Wage Effects of High-skilled Migration: International Evidence*

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Abstract

This paper argues that 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. We exploit a recent data set on international bilateral migration flows and provide evidence which is consistent with this hypothesis. We propose different instrumentation strategies to identify the causal effect of skilled migration on log differences of GDP per capita, total factor productivity, and wages of skilled workers between pairs of source and destination countries. These address the endogeneity problem which potentially arises when international wage differences affect migration decisions.

Key words: International high-skilled migration; Wage effects; Total factor productivity.

JEL classification: F22; O30.

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1 Introduction

The recent surge in international migration of high-skilled workers not only raised the standard concern about adverse brain drain effects for developing countries but also led to worries of native high-skilled workers in advanced destination countries.[1] Domestic workers with higher education levels are afraid to see their wages decline in response to increased competition from similarly qualified migrants. Whereas debates on migration have centered around asylum rights and low-skilled migrants in the past, over the years politicians and mass media discovered the issue of high-skilled immigration. For instance, in Switzerland and Austria, the discussion recently has become emotionally charged due to significant inflows of tertiary educated workers particularly from Germany.[2] For the US, Hanson, Scheve and Slaughter (2009) find that skilled natives tend to oppose immigration more in states with a relatively skilled mix of immigrants 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 towards immigration, the more skilled the immigrants are relative to average skill level in the destination country.

This paper examines the question whether domestic skilled workers have reason to oppose high-skilled immigration and, vice versa, whether non-migrating high-skilled workers win or lose from brain drain in source countries. We argue that international migration of high-skilled workers triggers productivity effects at the macro level such that the wage rate of skilled workers may well 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 wage income of skilled workers between pairs of source and destination countries. We propose a range of instrumental variables to address the potential reverse

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

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

causality problem which arises when international wage differences affect individual migration decisions (e.g., Lucas, 2005; Egger and Radulescu, 2009; Grogger and Hanson, 2011).

We derive an empirical model from a theoretical framework which suggests that, even when taking adjustments in educational decisions into account, an increase in high-skilled emigration (immigration) lowers (raises) the domestic skill-intensity in production.[3] This has two effects on relative wages of the high-skilled between destination and source economy. First, for a given TFP and as a consequence of declining marginal productivity of a certain type of labor, high-skilled workers lose in the destination and win in the source economy. Second, 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 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, due to 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 recent literature on 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 US and UK, respectively. In a similar vein, Friedberg (2001) shows that native wages may rise after immigrants have entered high-skilled occupations in the Israeli labor market. Our main 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.

[3] Grossmann and Stadelmann (2011) develop an overlapping-generations model with endogenous education choice which shows how migration is triggered by a decrease in 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.

Another strand of literature has emphasized positive effects of brain drain for market income in the source economy (e.g., Mountford, 1997; Stark, Helmenstein and Prskawetz, 1997; Beine, Docquier and Rapoport, 2001, 2008). The 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 seems to be positive except for very poor countries and/or countries with low human capital levels (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. As our empirical framework investigatives the effect of skilled migration on relative outcomes between destination and source, we do not test the alternative hypothesis put forward in the "brain gain" literature. What we can conclude, however, is that the destination country gains more from skilled migration than the source country.

The remainder of this paper is organized as follows. Section 2 presents a simple theoretical model. The model provides the basis for the empirical analysis in section 3 of the effects of higher emigration on relative GDP per capita, relative TFP and relative wage income of skilled workers between source and destination. The last section provides concluding remarks.

2 Theoretical Considerations

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

2.1 Set Up

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

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

where H and L denote high-skilled and low-skilled labor input, respectively, A is total factor productivity (TFP), function F is linearly homogenous, $k \equiv H/L$ denotes the skill-intensity of production, and $f(k) \equiv F(k,1)$. 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, $h := H/N$, on TFP:

$$A = a(h), \tag{2}$$

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 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 high-skilled domestic population. The empirical literature on human capital externalities is somewhat inconclusive though 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 US but not from an increased share of high school graduates. In a recent study, Gennaoli et al. (2011) find strong empirical evidence for human capital externalities. They employ a new data set with 1569 sub-national 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. Their conclusion is that the previous empirical literature has underestimated the magnitude of human capital externalities. In a similar vein, Hunt (2011) shows, by employing a US state panel data set for the period 1940-2000, that an increase in the immigrant college graduates' population share by one percentage point raises the patents per capita by 9-18 percent. This is strong evidence in favor of the hypothesis that skilled immigration raises TFP.

