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Wage Effects of High-Skilled Migration

International Evidence

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Abstract

The international migration of high-skilled workers may trigger productivity effects at the macro level such that the wage rate of skilled workers increases in host countries and decrease in source countries. The authors exploit data on international bilateral migration flows and provide evidence consistent with this theoretical hypothesis. They propose various instrumentation strategies to identify the causal effect of skilled migration on log differences of GDP per capita, total factor productivity, and the wages of skilled workers between pairs of source and destination countries. These strategies aim to address the endogeneity problem that arises when international wage differences affect migration decisions.

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The recent surge in the international migration of high-skilled workers not only raised standard concerns about adverse brain-drain effects for developing countries but also led to worries about native high-skilled workers in advanced destination countries.[1] Domestic workers with higher education levels fear that their wages will decline in response to increased competition from similarly qualified migrants. Whereas debates on migration in the past have centered on asylum rights and low-skilled migrants, over the years, politicians and the mass media have discovered the issue of high-skilled immigration. For instance, in Switzerland and Austria, the discussion has recently become emotionally charged owing to significant inflows of tertiary-educated workers, particularly from Germany.[2] For the United States, Hanson, Scheve and Slaughter (2009) find that skilled natives tend to oppose immigration in states with a relatively skilled mix of immigrants more than in states in which the skill composition of immigrants features a high proportion of low-skilled immigrants. Similarly, a recent panel study by Müller and Tai (2010) for Europe suggests that higher-skilled workers have less favorable attitudes toward immigration when immigrants are more skilled relative to the average skill level in the destination country.

This paper examines whether domestic skilled workers have reason to oppose high-skilled immigration and, vice versa, whether nonmigrating high-skilled workers win or lose from brain drain in source countries. We argue that the international migration of high-skilled workers triggers productivity effects at the macro level such that the wage rate of skilled workers may rise in host countries and decline in source countries. By exploiting data on international bilateral migration flows from Docquier, Marfouk and Lowell (2007), we empirically examine the impact of an increase in high-skilled emigration rates on log differences in GDP per capita, total factor productivity (TFP), and the wage income of skilled workers between pairs of source and destination countries. We propose a range of instrumental variables to address the potential reverse causality problem that arises when international wage differences affect individual migration decisions (e.g., Lucas, 2005; Egger and Radulescu, 2009; Grogger and Hanson, 2011).

Our theoretical model suggests that even when considering adjustments in educational decisions, an increase in high-skilled emigration (immigration) lowers (raises) the domestic skill intensity in production.[3] This relationship has two effects on the relative wages of high-skilled workers between destination and source economies. First, for a given TFP and as a consequence of the declining marginal productivity of a certain type of labor, high-skilled workers lose in the destination economy and win in the source economy. However, external effects of migration on TFP (positive in destination, adverse in source) may reverse this result. The net effect of high-skilled migration on international wage differences is thus theoretically ambiguous. This theoretical approach makes the relationship between high-skilled migration and wages an empirical question. Our analysis suggests that, if anything, the external productivity effect is likely to dominate. Moreover, because of complementarity between high-skilled and low-skilled labor, an increase in low-skilled migration unambiguously benefits high-skilled workers in the receiving country.

Our findings are consistent with the recent literature on the wage effects of high-skilled immigration in single countries. Borjas (2003) and Dustmann, Fabbri and Preston (2005) provide evidence for a small but positive impact of an inflow of immigrants with a college degree on wages for college-educated natives in the United States and United

Kingdom, respectively. Similarly, Friedberg (2001) suggests that native wages may rise after immigrants enter high-skilled occupations in the Israeli labor market. Our empirical contribution is to provide international evidence for the theoretical possibility of positive wage effects in destination countries relative to source countries. We exploit data on bilateral migration between country pairs, thereby complementing single-country studies on labor market effects of immigration.

Another strand of literature has emphasized the positive effects of brain drain on market income in the source economy (e.g., Mountford, 1997; Stark, Helmenstein and Prskawetz, 1997; Beine, Docquier and Rapoport, 2001, 2008). This possibility arises from the idea that an increase in immigration quotas in advanced countries improves immigration prospects for skilled workers in developing countries and thereby raises incentives to acquire education. However, empirically, the net effect on the size of the skilled labor force appears to be positive, except for very poor countries and/or countries with low levels of human capital (Beine et al., 2001, 2008). In our theoretical framework, brain drain reduces the skill intensity in the source country, even when educational decisions are adjusted. Because our empirical framework investigates the effect of skilled migration on relative outcomes between destination and source, we do not test the alternative hypothesis advanced in the “brain gain” literature. We can conclude, however, that the destination country tends to gain more from skilled migration than the source country.

The remainder of this paper is organized as follows. Section I presents a simple theoretical model. The model provides the basis for the empirical analysis in section II on the effects of higher emigration on relative GDP per capita, relative TFP, and the relative wage income of skilled workers between the source and the destination. The last section provides concluding remarks.

I. Theoretical Considerations

Our theoretical analysis shows that the presence of the external productivity effects of skilled labor implies that in response to an increase in high-skilled migration, the wage level of educated workers may increase in the host country relative to the source country.

Set Up

Consider two economies, home and foreign. There is a homogenous consumption good, which is chosen as the numeraire. Output Y is produced under perfect competition according to the technology

(1) $$Y = AF(H, L) \equiv ALf(k),$$

where H and L denote the high-skilled and low-skilled labor inputs, respectively, A is TFP, the function F is linearly homogenous, $k \equiv H/L$ denotes the skill intensity of production, and $f(k) \equiv F(k,1)$. Furthermore, f is increasing, strictly concave, and fulfills the standard boundary conditions.

Before migration, there is (for simplicity) the same number N of individuals/workers in both countries. There is a positive external effect of a higher concentration of skilled labor, $h \equiv H/N$, on TFP,

(2) $$A = a(h),$$

where a is an increasing function. This assumption captures human capital externalities as formalized, for instance, by Lucas (1988) in the context of endogenous growth. These human capital externalities may arise from learning spillover effects across workers, increased innovation activity in firms, and better institutional quality in a country, which may be associated with a more highly skilled domestic population. The empirical literature on human capital externalities is somewhat inconclusive but is mostly supportive. For instance, Acemoglu and Angrist (2000) find modest evidence in favor of human capital externalities from secondary schooling, whereas Ciccone and Peri (2006) find no evidence. Iranzo and Peri (2009) argue in favor of strong human capital externalities from college graduates in the United States but not from an increased share of high school graduates. In a recent study, Gennaioli et al. (2011) find strong empirical evidence of human capital externalities. They employ a new data set with 1569 subnational regions from 110 countries and argue that human capital is the primary driver of regional development. Moreover, they complement their finding with firm-level evidence on regional education levels for productivity and find large effects. The authors conclude that the previous empirical literature has underestimated the magnitude of human capital externalities. Similarly, Hunt (2011) employs a U.S. state panel data set for the period from 1940 to 2000 to show that an increase in the share of the immigrant college graduate population of one percentage point increases the number of patents per capita by 9–18 percent. This is strong evidence in favor of the hypothesis that skilled immigration increases TFP.

