.2
GCC	544.3	38,520.0	14.1	12.8	5.7	40.5	0.6	6.9
MENA	1,442.8	10,824.2	133.3	7.8	5.6	4.2	9.1	6.7
SSA	1,036.3	4,612.1	224.7	3.1	8.7	3.9	10.5	4.6
CIS	2,053.6	11,882.3	172.8	17.7	16.7	9.7	19.1	10.9
CHIND	7,712.2	6,214.9	1,240.9	3.4	5.2	0.4	10.0	0.8
ASIA	7,577.4	13,502.3	561.2	10.2	9.0	1.6	20.0	3.5
LAC	3,615.7	14,415.2	250.8	11.4	2.6	1.0	15.5	5.9
OTHERS	1,438.2	14,988.3	96.0	12.2	5.3	5.5	8.7	8.8

Notes: [a]GDP in USD (Source: World Development Indicators). [b]Non-migrant and migrant populations aged 25 (Source: Artuç *et al.*, 2014). [c]Share in the labor force of the country of residence. [d]Share in the native labor force. Regions: US = United States; EU15 = 15 members of the 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.

education. Hendricks (2004) provides Mincerian returns to schooling, MR_i, for 54 countries around the year 2000. For the same countries, we use Barro and Lee (2001) data and compute the difference in years of schooling between college graduates and the less educated in 2000, $DY_{i,00}$. The wage ratio is then computed as $\sigma_{i,00} = (1 + MR_{i,00})^{DY_{i,00}}$. For countries where data are not available, we predict the wage ratio using a log-linear function of the skill ratio in the resident labor force. A simple OLS regression gives $\ln(w_{i,h}/w_{i,l}) = 0.25 - 0.31 \ln[h_{i,00}/(1 - h_{i,00})]$ with $R^2 = 0.57$.

Bilateral Migration Data ($L_{ij,s}$). Effective migration data are taken from Artuç *et al.* (2014) who produce 195×195 comprehensive matrices of bilateral migration stocks. These matrices are computed for the two skill groups (college graduates and less-educated individuals), for individuals aged 25 and over, and for two years (1990 and 2000). We only use the 2000 matrices. Migration is defined on the basis of the country of birth. Columns 5–8 in Table A1 give the regional distributions of immigrants and emigrants (without the distinction of education levels) and the regional proportion of college graduates in immigration and emigration.

Remittances. Data on remittances are taken from the World Development Indicators. The propensity to remit is kept constant at its 2000 level for simplification purposes.

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Downgrading of Education. Coulombe and Tremblay (2009) compared the skill intensity and schooling levels of Canadian immigrants and natives who were all submitted to standardized tests in literacy, maths, and problem-solving. These tests provide measures of proficiency that are comparable across countries and over time. On this basis, Coulombe and Tremblay estimate a "skill-schooling gap" expressed in years of schooling. A skill-schooling gap of n years for a given country means that Canadian nationals with y years of schooling are as productive as immigrants with $y + n$ years of schooling. The larger the skill-schooling gap, the lower the quality of education in the country of origin. Simple bivariate OLS regressions show that the skill-schooling gap is a decreasing function of the per worker income of the origin country. Their -0.10 point estimate of the coefficient of the slope indicates that the skill-schooling gap decreases by one year when per worker income increases by 10,000 USD in the origin country. Using this estimate and cross-country data on per worker income, we construct an indicator of skill-schooling gap for each origin country. Then, assuming that one year of schooling generates a productivity gain of 8 percent, we estimate the relative productivity of educated immigrants and natives in each country, with a benchmark value of one for workers trained in Canada (as well as workers trained in richer origin countries; i.e., the upper bound of this index is one). For example, college-graduate immigrants from Angola and Portugal have productivity levels equal to 0.73 and 0.85 percent of Canadian college graduates, respectively.

In order to keep the world labor force constant across simulations, our adjustment consists of multiplying the number of college graduates originating from a given country by the relative productivity index computed for that country, and considering the remaining fraction as less-educated workers. In the previous example, a college graduate from Angola is considered as a combination of 0.73 of an actual college graduate and 0.27 of a non-college graduate. This method has two main limitations. First, because our adjustment factor is based on Canadian data, it suffers from a selection bias. Indeed, Moroccan migrants to Canada are likely to have higher skills than Moroccan migrants to France. To address this limitation, we have conducted simulations with a correction based on the square of the Canadian index. Under the squared correction, one college-graduate immigrant from Angola or Portugal accounts for 0.51 or 0.72 units of highly skilled workers, respectively. Taking the squared correction has little impact on the effects. Income per worker increases by 11.1 percent at the world level compared to 11.2 percent in the simple correction case. Regional outcomes also remain identical. Second, while our benchmark non-adjusted measure implies that the human capital of immigrants is equivalent to that of natives (as if all migrants were trained in the host country), our adjusted measure implies that all immigrants were trained in their birth country.