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

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

where $\theta_i = \theta^H > 1$ if i is skilled and $\theta_i = \theta^L > 1$ if i is unskilled. To model migration costs as discounted consumption follows Stark et al. (1997), among others. Education comes at time cost $e_i \geq 0$. These may be interpreted as learning costs. 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 by superscript (*). Thus, consumption of individual i born at home is given by

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

Denote by $G(e)$ the cumulative distribution function (c.d.f.) of 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 whether we assume that migration possibilities are already taken into account in the education decision of individuals or not. This 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.

2.2 Derivation of Testable Hypotheses

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

$$w_H = a(H)f'(k), \tag{5}$$

$$w_L = a(H)\left[f(k) - kf'(k)\right]. \tag{6}$$

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

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

A non-migrating individual i chooses education whenever $(1-e_i)w_H \geq w_L$. Moreover, staying at home and being educated gives 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 (7), again gives us condition $(1-e_i)w_H \geq w_L$. Moreover, migrating and being educated gives higher utility than not migrating and remaining unskilled if $(1-e_i)w_H^*/\theta^H = (1-e_i)w_H \geq w_L$.

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

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

Since $f'' < 0$, we have $\bar{e}' < 0$. The higher skill-intensity k is, the higher is the wage rate of unskilled individuals relative to skilled individuals, w_L/w_H; consequently, more individuals remain unskilled, which means that threshold learning cost $\bar{e}$ is lower.

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

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

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

$$S = \int_0^{\bar{e}(k)} (1-e)\mathrm{d}G(e) \equiv \tilde{S}(k). \tag{10}$$

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

Denote by m_S and m_U the fraction of skilled and unskilled labor units which are 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. Thus, using (9) and (10), the skill-intensity at home, $k = H/L$, is implicitly given by

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

Using $\tilde{U}' > 0$ and $\tilde{S}' < 0$, we see that the right-hand side of (11) is decreasing in k. Thus, in an interior labor market equilibrium, the skill-intensity as given by (11), denoted by $k \equiv \tilde{k}(m_S, m_U)$, is unique. 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. Thus, the foreign skill-intensity k^* is uniquely given by[5]

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

We write $k^* \equiv \tilde{k}^*(m_S, m_U)$. 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]

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

[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 (9) and (10), respectively.

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

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

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

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

$$\kappa_S \; : \; = -\frac{m_S}{\tilde{k}}\frac{\partial \tilde{k}}{\partial m_S}, \quad \kappa_U := \frac{m_U}{\tilde{k}}\frac{\partial \tilde{k}}{\partial m_U}, \tag{15}$$

$$\kappa_S^* \; : \; = \frac{m_S}{\tilde{k}^*}\frac{\partial \tilde{k}^*}{\partial m_S}, \quad \kappa_U^* := -\frac{m_U}{\tilde{k}^*}\frac{\partial \tilde{k}^*}{\partial m_U}. \tag{16}$$

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

$$\varepsilon(h) \; : \; = \frac{ha'(h)}{a(h)}, \tag{17}$$

$$\eta(k) \; : \; = -\frac{kf''(k)}{f'(k)}, \tag{18}$$

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 easy 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

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

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

respectively. Thus, 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 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, due to human capital externalities ($\varepsilon^*, \varepsilon^* > 0$), emigration of skilled labor also 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 since an increase in m_S fosters education incentives in the source country (and gives disincentives in the destination country).

Second, the elasticity of 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

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

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

respectively. Thus, the impact of migration of unskilled labor (increase in m_U) on relative destination-to-source wage income of skilled labor is unambiguouly positive. Not only does relative TFP rise due to education effects but also does the resulting increase in skill-intensity k lower wages of skilled labor in the source country (and vice versa in the destination country, where the skill-intensity decreases). By contrast, since for a given TFP the wage rate of skilled labor is decreasing in the skill-intensity, the impact of migration of skilled labor (increase in m_S) on relative destination-to-source wage income of skilled labor (ω_H) is ambiguous, even if relative destination-to-source TFP (α) rises. Only if TFP-effects are large enough, due to human capital externalities, an increase in m_S raises ω_H.

In sum, we predict that an increase in emigration rate of high-skilled labor (m_S) raises relative TFP $\alpha = A^*/A$, whereas the impact of 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 relative wages of the skilled, $\omega_H = w_H^*/w_H$. Finally, an increase in m_S may also rise

ω_H, if TFP-effects are sufficiently large. These are also potentially important theoretical results for the political debate some destination countries of skilled workers.