Each individual decides whether to become skilled and whether to migrate. Both skilled and unskilled individuals are internationally mobile, but they may differ in migration costs. Formally, let c_i denote the consumption level of individual i. Utility level u_i is given by

$$(3) \qquad u_i = \begin{cases} c_i \text{ if } i \text{ stays at home,} \\ c_i / \theta_i \text{ if } i \text{ migrates,} \end{cases}$$

where $\theta_i = \theta^H > 1$ if i is skilled and $\theta_i = \theta^L > 1$ if i is unskilled. The modeling of migration costs as discounted consumption follows Stark et al. (1997), among others. Education comes at time cost $e_i \geq 0$, which may be interpreted to be a learning cost. Whereas an unskilled individual supplies one unit of time to a perfect labor market, a skilled individual i supplies only $1 - e_i$ units of time. The wage rate per unit of time of high-skilled and low-skilled individuals at home is denoted by w_H and w_L, respectively. Moreover, denote all foreign variables and functions with superscript *. Therefore, the consumption of individual i born at home is given by

$$(4) \qquad c_i = \begin{cases} (1 - e_i) w_H \text{ if } i \text{ is skilled and stays at home,} \\ w_L \text{ if } i \text{ is unskilled and stays at home,} \\ (1 - e_i) w_H^* \text{ if } i \text{ is skilled and emigrates,} \\ w_L^* \text{ if } i \text{ is unskilled and emigrates.} \end{cases}$$

Denote by $G(e)$ the cumulative distribution function of the learning cost e in the population at home. For convenience, suppose that G is continuously differentiable. We allow functions G^*, F^*, and a^* (characterizing the foreign country) to be different to functions G, F, and a, respectively.

As will become apparent, the equilibrium outcome is the same regardless of whether we assume that migration possibilities are already considered in the education decisions of individuals. This condition is an implication of the simplifying assumptions that (i) learning abilities and migration costs are uncorrelated and (ii) individual migration costs are the same for all workers within a skill group.

Derivation of Testable Hypotheses

We will now derive the testable hypotheses. For this purpose, we treat migration as exogenous. According to equations (1) and (2), competitive factor prices are as follows:

(5) $$w_H = a(h) f'(k),$$

(6) $$w_L = a(h)\left[f(k) - kf'(k)\right].$$

According to equations (3) and (4), an individual of skill type $j \in \{H, L\}$ chooses to migrate if $w_j^* / \theta^j \geq w_j$; therefore, in an interior equilibrium,

(7) $$\frac{w_H^*}{\theta^H} = w_H, \; \frac{w_L^*}{\theta^L} = w_L.$$

A nonmigrating individual i chooses education whenever $(1 - e_i) w_H \geq w_L$. Moreover, staying at home and being educated yields higher utility than migrating and remaining unskilled if $(1 - e_i) w_H \geq w_L^* / \theta^L = w_L$, which is the same condition. Similarly, we find that a migrating individual chooses education if $(1 - e_i) w_H^* / \theta^H \geq w_L^* / \theta^L$, which, in view of equation (7), again gives us condition $(1 - e_i) w_H \geq w_L$. Moreover, migrating and being educated yields higher utility than not migrating and remaining unskilled if $(1 - e_i) w_H^* / \theta^H = (1 - e_i) w_H \geq w_L$.

Therefore, all individuals with learning costs below some endogenous threshold level, $\bar{e}$, which depends on domestic wages only, become skilled:

$$(8) \qquad e_i \leq 1 - \frac{w_L}{w_H} = 1 - \frac{f(k) - kf'(k)}{f'(k)} \equiv \bar{e}(k).$$

Because $f'' < 0$, we have $\bar{e}' < 0$. As the skill intensity, k, increases, the wage rate of unskilled individuals relative to skilled individuals, w_L / w_H, increases; consequently, more individuals remain unskilled, indicating that the threshold learning cost $\bar{e}$ is lower.

The fraction of domestically born unskilled workers, U, is given by

$$(9) \qquad U = 1 - G(\bar{e}(k)) \equiv \tilde{U}(k),$$

where $\tilde{U}' > 0$. The effective units of skilled labor in the home country per native, before migration, are given by[4]

$$(10) \qquad S = \int_0^{\bar{e}(k)} (1-e)dG(e) \equiv \tilde{S}(k).$$

Therefore, $\tilde{S}' < 0$.

Denote by m_S and m_U the fraction of skilled and unskilled labor units emigrating to the foreign country ("emigration rates"), respectively. After migration, we have $h := H / N = S - m_S$ and $l := L / N = U - m_U$, respectively. Therefore, using equations (9) and (10), the skill intensity at home, $k = H / L$, is implicitly given by

$$(11) \qquad k = \frac{\tilde{S}(k) - m_S}{\tilde{U}(k) - m_U}.$$

Using $\tilde{U}' > 0$ and $\tilde{S}' < 0$, we see that the right-hand side of equation (11) is decreasing in k. Therefore, in an interior labor market equilibrium, the skill intensity given by equation (11), denoted by $k \equiv \tilde{k}(m_S, m_U)$, is unique. The function $\tilde{k}$ is decreasing in the emigration rate of skilled labor, m_S, and increasing in the emigration rate of unskilled labor, m_U.

In a two-country world, emigrants of one country are immigrants of the other country. Therefore, the foreign skill intensity k^* is uniquely given by[5]

$$(12) \qquad k^* = \frac{\tilde{S}^*\left(k^*\right) + m_S}{\tilde{U}^*\left(k^*\right) + m_U}.$$

We write $k^* \equiv \tilde{k}^*(m_S, m_U)$. The function $\tilde{k}^*$ is increasing in m_S and decreasing in m_U.

Using $h = S - m_S$ and $h^* = S^* + m_S$, TFP in the foreign (host) country relative to the home (source) country can be written as[6]

$$(13) \qquad \alpha \equiv \frac{A^*}{A} = \frac{a^*(\tilde{S}^*\left(\tilde{k}^*(m_S, m_U)\right) + m_S)}{a(\tilde{S}\left(\tilde{k}(m_S, m_U)\right) + m_S)} \equiv \tilde{\alpha}(m_S, m_U),$$

according to equation (2). Moreover, according to equation (5), the relative wage rate for skilled workers is

$$(14) \qquad \omega_H \equiv \frac{w_H^*}{w_H} = \frac{a^*(\tilde{S}^*\left(\tilde{k}^*(m_S, m_U)\right) + m_S)(f^*)'(\tilde{k}^*(m_S, m_U))}{a(\tilde{S}\left(\tilde{k}(m_S, m_U)\right) + m_S)\, f'(\tilde{k}(m_S, m_U))} \equiv \tilde{\omega}_H(m_S, m_U).$$

Define the elasticities of the skill intensity at home and in the foreign country with respect to the migration of skilled and unskilled labor from the home country to the foreign country:

(15) $$\kappa_S \equiv -\frac{m_S}{\tilde{k}}\frac{\partial \tilde{k}}{\partial m_S}, \quad \kappa_U \equiv \frac{m_U}{\tilde{k}}\frac{\partial \tilde{k}}{\partial m_U},$$

(16) $$\kappa_S^* \equiv \frac{m_S}{\tilde{k}^*}\frac{\partial \tilde{k}^*}{\partial m_S}, \quad \kappa_U^* \equiv -\frac{m_U}{\tilde{k}^*}\frac{\partial \tilde{k}^*}{\partial m_U}.$$

Note that the elasticities are defined such that they are positive: $\kappa_S, \kappa_U, \kappa_S^*, \kappa_U^* > 0$. Moreover, define by

(17) $$\varepsilon(h) \equiv \frac{ha'(h)}{a(h)},$$

(18) $$\eta(k) \equiv -\frac{kf''(k)}{f'(k)},$$

the elasticity of TFP with respect to skilled labor per native h and the elasticity of f with respect to skill intensity k. (We define ε^* and η^* analogously.)