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Table A2. *Impact of liberalization on immigration, emigration, and income in selected countries*

	Immig. rate		Emig. rate		Inc. per worker		Inc. per native	
	Baseline[a]	CES[d]	Baseline[b]	CES[d]	Baseline[c]	CES[e]	Baseline[c]	CES[e]
Australia	0.28	0.41	0.03	0.05	39,989.4	−1.5	39,630.8	−0.9
Brazil	0.00	0.02	0.01	0.05	14,100.7	−0.3	14,201.2	5.1
Burkina Faso	0.05	0.02	0.41	0.11	3,160.8	−0.1	3,909.3	46.9
Canada	0.22	0.44	0.05	0.08	38,958.8	−4.6	39,447.3	1.4
China	0.00	0.00	0.01	0.03	6,676.5	−0.1	6,843.7	11.6
France	0.09	0.23	0.03	0.09	36,124.2	−1.0	36,206.9	−0.6
Germany	0.08	0.18	0.04	0.10	33,802.0	−0.4	34,049.5	0.2
Guyana	0.01	0.18	0.47	0.28	7,370.8	−2.5	23,532.1	29.8
India	0.01	0.00	0.01	0.04	5,487.0	−1.2	5,751.3	20.7
Italy	0.02	0.17	0.06	0.06	30,107.7	−0.7	30,430.5	0.6
Ivory Coast	0.65	0.07	0.08	0.20	5,643.1	−2.6	6,968.1	70.0
Japan	0.01	0.08	0.01	0.11	32,667.5	−1.3	32,736.0	1.1
Mexico	0.00	0.04	0.12	0.14	16,988.7	−2.3	20,089.5	9.2
New Zealand	0.21	0.52	0.16	0.09	32,224.6	0.5	33,502.3	1.7
Qatar	0.67	0.20	0.03	0.09	64,783.3	−5.7	55,846.7	−7.3
Russia	0.09	0.02	0.06	0.09	14,189.4	−0.4	14,283.0	12.9
Saudi Arabia	0.34	0.42	0.02	0.04	37,828.7	−6.1	35,691.5	−0.9
South Africa	0.04	0.14	0.02	0.09	16,437.6	−3.3	16,577.6	8.0
Spain	0.05	0.27	0.03	0.03	27,301.6	−0.6	27,407.9	0.1
Switzerland	0.24	0.45	0.06	0.10	40,216.5	2.0	40,033.4	−2.6
Trinidad and Tobago	0.04	0.05	0.27	0.11	21,371.0	−2.4	28,028.6	5.6
UAE	0.60	0.30	0.06	0.03	38,057.7	−3.5	31,486.6	−1.9
UK	0.09	0.31	0.08	0.18	35,567.5	−1.2	35,739.1	−0.3
US	0.13	0.25	0.01	0.04	52,133.3	−5.7	52,360.2	−0.3

Notes: [a]Share in the labor force of the country of residence. [b]Share in the native labor force. [c]Measured in USD. [d]Deviation in percentage points; [e]Percentage of deviation from the baseline.

The reality is obviously somewhere in between. However, our only objective here is to explore whether a correction for education quality can modify our predictions.

Additional Results

For the benchmark case with endogenous wages, Table A2 shows the impact of liberalizing mobility on some of the main origin and destination countries: the 12 preferred destination countries in the Gallup survey, the BRICS countries (i.e., Brazil, Russia, India, China, and South Africa), and some important origin and destination countries. The emigration rate increases most in traditional origin countries (e.g., 28 and 20 percentage points in Guyana and Ivory Coast, respectively). Traditional destination countries attract a higher number of immigrants. The immigration rate more than doubles in many OECD countries (e.g., Australia, Canada, France, etc.).