We have focussed the theoretical analysis on the predictions regarding the effects of migration, although we allowed individuals to take the migration decision into account when choosing education. As migration is endogenous according to the model and depends (inter alia) on international wage differences, the model also points to an endogeneity issue which may be addressed by using various instrumentation strategies.

3 Empirical Analysis

Our theoretical analysis has highlighted the effect of emigration of high-skilled and low-skilled labor to 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 how skilled migration affects wages of skilled workers: 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 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 decision of both high-skilled and low-skilled workers. They show that emigrants already living in the destination country positively affect migration flows in a causal way.[8]

Our analysis complements the research on the interaction between wage differences and skilled migration by focussing on the opposite direction, i.e., 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

[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 looked at 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 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).

stocks, as motivated by Beine et al. (2011).

3.1 Data and Estimation Strategy

The emigration rate of high-skilled individuals is our main explanatory variable. Docquier and Marfouk (2006) have 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 aged at least 25 who live in an OECD country and class them by educational attainment and country of origin. Thus, only emigration into OECD countries is captured, approximately 90 percent of educated migrants in the world.[9] As 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, denoted by $SMig_{ij}$, 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 low-skilled emigration rate, $UMig_{ij}$, which is constructed analogously.

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

$$\log\left(\frac{y_j}{y_i}\right) = \beta_0 + \beta_1 SMig_{ij} + \beta_2 UMig_{ij} + \mathbf{x}'_{ij}\boldsymbol{\beta}_{\mathbf{x}} + u_{ij}. \tag{23}$$

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 (14) and (13) derived in section 2, respectively. According to (19), the theoretical model suggests that $\beta_1 > 0$ when 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 TFP effects of migration are sufficiently high, according to (21). Moreover, we predict $\beta_2 > 0$ when $\log(w_H^*/w_H)$ is the dependent variable.

$\mathbf{x}_{ij}$ is a vector of other controls potentially affecting log income differences between i

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

and j like relative school enrolment 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 measure controls other than skilled migration at the year 1990 to reduce endogeneity bias. u_{ij} is an error term.

As an measure of $\log(w_H^*/w_H)$, we would like to use (log) wages differences for high-skilled individuals. However, since wage income by education category is not available, we construct several empirical proxy measures. Freeman and Oostendorp (2000) have collected information on earnings by occupation and industry from the International Labor Organization's (ILO) October Inquiry Survey from 1983-1998 for a number of countries.[10] For each country, we use Freeman and Oostendorp's earnings measures to calculate the 80th and the 90th percentile as two measures for wages of high-skilled workers. For most countries, data are available for just a few years. Thus, for each country we take the mean across the period between the years 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 percentile are denoted by $RelWage80_{ij}$ and $RelWage90_{ij}$.

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

For relative GDP and relative TFP between destination and source countries, denoted by $RelGDP_{ij}$ and $RelTFP_{ij}$, respectively, we use Penn World Tables and the UNIDO World productivity database. In particular, GDP data is better available than wage data such that the number of observations increases. Details of variable definitions, data

[10] In order 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 on http://www.nber.org/oww/.

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

sources and summary statistics of the employed variables are presented in the appendix (Tab. A1).

As indicated, while recent empirical literature has focussed on the impact of income differences on migration patterns, we aim to examine the opposite channel. Thus, the empirical analysis needs to address the potential endogeneity bias. In a first attempt to deal with endogeneity, we replace the high-skilled emigration rate in 2000 by the lagged one in 1990 in OLS regressions. This also allows for the possibility that TFP effects of migration flows of skilled workers, for instance, through innovation activity, take some time to come into effect.

Second, we explore potential instruments for the high-skilled emigration rate for the year 2000, $SMig_{ij,2000}$. We use the lagged rate of total expatriates in 1990 who emigrated from country i to j, denoted by $TotalMig_{ij,1990}$, as an instrument for $SMig_{ij,2000}$, thereby predicting the rate of high-skilled emigrants by the lagged rate of all emigrants. This can be 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 concerning openness in the destination country and treatment of foreigners by administrative bodies. Importantly, 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 also use the total emigration rate in 1960 instead of $TotalMig_{ij,1990}$ as instrument, which, however, cannot be readily observed. We therefore construct a proxy for the total emigration rate. Denote by $NetMig_{i,1960}$ the total net emigration rate (number of emigrants minus number of immigrants divided by population size) in country i in the year 1960, provided by the United

[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 instrument for contemporaneous migration. We confirmed that results do not change.