It is simple to show the following results. First, the elasticity of relative destination-to-source TFP ($\alpha = A^* / A$) with respect to the emigration rate of the skilled (m_S) and unskilled (m_U) is given by

(19) $$\frac{m_S}{\tilde{\alpha}}\frac{\partial \tilde{\alpha}}{\partial m_S} = \varepsilon(h)\left(\frac{\tilde{S}'(k)}{l}\kappa_S + \frac{m_S}{h}\right) + \varepsilon^*(h^*)\left(\frac{(\tilde{S}^*)'(k^*)}{l^*}\kappa_S^* + \frac{m_S^*}{h^*}\right),$$

(20) $$\frac{m_U}{\tilde{\alpha}}\frac{\partial \tilde{\alpha}}{\partial m_U} = -\varepsilon(h)\frac{\tilde{S}'(k)}{l}\kappa_U - \varepsilon^*(h^*)\frac{(\tilde{S}^*)'(k^*)}{l^*}\kappa_U^*,$$

respectively. Therefore, if the effect of a change in the skill intensity (triggered by migration) on the education decision is small (i.e., the magnitude of derivatives $\tilde{S}', (\tilde{S}^*)' < 0$ are small), the model predicts that an increase in the migration rate of skilled labor (m_S) has a positive effect on relative destination-to-source TFP (α). Moreover, an increase in the migration rate of unskilled labor (m_U) has a positive but small effect on α because the migration of unskilled labor only has an indirect TFP effect by lowering education incentives in the source country (and vice versa in the destination country). By contrast, as a result of human capital externalities ($\varepsilon, \varepsilon^* > 0$), the emigration of skilled labor also has a direct TFP effect on skilled labor input per native (h) in the source country (and, again, vice versa in the destination country). The effect is mitigated because an increase in m_S fosters education incentives in the source country (and provides disincentives in the destination country).

Second, the elasticity of the destination-to-source relative wage income of skilled labor ($\omega_H = w_H^* / w_H$) with respect to the emigration rate of skilled and unskilled labor is given by

$$(21) \qquad \frac{m_S}{\tilde{\omega}_H}\frac{\partial \tilde{\omega}_H}{\partial m_S} = \frac{m_S}{\tilde{\alpha}}\frac{\partial \tilde{\alpha}}{\partial m_S} - \eta(k)\kappa_S - \eta^*(k^*)\kappa_S^*,$$

$$(22) \qquad \frac{m_U}{\tilde{\omega}_H}\frac{\partial \tilde{\omega}_H}{\partial m_U} = \frac{m_U}{\tilde{\alpha}}\frac{\partial \tilde{\alpha}}{\partial m_U} + \eta(k)\kappa_U + \eta^*(k^*)\kappa_U^*,$$

respectively. Therefore, the impact of the migration of unskilled labor (increase in m_U) on the relative destination-to-source wage income of skilled labor is unambiguously positive. The relative TFP increases as a result of education effects, and the resulting increase in skill intensity k reduces the wages of skilled labor in the source country (and vice versa in the destination country, where the skill intensity decreases). By contrast, for a given TFP, the wage rate of skilled labor decreases with the skill intensity; therefore, the impact of the migration of skilled labor (increase in m_S) on the relative destination-to-source wage income of skilled labor (ω_H) is ambiguous, even if the relative destination-to-source TFP (α) increases. Only if the TFP effects are sufficiently large owing to human capital externalities does an increase in m_S increase ω_H.

In sum, we predict that an increase in the emigration rate of high-skilled labor (m_S) increases relative TFP $\alpha = A^* / A$, whereas the impact of the emigration of unskilled labor (m_U) on α may be small. Moreover, an increase in m_U has a positive and possibly large effect on the relative wages of the skilled, $\omega_H = w_H^* / w_H$. Finally, an increase in m_S may lead to an increase in ω_H if TFP effects are sufficiently large. These are important theoretical results for political debate in some destination countries of skilled workers.

We have focused the theoretical analysis on the predictions of the effects of migration, although we allowed individuals to consider the migration decision when choosing education. Because migration is endogenous according to the model and depends (inter alia) on international wage differences, the model also indicates an empirical endogeneity issue, which we try to address by using instrumentation strategies.

II. Empirical Analysis

Our theoretical analysis has highlighted the effect of the emigration of high-skilled and low-skilled labor on TFP differences and the wage income gap of skilled labor to potential host economies of expatriates. We have seen that there may be counteracting channels by which skilled migration affects the wages of skilled workers: the external TFP effects of migration and the effect on the marginal productivity of skilled labor when TFP is held constant.

The direction from (wage) income differences to migration flows has been examined empirically elsewhere. Two recent papers are notable. First, Grogger and Hanson (2011) provide convincing evidence for the critical role of wage differences between country pairs on the emigration patterns of tertiary educated workers.[7] Second, Beine et al. (2011) show that in addition to wage differences, network effects are important for the migration decisions of both high-skilled and low-skilled workers. The authors show that emigrants already living in the destination country positively affect migration flows.[8]

Our analysis complements research on the interaction between wage differences and skilled migration by focusing on the opposite direction, the impact of migration on both international (wage) income differences for skilled workers and TFP differences between country pairs. Inter alia, we instrument skilled migration with past migration stocks, as suggested by Beine et al. (2011).

Data and Estimation Strategy

The emigration rate of highly skilled individuals is our main explanatory variable. Docquier and Marfouk (2006) established a dataset of emigration stocks and rates by educational attainment for the years 1990 and 2000. The authors count as emigrants all foreign-born individuals at least 25 years old who live in an OECD country and class them by educational attainment and country of origin. Thereby, emigration into OECD countries is captured, representing approximately 90 percent of educated migrants in the world.[9] Because we are interested in bilateral migration patterns, we employ an extended dataset by Docquier et al. (2007). We construct the high-skilled emigration rate from country i to j in year t, denoted by $SMig_{ij,t}$, as the stock of skilled emigrants from country i living in (OECD) country j divided by the stock of skilled residents in (source) country i. In some regressions, we also control for the (lagged) low-skilled emigration rate, $UMig_{ij,t-1}$, which is constructed analogously.

Denote by $y_{i,t}$ the outcome measure in country i in year t. We consider GDP per capita, TFP, and the wage income of skilled workers. For a country pair (i, j), we estimate

$$(23) \qquad \log\left(\frac{y_{j,t}}{y_{i,t}}\right) = \beta_0 + \beta_1 SMig_{ij,t} + \beta_2 UMig_{ij,t-1} + x'_{ij,t-1}\beta_x + u_{ij}.$$

Equation (23) is theoretically motivated by relationships $w_H^* / w_H = \tilde{\omega}_H(m_S, m_U)$ and $A^* / A = \tilde{\alpha}(m_S, m_U)$; see equations (14) and (13) derived in section I, respectively. According to equation (19), the theoretical model suggests that $\beta_1 > 0$ when the log difference in TFP, $\log(A^* / A)$, is the dependent variable. When the log difference of wages for skilled workers, $\log(w_H^* / w_H)$, is the dependent variable, then we predict $\beta_1 > 0$ if and only if the TFP effects of migration are sufficiently high, according to equation (21). Moreover, we predict $\beta_2 > 0$ when $\log(w_H^* / w_H)$ is the dependent variable. $x_{ij,t-1}$ is a vector of other (lagged) controls that potentially affect log income differences between i and j, such as relative school enrollment rates, relative investment rates, relative urban population shares, and fixed effects for the source country to capture institutional differences to OECD destination countries. With respect to the dependent outcome measures, we focus on the year 2000 and usually measure controls other than skilled migration in lagged form (for 1990) to reduce endogeneity bias. u_{ij} is an error term.

To construct a measure of $\log(w_H^* / w_H)$, we would like to use (log) wages differences for high-skilled individuals. However, because wage income by education category is not available, we construct several empirical proxy measures. Freeman and Oostendorp (2000) analyze information on earnings by occupation and industry from the ILO October Inquiry Survey from 1983 to 1998 for a number of countries.[10] For each country, we use Freeman and Oostendorp's earnings measures to calculate the 80th and the 90th percentiles as two measures for wages of high-skilled workers. For most countries, data are available for only a few years. Therefore, for each country, we take the mean across the period from 1995 to 2003 to obtain wage data for the year 2000.[11] The two constructed (log) relative wage variables for the 80th and the 90th percentiles are denoted by $RelWage80_{ij,t}$ and $RelWage90_{ij,t}$.