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Table A3. *Robustness 1 – interpretation of Gallup questions: potential migration stocks by region (partial equilibrium)*

	Emigration				Immigration			
Regions	Actual $\times 10^6$ (1)	Relocation $\times 10^6$ (2)	Temp.15 $\times 10^6$ (3)	Temp.30 $\times 10^6$ (4)	Actual $\times 10^6$ (5)	Relocation $\times 10^6$ (6)	Temp.15 $\times 10^6$ (7)	Temp.30 $\times 10^6$ (8)
WORLD	386.1	386.1	407.0	428.0	386.1	386.1	407.0	428.0
US	7.2	7.2	8.8	10.3	98.0	97.9	104.0	110.0
EU15	38.2	38.2	39.7	41.2	90.5	107.9	95.7	101.0
CANZ	3.6	3.6	4.2	4.8	53.3	60.3	56.9	60.6
GCC	1.1	1.1	1.1	1.2	29.0	31.0	29.9	30.9
MENA	31.0	31.0	31.5	32.0	11.4	8.4	11.8	12.1
SSA	56.3	56.3	58.8	61.4	18.4	13.1	18.9	19.4
CIS	34.1	34.1	35.2	36.4	18.7	8.1	18.8	19.0
CHIND	53.7	53.7	58.8	63.9	9.0	4.9	9.3	9.5
ASIA	85.4	85.4	89.0	92.6	30.2	27.0	32.2	34.2
LAC	54.1	54.1	57.8	61.5	11.5	11.6	12.5	13.5
OTHERS	21.5	21.5	22.2	22.9	16.1	15.7	17.0	17.9

Notes: [a]Regions: US = United States; EU15 = 15 members of the 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.

Table A4. *Robustness 4 – adding network effects: actual, desired, and potential migration by region (partial equilibrium)*

	Emigration				Immigration			
Regions	Actual[a] $\times 10^6$	Desired[b] $\times 10^6$	Potential[c] $\times 10^6$	Potential[c,d] As %	Actual[a] $\times 10^6$	Desired[b] $\times 10^6$	Potential[c] $\times 10^6$	Potential[c,e] As %
WORLD	111.6	478.0	589.5	18.5	111.6	478.0	589.5	18.5
US	0.9	9.8	10.8	6.7	24.2	106.0	130.2	46.5
EU15	15.6	37.5	53.1	20.1	19.9	113.7	133.7	38.8
CANZ	1.5	3.1	4.6	16.0	8.6	67.9	76.5	76.2
GCC	0.6	1.2	1.8	20.3	5.7	39.1	44.9	86.2
MENA	9.1	34.8	43.9	32.1	5.6	15.1	20.8	18.3
SSA	10.5	87.2	97.6	43.1	8.7	18.7	27.4	17.5
CIS	19.1	25.7	44.8	25.6	16.7	2.6	19.3	12.9
CHIND	10.0	82.5	92.6	7.4	5.2	11.2	16.4	1.4
ASIA	20.0	115.7	135.6	23.7	9.0	60.1	69.1	13.7
LAC	15.5	60.5	76.0	28.8	2.6	22.0	24.6	11.6
OTHERS	8.7	20.0	28.7	28.9	5.3	21.4	26.6	27.4

Notes: [a]Stock of migrants aged 25 and over in 2000 (Source: Artuç *et al.*, 2014). [b]Stock of non-migrants aged 25 and over who would like to leave their country if they had the opportunity (Source: Gallup, 2014). [c]Potential migration = Actual migration + Desired migration. [d]Share in the native labor force. [e]Share in the labor force of the country of residence. Regions: US = United States, EU15 = 15 members of the 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.

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The proportion of highly educated workers decreases in almost all the countries reported. The negative selection in immigration is particularly important in traditional destination countries (e.g., Australia, Canada, and the US), but emigration is also positively selected in most origin countries (e.g., Guyana, Mexico, and Trinidad and Tobago). This is reflected by the lower GDP per worker in most countries, which decreases by more than 5 percent in popular destinations such as Qatar, Saudi Arabia, and the US. Exceptions are New Zealand and Switzerland, where the skill ratio of the labor force increases, leading to a slight increase in GDP per worker. In most European countries, GDP per worker contracts close to 1 percent.

Income per natural increases particularly for individuals born in developing origin countries, such as Burkina Faso, Ivory Coast, Guyana, and India. In most receiving countries, income per natural decreases less than GDP per worker. As can be deduced from the changes in the immigration and emigration rates, few workers emigrate from these richer countries, while they receive many additional immigrants. This inflow of generally negatively selected immigrants decreases the average GDP per worker, while the wage effect on stayers remains limited. An exception is observed for New Zealand and Switzerland, where GDP per worker increases while income per natural decreases. This is because of the positive selection in immigration, which increases the average production per worker, while exerting a downward pressure on the wage of skilled natives in these countries.

Supporting Information

The following supporting information can be found in the online version of this article at the publisher's web site.

Online Appendix

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