Nations Population Division.[13] Our measure of bilateral total emigration rates in 1960 is defined by

$$TotalMig_{ij,1960} := \frac{NetMig_{i,1960}}{100} \times \frac{Pop_{j,1960}}{Pop_{i,1960}}, \tag{24}$$

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 argued by Beine, Docquier and Rapoport (2001), one may use countries' population sizes to reflect immigration quotas. $NetMig_{i,1960} \times Pop_{j,1960}$ thus is a proxy for the net stock of emigrants from country i received in country j in 1960. As 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 and thus 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 is supported by J-tests.

3.2 Results

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

< Table 1>

Tab. 1 presents OLS estimates of equation (23). We first leave out the low-skilled migration rate. We see that estimated effects of an increase in the high-skilled migration rate on relative GDP ($RelGDP_{ij}$), relative TFP ($RelTFP_{ij},$), and relative wages ($RelWage80_{ij}$, $RelWage90_{ij}$) between destination and source countries are positive and significant. Using the lagged high-skilled migration rate ($SMig_{ij,1990}$) rather than the

[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 indeed well correlated with the high-skilled emigration rate in 2000, $Smig_{ij,2000}$.

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

contemporanous one ($SMig_{ij,2000}$) only slighly decreases the coefficient. Thus, an increase in the high-skilled emigration rate raises (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 primary school enrolment ($RelPrimSchool_{ij,1990}$), which is never significant, the controls have the expected signs. The (lagged) relative investment rate ($RelInvest_{ij,1990}$) and the (lagged) relative urban population share ($RelUrban_{ij,1990}$) are typically significantly different from zero.

To consider the effect quantitatively, we use a coefficient β_1 around 0.2 in the wage-regressions presented in columns (5)-(8). Doubling the high-skilled emigration rate ($SMig_{ij}$) from its mean level of 0.025 thus implies that the relative wage for high-skilled workers between destination and source rises by approximately 0.5 percent ($= 0.2 \times 0.025$).[17] This effect is small, thereby being consistent with the microeconomic estimates of the effect of high-skilled immigration on wages for the high-skilled inside the US by Borjas (2003) and for the UK by Dustmann et al. (2005).

< **Table 2**>

Tab. 2-4 deal with the potential reverse causality problem by providing instrumental variable (IV) estimations of (23). The upper panels report second stage results while the lower panels in Tab. 2 and 3 report the partial correlations of the instruments in the first stage.

We start with the results for relative GDP as dependent variable in Tab. 2. In columns (1) and (2) we use the total emigration rate from country i to j in 1990 ($TotalMig_{ij,1990}$) as 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 common language of source and destination country ($ComLang_{ij}$) are used as additional instruments in addition to the total emigration rate. We use $TotalMig_{ij,1990}$ in columns (3) and (4) and our proxy for the total emigration rate 1960, $TotalMig_{ij,1960}$,

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

in columns (5) and (6). As in Tab. 1, we still control for lagged relative values of school enrolment, private investment and urbanization and include source country fixed effects (results not shown). The effect of high-skilled migration on log GDP differences between destination and source country is, like in the OLS estimations, positive. All estimates suggest a significant and even higher effect of skilled migration on relative GDP compared to the OLS estimates in Tab. 1. Columns (2), (4) and (6) also control for the (lagged) low-skilled migration rate in 1990, $UMig_{ij,1990}$. We see that the coefficient on $UMig_{ij,1990}$, β_2 in eq. (23), is neither significantly different from zero nor does it alter the coefficient of the instrumented variable $SMig_{ij,2000}$ in an important way.

Columns (7)-(12) in Tab. 2 present 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 to OLS estimates whereas low-skilled migration is not significant. In particular, the estimates of β_1 in columns (7)-(12) of Tab. 2 confirm our theoretical prediction that $\alpha = A^*/A$ is increasing in m_S, due to human capital externalities. Again, the coefficient on $UMig_{ij,1990}$, β_2, is not significantly different from zero and sometimes positive, in line with the theoretical model.

A F-test for the first stage results shows that the instruments are significantly related to the emigration rate. Particularly, past migration seems to be an important determinant of high-skilled migration.[18] None of the J-statistics, which deal with the overidentifying restrictions, point to problems with the instruments.