One may argue that migrating skilled workers do not receive wage income in the same percentile as they do at home. In particular, high-skilled workers from developing countries may not be considered highly skilled in the destination country. Therefore, as a robustness check, we assume that someone working in the 80th percentile at home earns only the median wage income abroad. The corresponding relative wage measure is denoted by $RelWage80to50_{ij,t}$.

For relative GDP and relative TFP between destination and source countries, denoted by $RelGDP_{ij,t}$ and $RelTFP_{ij,t}$, respectively, we use Penn World Tables and the UNIDO World productivity database. In particular, GDP data have better availability than wage data such that the number of observations increases. Details on variable definitions, data sources, and the summary statistics of the employed variables are presented in the appendix (table A1).

As indicated, although recent empirical literature has focused on the impact of income differences on migration patterns, we aim to examine the opposite channel. In a first attempt to address endogeneity, we replace the high-skilled emigration rate in 2000 by the lagged one in 1990, denoted by $SMig_{ij,t-1}$, in OLS regressions. Doing so allows for the possibility that the TFP effects of the migration flows of skilled workers (for instance, through innovation activity) take time to come into effect.

Second, we explore potential instruments for the high-skilled emigration rate for 2000. We use the lagged rate of expatriates in 1990 emigrating from country i to j, denoted by $TotalMig_{ij,t-1}$, as an instrument for $SMig_{ij,t}$, thereby predicting the rate of high-skilled emigrants by the lagged rate of all emigrants. This approach is motivated by the notion that a larger percentage of emigrants from a certain source country already living abroad act as a signal to potential high-skilled migrants regarding the destination country's openness and its administrative bodies' treatment of foreigners. The presence of more emigrants to a certain destination creates mobility cost-reducing network effects for potential emigrants (e.g., Massey et al., 1993; Beine, Docquier and Ozden, 2011).[12] Past migration also measures other intangible factors unrelated to income, such as trust, cultural proximity, and social openness to migrants of the destination as perceived by emigrants of the source country. Moreover, we employ indicators for geographical factors ($Dist_{ij}$, $Contig_{ij}$) and linguistic proximity ($ComLang_{ij}$), which are typically used in the literature on migration as additional instruments.

To further address potential endogeneity bias, we use the total emigration rate in 1960 instead of $TotalMig_{ij,t-1}$ as an instrument, which, however, cannot be readily observed at the time of analysis. We thus construct a proxy for the total emigration rate. Denote by $NetMig_{i,1960}$ the total net emigration rate (the number of emigrants minus the number of immigrants divided by population size) in country i in 1960, provided by the United Nations Population Division.[13] Our measure of bilateral total emigration rates in 1960 is defined by

$$(24) \qquad TotalMig_{ij,1960} = \frac{NetMig_{i,1960}}{100} \times \frac{Pop_{j,1960}}{Pop_{i,1960}},$$

where $Pop_{i,1960}$ is population size in the source i and $Pop_{j,1960}$ is the population size in the destination j in the year 1960.[14] As suggested by Beine, Docquier and Rapoport (2001), one may use countries' population sizes to reflect immigration quotas. $NetMig_{i,1960} \times Pop_{j,1960}$ is thus a proxy for the net stock of emigrants from country i received in country j in 1960. Because our empirical strategy focuses on emigration rates rather than stocks, we divide this measure by (100 times) the population size of source country i to obtain an estimate for the past bilateral emigration rate.[15] The fraction of high-skilled migrants before 1960 was comparatively low; therefore, potential effects of past migration should only work through induced high-skilled emigration. In other words, the instrument should be uncorrelated with the dependent variable, which is supported by J-tests.

Results

Reported standard errors from all estimates account for destination clusters, following Grogger and Hanson (2011), among others.[16]

<<table 1 about here>>

Table 1 presents OLS estimates of equation (23). We first omit the low-skilled migration rate. We observe that the estimated effects of an increase in the high-skilled migration rate on relative GDP ($RelGDP_{ij,t}$), relative TFP ($RelTFP_{ij,t}$), and relative wages ($RelWage80_{ij,t}$ and $RelWage90_{ij,t}$) between destination and source countries are positive and significant. Using the lagged high-skilled migration rate ($SMig_{ij,t-1}$) rather than the contemporaneous one ($SMig_{ij,t}$) only slightly decreases the coefficient. Therefore, an increase in the high-skilled emigration rate increases (log) income differences between countries. The control variables of all estimates include the lagged relative school enrolment (primary and tertiary), the relative capital investment, and the relative urban population share as well as source fixed effects. Except for (lagged) primary school enrollment, which is never significant, the controls have the expected signs. The (lagged) relative investment rate and the (lagged) relative urban population share are typically significantly different from zero.

To consider the effect quantitatively, we use a coefficient β_1 of about 0.2 in the wage regressions presented in columns (5)–(8). Doubling the high-skilled emigration rate

($SMig_{ij,t}$) from its mean level of 0.025 thus implies that the relative wage for high-skilled workers between the destination and the source increases by approximately 0.5 percent ($= 0.2 \times 0.025$).[17] This effect is small, which is consistent with the microeconomic estimates of the effect of high-skilled immigration on wages for highly skilled individuals inside the United States by Borjas (2003) and for the United Kingdom by Dustmann et al. (2005).

<<table 2 about here>>

Tables 2–4 address the potential problem of reverse causality by providing instrumental variable estimations of (23). The upper panels report second-stage results, whereas the lower panels in tables 2 and 3 report the partial correlations of the instruments in the first stage.

We start with the results for relative GDP as a dependent variable in table 2. In columns (1) and (2), we use the total emigration rate from country i to j in 1990 ($TotalMig_{ij,t-1}$) as a single instrument. In columns (3)–(6), the bilateral geographical distance between i and j ($Dist_{ij}$), an indicator for a common border ($Contig_{ij}$), and an indicator for the common language of the source and destination countries ($ComLang_{ij}$) are used as instruments in addition to the total emigration rate. We use $TotalMig_{ij,t-1}$ in columns (3) and (4) and our proxy for the total emigration rate for 1960, $TotalMig_{ij,1960}$, in columns (5) and (6). As in table 1, we control for the lagged relative values of school enrollment, private investment, and urbanization and include source country fixed effects (results not shown). The effect of high-skilled migration on log GDP differences between the destination and the source country is positive, as in the OLS estimations. All estimates suggest a significant and higher effect of skilled migration on relative GDP compared to the OLS estimates in table 1. Columns (2), (4), and (6) also control for the (lagged) low-skilled migration rate in 1990, $UMig_{ij,t-1}$. We observe that the coefficient on $UMig_{ij,t-1}$, β_2 in equation (23), is not significantly different from zero and does not alter the coefficient of the instrumented variable $SMig_{ij,t}$ in an important way.

Columns (7)–(12) in table 2 present the results for relative TFP analogously to columns (1)–(6). The results are similar to those for relative GDP: the estimated effect of high-skilled migration is always positive and increases compared with OLS estimates, whereas low-skilled migration is not significant. In particular, the estimates of β_1 in columns (7)–(12) of table 2 confirm our theoretical prediction that $\alpha = A^* / A$ is increasing in m_S as a result of human capital externalities. Again, the coefficient of the (lagged) low-skilled migration rate, β_2, is not significantly different from zero and is sometimes positive, in line with the theoretical model.

An F-test for the first-stage results shows that the instruments are significantly related to the emigration rate. In particular, past migration appears to be an important determinant of high-skilled migration.[18] None of the J-statistics suggest problems with the instruments.