< Table 3>

In Tab. 3 we present the analogous results to Tab. 2 for relative wages in the 80th and 90th percentile instead of relative GDP and relative TFP, respectively. Again, columns (1)-(2) and (7)-(8) use the total emigration rate in 1990, $TotalMig_{ij,1990}$, as a single instrument for the high-skilled emigration rate, $SMig_{ij,2000}$. The first stage results indicate that the total emigration rate in 1990 is well correlated with $SMig_{ij,2000}$. β_1 is

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

again positive and significantly different from zero. According to the other estimations in Tab. 3, the results are similar when using the measure for the total migration rate in 1960 ($TotalMig_{ij,1960}$) and/or geographical variables and linguistic proximity as instruments. According to the theoretical prediction in (21), β_1 should be higher when relative TFP (α) rather than relative wages of skilled labor (ω_H) is the dependent variable. Comparing the estimates in Tab. 2 and 3, this is not the case in our estimates. It is important to note, however, that sample sizes are very different, as wage data is available for less (and, on average, richer) countries than TFP.

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

In sum, we may conclude that the effect of skilled migration on international wage differences, albeit limited in magnitude, is always and often significant. Seeing the results on relative TFP in Tab. 2 and the results in Tab. 3 in connection with our theoretical considerations seems to suggest that possible positive effects of skilled immigration on the wages of skilled workers come from positive TFP effects of skilled immigration. Moreover, low-skilled migration always benefits the skilled labor force in the receiving country.

First stage results in Tab. 3 again suggest that factors which are potentially unrelated to income − such as network effects, language and geography − drive the high-skilled emigration rate. Interestingly, the coefficients on the instrumented variable $SMig_{ij}$ in Tab. 3 are often more than twice as high than in OLS regressions (Tab. 1). This 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 seem to find it easier to integrate in the host country and thus have a larger effect on TFP (possibly being employed in jobs which 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 in the source country, often earning wages which are in 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, an skilled immigrant may occupy a low-skilled job at least shortly after arrival due to language problems in the destination country. We account for these possibilities in taking as dependent variable the log difference between the wage of the median in the destination country and the 80th percentile in the source country, $RelWage80to50_{ij}$.

$<$ **Table 4**$>$

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

We conducted further sensitivity analysis. The results are reported in an online appendix. They suggest that our conclusions are overall fairly robust. First, we include destination fixed effects rather than source fixed effects as additional controls in all estimations. With destination fixed effects results are similar to those with source fixed effects.[19] We also checked whether results are sensitive to a specific destination country. We run "rolling" regressions where we left out one destination country each time and confirmed that results were basically unchanged. Second, we include regional dummies and a dummy variable which indicates whether also the source country belongs to the OECD[20] instead of fixed effects as controls, in order to account for in an alternative way for institutional differences which may affect income differences. Third, we employ an alternative emigration data set by Defoort (2006) to construct a proxy for the total emigration rate. The data set contains emigration to six important destination countries

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

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

in the year 1975. The proxy is constructed analogously to (24) and used as an instrument for the skilled migration rate in 2000, $SMig_{ij,2000}$. Finally, we use the stock of high-skilled and low-skilled migrants rather than migration rates as regressors. Our main conclusion remain qualitatively unchanged and overall robust.

4 Concluding Remarks

In this paper we analyzed the impact of an increase in 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 considerations suggest that an increase in the number of skilled migrants may increase international wage inequality by adversely affecting TFP in the source economy and raising it in the host economy. Our empirical analysis provided evidence which is consistent with this hypothesis. Using a data set on bilateral emigration of skilled workers, our results suggest that an increase in high-skilled emigration rates slightly raises TFP differences and therefore − albeit also slightly − wage income for skilled workers in destination relative to source countries in a causal way. None of our estimations suggests that skilled workers in the destination country lose from skilled migration relative to the source country. Moreover, skilled workers in the receiving countries unambiguously gain from low-skilled migration.

Appendix

Tab. A1 provides data sources, variable definitions and summary statistics.

< Table A1>

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Table 1: Effect of high skilled emigration rates on wage, GDP and TFP differences between countries

	Dependent variable: **RelGDP**$_{ij,2000}$		Dependent variable: **RelTFP**$_{ij,2000}$		Dependent variable: **RelWage80**$_{ij,2000}$		Dependent variable: **RelWage90**$_{ij,2000}$	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
SMig$_{ij,2000}$	0.1630***		0.0830***		0.2168***		0.2290***	
	(0.0276)		(0.0140)		(0.0490)		(0.0483)	
SMig$_{ij,1990}$		0.1386***		0.0796***		0.1645**		0.1738**
		(0.0418)		(0.0198)		(0.0678)		(0.0699)
RelInvest$_{ij,1990}$	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$_{ij,1990}$	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$_{ij,1990}$	-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$_{ij,1990}$	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)
(Incercept)	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. R2	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
Destination clusters	YES	YES	YES	YES	YES	YES	YES	YES

Notes: All dependent variables are expressed in logs and represent relative differences between countries j and i. SMig$_{ij,2000[1990]}$ denotes stock of high-skilled emigrants from country i living in country j divided by stock of high skilled residents in i. RelInvest$_{ij,1990}$, RelUrban$_{ij,1990}$, RelPrimSchool$_{ij,1990}$, RelTertSchool$_{ij,1990}$ denote relative investment share, relative urbanization share, relative primary school enrollment and relative tertary school enrollment between j and i. Table A1 in the appendix provides additional information on all variables. Robust standard errors in parenthesis clustered for migration destinations. *** indicates a significance level of below 1 %; ** indicates a significance level between 1 and 5 %; * indicates significance level between 5 and 10 %.

Table 2: Effect of high skilled emigration rates on GDP and TFP differences between countries (instrumental variables estimations)

	Dependent variable: **RelGDP**$_{ij,2000}$						Dependent variable: **RelTPF**$_{ij,2000}$					
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
$SMig_{ij,2000}$	0.3036*	0.3269***	0.3017**	0.3015***	0.3883*	0.5138**	0.1771**	0.1452***	0.1863**	0.1437***	0.3569***	0.4021***
	(0.1601)	(0.0882)	(0.1532)	(0.0875)	(0.2371)	(0.2064)	(0.0784)	(0.0235)	(0.0734)	(0.0256)	(0.0587)	(0.0703)
$UMig_{ij,1990}$		-0.1677		-0.0672		-0.9417		0.3707		0.3789		-1.0854
		(0.3579)		(0.4101)		(0.8753)		(0.4117)		(0.4349)		(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. R2	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
Destination clusters	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
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	*$TotalMig_{ij,1990}$*	*$TotalMig_{ij,1990}$*	*$TotalMig_{ij,1990}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$*	*$TotalMig_{ij,1990}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$*	*$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$*	*$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$*	*$TotalMig_{ij,1990}$*	*$TotalMig_{ij,1990}$*	*$TotalMig_{ij,1990}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$*	*$TotalMig_{ij,1990}$ + $Dist_{ij}$ + $ComLang_{ij}$ + $Contig_{ij}$*	*$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$*	*$TotalMig_{ij,1960}$ + $Dist_{i}$ + $ComLang_{ij}$ + $Contig_{ij}$*
						First stage (partial correlations)						
$TotalMig_{ij,1990}$	0.0124***	0.0322***	0.0123***	0.0323***			0.0184***	0.0437***	0.0187***	0.0438***		
	(3.7e-04)	(7.9e-04)	(3.8e-04)	(8.0e-04)			(5.8e-04)	(0.0010)	(6.0e-04)	(0.0010)		
$TotalMig_{ij,P1960}$					1.2e-04***	1.0e-04***					3.9e-04***	3.2e-04***
					(1.1e-05)	(1.0e-05)					(3.1e-05)	(3.0e-05)
$Dist_{ij}$			-0.0166***	-0.0217***	-0.0265***	-0.0197***			-0.0198***	-0.0184***	-0.0365***	-0.0299***
			(0.0053)	(0.0045)	(0.0063)	(0.0059)			(0.0074)	(0.0060)	(0.0091)	(0.0087)
$ComLang_{ij}$			0.0227**	-0.0026	0.0943***	0.0615***			0.0054	-0.0169*	0.0836***	0.0545***
			(0.0108)	(0.0093)	(0.0126)	(0.0120)			(0.0126)	(0.0102)	(0.0153)	(0.0148)
$Contig_{ij}$			-0.1009***	-0.0537***	-0.0606**	-0.0951***			-0.1992***	-0.0621**	-0.0736*	-0.1652***
			(0.0219)	(0.0189)	(0.0260)	(0.0246)			(0.0339)	(0.0278)	(0.0416)	(0.0403)

Notes: All dependent variables are expressed in logs and represent relative differences between countries j and i. $SMig_{ij,2000}$ ($UMig_{ij,1990}$) denotes stock of high- (low-) skilled emigrants from country i living in country j divided by stock of high (low) skilled residents in i. All estimations include $RelPrimSchool_{ij,1990}$, $RelTertSchool_{ij,1990}$, $RelInvest_{ij,1990}$ and $RelUrban_{ij,1990}$ as additional control variables. $TotalMig_{ij,1990}$, $Dist_{ij}$, $ComLang_{ij}$, $Contig_{ij}$ 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 in parenthesis clustered for migration destinations.*** indicates a significance level of below 1 %; ** indicates a significance level between 1 and 5 %; * indicates significance level between 5 and 10 %.