<<table 3 about here>>

In table 3, we present the results analogous to table 2 for relative wages in the 80th and 90th percentiles instead of relative GDP and relative TFP, respectively. Again, columns (1)–(2) and (7)–(8) use the total emigration rate in 1990 as a single instrument for the high-skilled emigration rate. The first-stage results indicate that the total emigration rate in 1990 is well correlated with $SMig_{ij,t}$. β_1 is again positive and significantly different from zero. According to the other estimations in table 3, the results are similar when using the measure for the total migration rate in 1960, geographical variables, and linguistic proximity as instruments. According to the theoretical prediction in equation (21), β_1 should be higher when relative TFP (α) rather than the relative wages of skilled labor (ω_H) is the dependent variable. In the estimates presented in tables 2 and 3, this is not the case. It is important to note, however, that sample sizes are very different because wage data are available for less (and, on average, richer) countries than TFP.

Estimated coefficients of the instrumented high-skilled migration rate in 2000, $SMig_{ij,t}$, become smaller when we also control for the lagged low-skilled migration rate in 1990, $UMig_{ij,t-1}$. Moreover, coefficient β_2 of $UMig_{ij,t-1}$ is positive and typically significant (and is higher than β_1). This finding is in line with the theoretical prediction and is due to the complementarity between skilled and unskilled labor. Only in columns (6) and (12) does β_1 become insignificant; in these cases, it remains positive and quantitatively sizable.

In sum, we may conclude that the effect of skilled migration on international wage differences, albeit limited in magnitude, is positive and also often significant. The results of relative TFP in table 2 and those in table 3 in connection with our theoretical considerations appear to suggest that the possible positive effects of skilled immigration on the wages of skilled workers are derived from the positive TFP effects of skilled immigration. Moreover, low-skilled migration tends to benefit the skilled labor force in the receiving country.

The first-stage results in table 3 suggest that factors that are potentially unrelated to income, such as network effects, language, and geography, drive the high-skilled emigration rate. Interestingly, the coefficients of the instrumented variable $SMig_{ij,t}$ in table 3 are often more than twice as high as in OLS regressions (table 1). This finding suggests that migrants who arrive through social networks have a particularly high impact on international differences in (log) wages of skilled workers. Migrants who arrive through social networks appear to find it easier to integrate into the host country and thus have a larger effect on TFP (possibly being employed in jobs that are more suitable to their qualifications) than workers without social networks.

In fact, we cannot rule out that skilled immigrants work in different jobs than they do in the source country, often earning wages that are within a lower percentile of the wage distribution than at home. For instance, a university degree in a developing source country may reflect a lower acquired skill level than a university degree in an OECD destination country. Moreover, a skilled immigrant may occupy a low-skilled job briefly after arrival owing to language problems in the destination country. We account for these possibilities by using as the dependent variable the log difference between the wage of the median in the destination country and the 80th percentile in the source country, $RelWage80to50_{ij,t}$.

<<table 4 about here>>

The results are reported in table 4. Columns (1) and (2) are analogous to the OLS estimations in table 1 and show similar results as the wage regressions (5)–(8) in table 1. Columns (3)–(8) are instrumental variable estimations, which are analogous, for instance, to columns (1)–(6) of table 3 with respect to the use of instruments. The instrumental variable estimates are similar in significance and magnitude to the results of the wage regressions in table 3.

We conduct a further sensitivity analysis (see table S.1 to S.4).[19] This analysis suggests that our conclusions are fairly robust overall. First, we include destination fixed effects rather than source fixed effects. The results with destination fixed effects are similar to those with source fixed effects.[20] We also examine whether results are sensitive to a specific destination country. We run “rolling” regressions, in which we omit one destination country each time, to confirm that the results are basically unchanged. Second, we include regional dummies and a dummy variable that indicates whether the source country also belongs to the OECD[21] instead of fixed effects as controls to consider institutional differences, which may affect income differences, in an alternative way. Third, we employ an emigration data set by Defoort (2006) to construct an alternative proxy for the total emigration rate. The data set contains emigration to six important destination countries in the year 1975. The proxy is constructed analogously to equation (24) and is used as an instrument for the skilled migration rate. Finally, we use the stock of high-skilled and low-skilled migrants rather than migration rates as regressors. Our main conclusions remain qualitatively unchanged and overall robust.

III. Concluding Remarks

In this paper, we analyzed the impact of an increase in the international bilateral migration of high-skilled and low-skilled workers on relative income and relative TFP between pairs of source and destination countries of expatriates. Our theoretical model suggested that an increase in the number of skilled migrants increases international wage inequality by adversely affecting TFP in the source economy and increasing it in the host economy. Our empirical analysis provided evidence which is consistent with this hypothesis. Using a data set on the bilateral emigration of skilled workers, our results suggested that an increase in high-skilled emigration rates tends to slightly increases TFP differences and therefore (albeit also slightly) wage income for skilled workers in destination countries relative to source countries in a causal way. None of our estimations suggested that skilled workers in the destination country lose from skilled migration relative to the source country. Finally, skilled workers in the receiving countries unambiguously gain from low-skilled migration.

APPENDIX

<<table A.1 about here>>

REFERENCES

Acemoglu, Daron, and Joshua Angrist. 2000. “How Large are Human-Capital Externalities? Evidence from Compulsory Schooling Laws.” *NBER Macroeconomics Annual* 15: 9–59.

Beine, Michel, Frédéric Docquier, and Hillel Rapoport. 2001. “Brain Drain and Economic Growth: Theory And Evidence.” *Journal of Development Economics* 64: 275–89.

Beine, Michel, Fréderic Docquier, and Hillel Rapoport. 2008. “Brain Drain and Human Capital Formation in Developing Countries: Winners and Losers.” *Economic Journal* 118: 631–52.

Beine, Michel, Frédéric Docquier, and Caglar Ozden. 2011. “Diasporas.” *Journal of Development Economics* 95: 30–41.

Borjas, George J. 2003. “The Labor Demand Curve is Downward Sloping: Reexamining the Impact of Immigration on the Labor Market.” *Quarterly Journal of Economics* 118: 1335–74.

Defoort, Cecile. 2006. “Tendances de Long Terme en Migrations Internationales: Analyse à Partir de 6 Pays Receveurs.” Université Catholique de Louvain (mimeo).

Docquier, Frédéric, and Aldeslam Marfouk. 2006. “International Migration by Educational Attainment (1990–2000) - Release 1.1.” In *International Migration, Remittances and Development*. Ed. C. Ozden and M. Schiff, pp.151-199. New York: Palgrave Macmillan.

Docquier, Frédéric, B. Lindsay Lowell, and Abdeslam Marfouk. 2007. A Gendered Assessment of the Brain Drain.” IZA Discussion Papers No. 3235.

Dustmann, Christian, Francesca Fabbri, and Ian Preston. 2005. “The Impact of Immigration on the British Labour Market.” *Economic Journal* 115: F324–41.

Egger, Peter, and Doina Maria Radulescu. 2009. “The Influence of Labour Taxes on the Migration of Skilled Workers.” *The World Economy* 32: 1365–79.

Friedberg, Rachel M. 2001. “The Impact Of Mass Migration On The Israeli Labor Market.” *Quarterly Journal of Economics* 116: 1373–1408.

Freeman, Richard B., and Remco H. Oostendorp. 2000. “Wages Around the World: Pay Across Occupations and Countries.” NBER Working Paper No. 8058.

Gennaioli, Nicola, Rafael La Porta, Florencio Lopez-de-Silanes, and Andrei Shleifer. 2011. “Human Capital and Regional Development.” NBER Working Paper No. 17158.

Grogger, Jeffrey, and Gordon H. Hanson. 2011. “Income maximization and the selection and sorting of international migrants.” *Journal of Development Economics* 95: 42–57.

Grossmann, Volker, and David Stadelmann. 2008. “International mobility of the highly skilled, endogenous R&D, and public infrastructure investment.” IZA Discussion Paper No. 3366.