Table 3: Effect of high skilled emigration rates on wage differences between countries (instrumental variables estimations)

	Dependent variable: **RelWage80**$_{ij,2000}$						Dependent variable: **RelWage90**$_{ij,2000}$					
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
SMig$_{ij,2000}$	0.6026***	0.2490***	0.5948***	0.2125***	0.6676***	0.5447	0.5888***	0.2795***	0.5788***	0.2360***	0.6875***	0.6382
	(0.1457)	(0.0673)	(0.1406)	(0.0653)	(0.2123)	(0.4028)	(0.1443)	(0.0588)	(0.1374)	(0.0557)	(0.2193)	(0.4059)
UMig$_{ij,1990}$		5.2286***		5.5204***		2.7071		4.5736***		4.9178***		1.5121
		(1.9307)		(2.0235)		(4.5031)		(1.6763)		(1.8263)		(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. R2	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
Destination clusters	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
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* $_{ij,1990}$	*TotalMig* $_{ij,1990}$	*TotalMig* $_{ij,1990}$ + *Dist* $_{ij}$ + *ComLang* $_{ij}$ + *Contig* $_{ij}$	*TotalMig* $_{ij,1990}$ + *Dist* $_{ij}$ + *ComLang* $_{ij}$ + *Contig* $_{ij}$	*TotalMig* $_{ij,P1960}$ + *Dist* $_{i}$ + *ComLang* $_{ij}$ + *Contig* $_{ij}$	*TotalMig* $_{ij,P1960}$ + *Dist* $_{i}$ + *ComLang* $_{ij}$ + *Contig* $_{ij}$	*TotalMig* $_{ij,1990}$	*TotalMig* $_{ij,1990}$	*TotalMig* $_{ij,1990}$ + *Dist* $_{ij}$ + *ComLang* $_{ij}$ + *Contig* $_{ij}$	*TotalMig* $_{ij,1990}$ + *Dist* $_{ij}$ + *ComLang* $_{ij}$ + *Contig* $_{ij}$	*TotalMig* $_{ij,P1960}$ + *Dist* $_{i}$ + *ComLang* $_{ij}$ + *Contig* $_{ij}$	*TotalMig* $_{ij,P1960}$ + *Dist* $_{i}$ + *ComLang* $_{ij}$ + *Contig* $_{ij}$
	First stage (partial correlations)											
TotalMig$_{ij,1990}$	0.0198***	0.0196***	0.0196***	0.0463***			0.0459***	0.0198***	0.0196***	0.0463***		
	(5.5e-04)	(5.7e-04)	(5.7e-04)	(8.8e-04)			(8.8e-04)	(5.5e-04)	(5.7e-04)	(8.8e-04)		
TotalMig$_{ij,P1960}$					1.8e-04***	9.5e-05***					1.8e-04***	9.5e-05***
					(1.6e-05)	(1.7e-05)					(1.6e-05)	(1.7e-05)
Dist$_{ij}$		-0.0099	-0.0099	-0.0205***	-0.0145	-0.0088			-0.0099	-0.0205***	-0.0145	-0.0088
		(0.0068)	(0.0068)	(0.0046)	(0.0096)	(0.0089)			(0.0068)	(0.0046)	(0.0096)	(0.0089)
ComLang$_{ij}$		0.0277*	0.0277*	0.0050	0.1294***	0.0904***			0.0277*	0.0050	0.1294***	0.0904***
		(0.0151)	(0.0151)	(0.0102)	(0.0209)	(0.0197)			(0.0151)	(0.0102)	(0.0209)	(0.0197)
Contig$_{ij}$		-0.0772***	-0.0772***	-0.0207	-0.0516	-0.0830***			-0.0772***	-0.0207	-0.0516	-0.0830***
		(0.0236)	(0.0236)	(0.0159)	(0.0334)	(0.0312)			(0.0236)	(0.0159)	(0.0334)	(0.0312)

Notes: All dependent variables are expressed in logs and represent relative differences between countries j and i. SMig$_{ij,2000}$ (UMig$_{ij,1990}$) denotes stock of high- (low-) skilled emigrants from country i living in country j divided by stock of high (low) skilled residents in i. All estimations include RelPrimSchool$_{ij,1990}$, RelTertSchool$_{ij,1990}$, RelInvest$_{ij,1990}$ and RelUrban$_{ij,1990}$ as additional control variables. TotalMig$_{ij,1990}$, Dist$_{ij}$, ComLang$_{ij}$, 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 in parenthesis clustered for migration destinations.*** indicates a significance level of below 1 %; ** indicates a significance level between 1 and 5 %; * indicates significance level between 5 and 10 %.