Grossmann, Volker, and David Stadelmann. 2011. Does international mobility of high-skilled workers aggravate between-country inequality? *Journal of Development Economics* 95: 88–94.

Hanson, Gordon H., Kenneth Scheve, and Matthew J. Slaughter. 2009. “Individual Preferences over High-Skilled Immigration in the United States.” In *Skilled Immigration Today: Problems, Prospects, and Policies*, eds. Jagdish Bhagwati and Gordon Hanson, 207–46. Oxford University Press.

Hunt, Jennifer, and Marjolaine Gauthier-Loiselle. 2011. “How Much Does Immigration Boost Innovation?” *American Economic Journal: Macroeconomics* 2:31–56.

Iranzo, Susana, and Giovanni Peri (2009). Schooling Externalities, Technology, and Productivity: Theory and Evidence from U.S. States, Review of Economics and Statistics 91, 420–31.

Lucas, Robert E. (1988). On the Mechanics of Economic Development, Journal of Monetary Economics 22, 3–42.

Lucas, Robert E.B. 2005. *International Migration and Economic Development: Lessons from Low-income Countries*. Cheltenham, Edward Elgar Publishing.

Massey, Douglas S., Joaquín Arango, Graeme Hugo, Ali Kouaouci, Adela Pellegrino, and J. Edward Taylor. 1993. "Theories of International Migration: A Review and Appraisal." *Population and Development Review* 19: 431–66.

Mayer, Thierry, and Soledad Zignago. 2006. "A Note on CEPII's Distances Measures, Explanatory note, CEPII, Paris.

Mountford, Andrew. 1997. "Can a Brain Drain be Good for Growth in the Source Economy?" *Journal of Development Economics* 53: 287–303.

Müller, Tobias, and Silvio H.T. Tai. 2010. "Individual attitudes towards migration: a reexamination of the evidence." University of Geneva, mimeo.

Stark, Oded, Christian Helmenstein, and Alexia Prskawetz. 1997. "A Brain Gain with a Brain Drain." *Economics Letters* 55: 227–34.

Notes

[1] The number of tertiary-educated immigrants living in OECD countries increased from 12.5 million in 1990 to 20.4 million in 2000 (Docquier and Marfouk, 2006). Half of the skilled migrants resided in the United States, and approximately one-quarter resided in other Anglo-Saxon countries.

[2] High-skilled immigration surged in Switzerland after the enactment of a bilateral agreement between Switzerland and the European Union on the free movement of labor in June 2007.

[3] Grossmann and Stadelmann (2011) develop an overlapping-generations model with endogenous education choice that shows how migration is triggered by a decrease in the mobility costs of high-skilled workers and how it may evolve over time. In the present paper, we focus empirically on the effect of higher international migration.

[4] Recall that individual i provides $1 - e_i$ units of skilled labor when $e_i \leq \bar{e}(k)$.

[5] Functions $\tilde{U}^*$ and $\tilde{S}^*$ are defined analogously to equations (9) and (10), respectively.

[6] Without a loss of generality, we label the foreign country the host country.

[7] In Grossmann and Stadelmann (2008), we presented evidence for the interaction between emigration flows and income changes using a structural equation model. However, we examined the impact of a higher aggregate emigration stock of a country on its per capita income. That is, we did not consider bilateral relationships.

[8] This finding suggests that there exist mobility-cost reducing network effects from communities of people from the same nation and from friends and relatives already living abroad (see also Massey et al., 1993).

[9] See Docquier and Marfouk (2006) for a detailed discussion concerning data collection and construction issues.

[10] To correct for differences in how countries report earnings, Freeman and Oostendorp (2000) use a standardization procedure to make the data comparable across countries and time. In 2005, they provided an update for their earnings measures for the 1983-2003 ILO October Inquiry data using an improved version of the standardization procedure and the application of country-specific data type correction factors. A detailed technical documentation of the standardization procedure for the 1983-2003 ILO October Inquiry data is available online at http://www.nber.org/oww/.

[11] We also included data for Turkey for the year 1994.

[12] Another way to capture the effect of mobility cost-reducing network effects is to use the past total number of migrants instead of the past emigration rate as the instrument for contemporaneous migration. We confirm that the results do not change.

[13] Countries with negative net emigration are coded to have an emigration rate equal to zero.

[14] The measure is inspired by Beine, Docquier and Ozden (2011). They use a similarly constructed proxy as an instrument for the total diaspora of migrants in 1990 (rather than the high-skilled emigration rate).

[15] Calculating partial correlations confirms that the past total emigration rate is well correlated with the high-skilled emigration rate in 2000.

[16] We use the Huber-White method to adjust the variance-covariance matrix from our least squares results.

[17] In fact, between 1990 and 2000, the number of tertiary-educated immigrants living in OECD countries almost doubled (Docquier and Marfouk, 2006).

[18] That contiguity (variable $Contig_{ij}$) has a negative effect on high-skilled emigration in our first-stage estimate parallels a finding similar to Grogger and Hanson (2011). They explain the result by selection and sorting effects.

[19] The results are reported in an online appendix available at http://wber.oxfordjournals.org/.

[20] We cannot include both simultaneously because they would, by construction, fully explain the different relative income variables due to multicollinearity.

[21] Recall that all destination countries are OECD countries.

TABLE 1. Effect of high-Skilled Emigration Rates on Wage, GDP, and TFP Differences between Countries

	Dependent variable: **$RelGDP_{ij,t}$**		Dependent variable: **$RelTFP_{ij,t}$**		Dependent variable: **$RelWage80_{ij,t}$**		Dependent variable: **$RelWage90_{ij,t}$**	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
$SMig_{ij,t}$	0.1630***		0.0830***		0.2168***		0.2290***	
	(0.0276)		(0.0140)		(0.0490)		(0.0483)	
$SMig_{ij,t-1}$		0.1386***		0.0796***		0.1645**		0.1738**
		(0.0418)		(0.0198)		(0.0678)		(0.0699)
$RelInvest_{ij,t-1}$	0.2331*	0.2317*	0.0333	0.0327	0.4989**	0.4975**	0.4356*	0.4341*
	(0.1216)	(0.1215)	(0.0618)	(0.0617)	(0.2533)	(0.2533)	(0.2430)	(0.2430)
$RelUrban_{ij,t-1}$	0.2113***	0.2109***	0.0617	0.0615	0.6594**	0.6587**	0.5761*	0.5754*
	(0.0805)	(0.0806)	(0.0432)	(0.0433)	(0.3052)	(0.3054)	(0.3015)	(0.3017)
$RelPrimSchool_{ij,t-1}$	−0.3658	−0.3683	−0.4618	−0.4634	−1.0022	−1.0057	−0.5458	−0.5495
	(0.7655)	(0.7668)	(0.3875)	(0.3882)	(2.2117)	(2.2127)	(2.0325)	(2.0336)
$RelTertSchool_{ij,t-1}$	0.0046	0.0047*	0.0022*	0.0022*	0.0105	0.0106	0.0104	0.0105
	(0.0028)	(0.0028)	(0.0013)	(0.0013)	(0.0102)	(0.0101)	(0.0099)	(0.0099)
(Intercept)	3.6064	3.6211	0.6013	0.6045	0.6731	0.6802	0.3170	0.3245
	(3.0786)	(3.0845)	(0.4408)	(0.4415)	(2.7047)	(2.7058)	(2.5903)	(2.5916)
Origin FE	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R^2	0.9429	0.9428	0.9541	0.9541	0.8584	0.8582	0.8555	0.8553
N	2275	2275	1550	1550	1010	1010	1010	1010

Note: All dependent variables are expressed in logs and represent relative differences between countries j and i. $SMig_{ij,t}$ denotes the stock of high-skilled emigrants from country i living in country j divided by the stock of high-skilled residents in i. $RelInvest_{ij,t-1}$, $RelUrban_{ij,t-1}$, $RelPrimSchool_{ij,t-1}$ and $RelTertSchool_{ij,t-1}$ denote the lagged relative investment share, relative urbanization share, relative primary school enrollment, and relative tertiary school enrollment between j and i. Table A1 in the appendix provides additional information on all variables. Robust standard errors are in parentheses and clustered for migration destinations. *** indicates a significance level below 1 percent; ** indicates a significance level between 1 and 5 percent; * indicates a significance level between 5 and 10 percent.

TABLE 2. Effect of High-Skilled Emigration Rates on GDP and TFP Differences between Countries (Instrumental Variables Estimations)

	Dependent variable: **$RelGDP_{ij,t}$**						Dependent variable: **$RelTPF_{ij,t}$**					
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
$SMig_{ij,t}$	0.3036* (0.1601)	0.3269*** (0.0882)	0.3017** (0.1532)	0.3015*** (0.0875)	0.3883* (0.2371)	0.5138** (0.2064)	0.1771** (0.0784)	0.1452*** (0.0235)	0.1863** (0.0734)	0.1437*** (0.0256)	0.3569*** (0.0587)	0.4021*** (0.0703)
$UMig_{ij,t-1}$		−0.1677 (0.3579)		−0.0672 (0.4101)		−0.9417 (0.8753)		0.3707 (0.4117)		0.3789 (0.4349)		−1.0854 (0.8486)
Other controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Origin FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R^2	0.9430	0.9434	0.9429	0.9431	0.9420	0.9422	0.9547	0.9549	0.9548	0.9549	0.9547	0.9549
N	2275	2275	2266	2266	2250	2250	1550	1550	1550	1550	1536	1536
F-Test (first stage)	12.57	22.65	12.67	22.69	14.40	16.89	14.46	30.53	14.69	30.00	14.90	16.81
J-Test	-	-	0.4611	0.4654	0.1397	0.3187	-	-	0.5060	0.3858	0.8406	0.9022
Instruments used	$TotalMig_{ij,t-1}$	$TotalMig_{ij,t-1}$	$TotalMig_{ij,t-1}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,t-1}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,t-1}$	$TotalMig_{ij,t-1}$	$TotalMig_{ij,t-1}$+ $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,t-1}$+ $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$
						First stage (partial correlations)						
$TotalMig_{ij,t-1}$	0.0124*** ($3.7e^{-04}$)	0.0322*** ($7.9e^{-04}$)	0.0123*** ($3.8e^{-04}$)	0.0323*** ($8.0e^{-04}$)			0.0184*** ($5.8e^{-04}$)	0.0437*** (0.0010)	0.0187*** ($6.0e^{-04}$)	0.0438*** (0.0010)		
$TotalMig_{ij,1960}$					$1.2e^{-04}$*** ($1.1e^{-05}$)	$1.0e^{-04}$*** ($1.0e^{-05}$)					$3.9e^{-04}$*** ($3.1e^{-05}$)	$3.2e^{-04}$*** ($3.0e^{-05}$)
$Dist_{ij}$			−0.0166*** (0.0053)	−0.0217*** (0.0045)	−0.0265*** (0.0063)	−0.0197*** (0.0059)			−0.0198*** (0.0074)	−0.0184*** (0.0060)	−0.0365*** (0.0091)	−0.0299*** (0.0087)
$ComLang_{ij}$			0.0227** (0.0108)	−0.0026 (0.0093)	0.0943*** (0.0126)	0.0615*** (0.0120)			0.0054 (0.0126)	−0.0169* (0.0102)	0.0836*** (0.0153)	0.0545*** (0.0148)
$Contig_{ij}$			−0.1009*** (0.0219)	−0.0537*** (0.0189)	−0.0606** (0.0260)	−0.0951*** (0.0246)			−0.1992*** (0.0339)	−0.0621** (0.0278)	−0.0736* (0.0416)	−0.1652*** (0.0403)

Note: All dependent variables are expressed in logs and represent relative differences between countries j and i. $SMig_{ij,t}$ ($UMig_{ij,t-1}$) denotes the stock of high- (low-) skilled emigrants from country i living in country j divided by the stock of high- (low-) skilled residents in i. All estimations include $RelInvest_{ij,t-1}$, $RelUrban_{ij,t-1}$, $RelPrimSchool_{ij,t-1}$ and $RelTertSchool_{ij,t-1}$ as additional control variables. $TotalMig_{ij,t-1}$, $Dist_{ij}$, $ComLang_{ij}$, and $Contig_{ij}$ represent the share of the emigrant population from country i living in country j, the distance between i and j, whether i and j share a common language, and whether i and j have a common border, respectively. Table A1 in the appendix provides additional information on all variables and instruments. Robust standard errors are in parentheses and clustered for migration destinations.*** indicates a significance level below 1 percent; ** indicates a significance level between 1 and 5 percent; * indicates a significance level between 5 and 10 percent.

TABLE 3. Effect of High-Skilled Emigration Rates on Wage Differences between Countries (Instrumental Variables Estimations)

	Dependent variable: **$RelWage80_{ij,t}$**						Dependent variable: **$RelWage90_{ij,t}$**					
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
$SMig_{ij,t}$	0.6026*** (0.1457)	0.2490*** (0.0673)	0.5948*** (0.1406)	0.2125*** (0.0653)	0.6676*** (0.2123)	0.5447 (0.4028)	0.5888*** (0.1443)	0.2795*** (0.0588)	0.5788*** (0.1374)	0.2360*** (0.0557)	0.6875*** (0.2193)	0.6382 (0.4059)
$UMig_{ij,t-1}$		5.2286*** (1.9307)		5.5204*** (2.0235)		2.7071 (4.5031)		4.5736*** (1.6763)		4.9178*** (1.8263)		1.5121 (4.2180)
Other controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Origin FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R^2	0.8609	0.8611	0.8607	0.8610	0.8590	0.8608	0.8582	0.8585	0.8583	0.8589	0.8563	0.8581
N	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010
F-Test (first stage)	25.09	68.44	24.74	69.07	15.91	18.73	25.09	68.44	24.74	69.07	15.91	18.73
J-Test	-	-	0.8055	0.7491	0.7022	0.6947	-	-	0.8055	0.7491	0.7022	0.6947
Instruments used	$TotalMig_{ij,t-1}$	$TotalMig_{ij,t-1}$	$TotalMig_{ij,t-1}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,t-1}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,t-1}$	$TotalMig_{ij,t-1}$	$TotalMig_{ij,t-1}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,t-1}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$
	First stage (partial correlations)											
$TotalMig_{ij,t-1}$	0.0198*** ($5.5e^{-04}$)	0.0196*** ($5.7e^{-04}$)	0.0196*** ($5.7e^{-04}$)	0.0463*** ($8.8e^{-04}$)			0.0459*** ($8.8e^{-04}$)	0.0198*** ($5.5e^{-04}$)	0.0196*** ($5.7e^{-04}$)	0.0463*** ($8.8e^{-04}$)		
$TotalMig_{ij,P1960}$					$1.8e^{-04}$*** ($1.6e^{-05}$)	$9.5e^{-05}$*** ($1.7e^{-05}$)					$1.8e^{-04}$*** ($1.6e^{-05}$)	$9.5e^{-05}$*** ($1.7e^{-05}$)
$Dist_{ij}$		−0.0099 (0.0068)	−0.0099 (0.0068)	−0.0205*** (0.0046)	−0.0145 (0.0096)	−0.0088 (0.0089)			−0.0099 (0.0068)	−0.0205*** (0.0046)	−0.0145 (0.0096)	−0.0088 (0.0089)
$ComLang_{ij}$		0.0277* (0.0151)	0.0277* (0.0151)	0.0050 (0.0102)	0.1294*** (0.0209)	0.0904*** (0.0197)			0.0277* (0.0151)	0.0050 (0.0102)	0.1294*** (0.0209)	0.0904*** (0.0197)
$Contig_{ij}$		−0.0772*** (0.0236)	−0.0772*** (0.0236)	−0.0207 (0.0159)	−0.0516 (0.0334)	−0.0830*** (0.0312)			−0.0772*** (0.0236)	−0.0207 (0.0159)	−0.0516 (0.0334)	−0.0830*** (0.0312)