Table 4: Effect of high skilled emigration rates on wage differences between countries when migrants change from 80th percentile to 50th percentile

	Dependent variable: **RelWage80to50**$_{ij,2000}$							
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
$SMig_{ij,2000}$	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)
$SMig_{ij,1990}$		0.1461**						
		(0.0679)						
$UMig_{ij,1990}$				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. R2	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
Destination clusters	YES	YES	YES	YES	YES	YES	YES	YES
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*	$TotalMig_{ij,1990}$	$TotalMig_{ij,1990}$	$TotalMig_{ij,1990} + Dist_{ij} + ComLang_{ij} + Contig_{ij}$	$TotalMig_{ij,1990} + Dist_{ij} + ComLang_{ij} + Contig_{ij}$	$TotalMig_{ij,P1960} + Dist_{i} + ComLang_{ij} + Contig_{ij}$	$TotalMig_{ij,P1960} + Dist_{i} + ComLang_{ij} + Contig_{ij}$

Notes: All dependent variables are expressed in logs and represent relative differences between countries j and i. $SMig_{ij,2000}$ ($UMig_{ij,1990}$) denotes stock of high- (low-) skilled emigrants from country i living in country j divided by stock of high (low) skilled residents in i. All estimations include $RelPrimSchool_{ij,1990}$, $RelTertSchool_{ij,1990}$, $RelInvest_{ij,1990}$ and $RelUrban_{ij,1990}$ as additional control variables. $TotalMig_{ij,1990}$, $Dist_{ij}$, $ComLang_{ij}$, $Contig_{ij}$ 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 in parenthesis clustered for migration destinations.*** indicates a significance level of below 1 %; ** indicates a significance level between 1 and 5 %; * indicates significance level between 5 and 10 %.

Table A1: Data description and sources

Variable	*Description & Source*	*N*	*Mean*	*SD*
$SMig_{ij,2000}$ [$SMig_{ij,1990}$]	Stock of emigrants of educational category "high" aged 25+ born in country *i* and living in OECD country *j* in year 2000 [1990] divided by stock of residents of educational category "high" in country *i* in year 2000 [1990]. Stock of emigration and stock of residents of educational category "high" from Docquier, Marfouk and Lowell (2007).	3052	0.0246	0.1909
$RelGDP_{ij,2000}$	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
$RelTFP_{ij,2000}$	Log of total factor productivity (measure TPF_K06) per capita of country *j* minus log of total factor productivity of country *i* in year 2000. UNIDO World Productivity Database, Isaksson (2007).	1983	0.7860	0.7628
$RelWage80_{ij,2000}$	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 (OWW) Database.	1247	1.2650	1.4945
$RelWage90_{ij,2000}$	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 (OWW) Database.	1247	1.1810	1.3953
$RelWage80to50_{ij,2000}$	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 (OWW) Database.	1247	0.9409	1.4348
$UMig_{ij,1990}$	Stock of emigrants of educational category "low" aged 25+ born in country *i* and living in OECD country *j* in year 1990 divided by stock of residents of educational category "low" in country *i* in year 1990. Stock of emigration and stock of residents of educational category "low" from Docquier, Marfouk and Lowell (2007).	3052	0.0026	0.0197
$RelPrimSchool_{ij,1990}$	Primary school enrolment in country *j* divided by primary school enrolment in country *i* in year 1990. Primary school enrolment rate from Global Development Finance & World Development Indicators.	2403	1.2040	0.5211
$RelTertSchool_{ij,1990}$	Tertiary school enrolment in country *j* divided by tertiary school enrolment in country *i* in year 1990. Tertiary school enrolment rate from Global Development Finance & World Development Indicators.	2477	10.2700	22.2216
$RelInvest_{ij,1990}$	Investment share in country *j* divided by investment share in country *i* in year 1990. Investment share from Penn World Table Version 6.2.	3052	2.3350	1.9566
$RelUrban_{ij,1990}$	Urban population share in country *j* divided by urban population share in country *i* in year 1990. Urban population share from Global Development Finance & World Development Indicators.	3013	2.0500	1.8872
$TotalMig_{ij,1990}$	Emigrant population from country *i* living in country *j* divided by population in 1000 of country *i* in year 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 kms between country *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 % of the population in country *i* and *j*. Mayer and Soledad (2006).	3052	0.1311	0.3375
$Contig_{ij}$	Dummy variable capturing if country *i* and *j* are contiguous. Mayer and Soledad (2006).	3052	0.0269	0.1617

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