Note: All dependent variables are expressed in logs and represent relative differences between countries j and i. $SMig_{ij,t}$ ($UMig_{ij,t-1}$) denotes the stock of high- (low-) skilled emigrants from country i living in country j divided by the stock of high- (low-) skilled residents in i. All estimations include $RelInvest_{ij,t-1}$, $RelUrban_{ij,t-1}$, $RelPrimSchool_{ij,t-1}$ and $RelTertSchool_{ij,t-1}$ as additional control variables. $TotalMig_{ij,t-1}$, $Dist_{ij}$, $ComLang_{ij}$, and $Contig_{ij}$ represent the share of the emigrant population from country i living in country j, the distance between i and j, whether i and j share a common language, and whether i and j have a common border, respectively. Table A1 in the appendix provides additional information on all variables and instruments. Robust standard errors are in parentheses and clustered for migration destinations.*** indicates a significance level below 1 percent; ** indicates a significance level between 1 and 5 percent; * indicates a significance level between 5 and 10 percent.

TABLE 4. Effect of High-Skilled Emigration Rates on Wage Differences between Countries when Migrants Change from the 80th Percentile to the 50th Percentile

	Dependent variable: **$RelWage80to50_{ij,t}$**							
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
$SMig_{ij,t}$	0.1963***		0.5774***	0.2006**	0.5722***	0.1707**	0.6249***	0.4626
	(0.0511)		(0.1464)	(0.0822)	(0.1421)	(0.0751)	(0.2097)	(0.3889)
$SMig_{ij,t-1}$		0.1461**						
		(0.0679)						
$UMig_{ij,t-1}$				5.5716***		5.8135***		3.3417
				(2.0616)		(2.1127)		(4.4442)
Other controls	YES	YES	YES	YES	YES	YES	YES	YES
Origin FE	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R^2	0.8355	0.8353	0.8361	0.8381	0.8364	0.8384	0.8363	0.8382
N	1010	1010	1010	1010	1010	1010	1010	1010
F-Test (first stage)	-	-	25.09	68.44	24.74	69.07	15.91	18.73
J-Test	-	-	-	-	0.8055	0.7491	0.7022	0.6947
Instruments used	OLS estimation	OLS estimation	$TotalMig_{ij,t-1}$	$TotalMig_{ij,t-1}$	$TotalMig_{ij,t-1}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,t-1}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$	$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$

Note: All dependent variables are expressed in logs and represent relative differences between countries j and i. $SMig_{ij,t}$ ($UMig_{ij,t-1}$) denotes the stock of high- (low-) skilled emigrants from country i living in country j divided by the stock of high- (low-) skilled residents in i. All estimations include $RelInvest_{ij,t-1}$, $RelUrban_{ij,t-1}$, $RelPrimSchool_{ij,t-1}$ and $RelTertSchool_{ij,t-1}$ as additional control variables. $TotalMig_{ij,t-1}$, $Dist_{ij}$, $ComLang_{ij}$, and $Contig_{ij}$ represent the share of the emigrant population from country i living in country j, the distance between i and j, whether i and j share a common language, and whether i and j have a common border, respectively. Table A1 in the appendix provides additional information on all variables and instruments. Robust standard errors are in parentheses clustered for migration destinations.*** indicates a significance level below 1 percent; ** indicates a significance level between 1 and 5 percent; * indicates significance level between 5 and 10 percent.

TABLE A.1. Data Description and Sources

Variable	Description & Source	N	Mean	SD
$SMig_{ij,t}$	Stock of emigrants of educational category "high" aged 25+ born in country *i* and living in OECD country *j* in *t* (2000 or 1990) divided by stock of residents of educational category "high" in country *i* in year *t*. Stock of emigration and stock of residents of educational category "high" from Docquier, Marfouk and Lowell (2007).	3052	0.0246	0.1909
$RelGDP_{ij,t}$	Log of GDP per capita of country *j* minus log of GDP per capita of country *i* in year 2000. GDP data from Penn World Table Version 6.2.	3052	1.4360	1.2890
$RelTFP_{ij,t}$	Log of TFP (measure TPF_K06) per capita of country *j* minus log of TFP of country *i* in year 2000. UNIDO World Productivity Database, Isaksson (2007).	1983	0.7860	0.7628
$RelWage80_{ij,t}$	Log of wage in 80th percentile of country *j* minus log of wage in 80th percentile of country *i*. Wage data from Occupational Wages around the World Database.	1247	1.2650	1.4945
$RelWage90_{ij,t}$	Log of wage in 90th percentile of country *j* minus log of wage in 90th percentile of country *i*. Wage data from Occupational Wages around the World Database.	1247	1.1810	1.3953
$RelWage80to50_{ij,t}$	Log of wage in 80th percentile of country *j* minus log of wage in 50th percentile of country *i*. Wage data from Occupational Wages around the World Database.	1247	0.9409	1.4348
$UMig_{ij,t-1}$	Stock of emigrants of educational category "low" aged 25+ born in country *i* and living in OECD country *j* in *t-1* (1990) divided by stock of residents of educational category "low" in country *i* in *t-1*. Stock of emigration and stock of residents of educational category "low" from Docquier, Marfouk and Lowell (2007).	3052	0.0026	0.0197
$RelPrimSchool_{ij,t-1}$	Primary school enrollment in country *j* divided by primary school enrollment in country *i* in *t-1* (1990). Primary school enrollment rate from *GDF* and *WDI*.	2403	1.2040	0.5211
$RelTertSchool_{ij,t-1}$	Tertiary school enrollment in country *j* divided by tertiary school enrollment in country *i* in *t-1* (1990). Tertiary school enrollment rate from *GDF* and *WDI*.	2477	10.2700	22.2216
$RelInvest_{ij,t-1}$	Investment share in country *j* divided by investment share in country *i* in *t-1* (1990). Investment share from Penn World Table Version 6.2.	3052	2.3350	1.9566
$RelUrban_{ij,t-1}$	Urban population share in country *j* divided by urban population share in country *i* in *t-1* (1990). Urban population share from *GDF* and *WDI*.	3013	2.0500	1.8872
$TotalMig_{ij,t-1}$	Emigrant population from country *i* living in country *j* divided by population (in thousands) of country *i* in *t-1* (1990). Docquier, Marfouk and Lowell (2007).	3052	1.6870	11.1509
$TotalMig_{ij,1960}$	Proxy of emigrant population from country *i* living in country *j* in year 1960. Constructed as described in text, based on data from the United Nations Population Division.	3052	1.6120	20.5570
$Dist_{ij}$	Log geodesic distance in km between countries *i* and *j*. Mayer and Soledad (2006).	3042	8.5170	0.9313
$ComLang_{ij}$	Dummy variable capturing if same language is spoken by at least 9 percent of the population in country *i* and *j*. Mayer and Soledad (2006).	3052	0.1311	0.3375
$Contig_{ij}$	Dummy variable capturing whether countries *i* and *j* are contiguous. Mayer and Soledad (2006).	3052	0.0269	0.1617

Note: The ranges, means, and standard deviations are not weighted and are based on the respective number of observations. Destination countries are the 30 OECD members. The total number of observations depends on the data availability for destination and source countries. An observation is excluded if bilateral data are not available or the source country does not have any emigrants in the destination country.