Impact of Migration on Income Levels in Advanced Economies

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Abstract: *This paper examines the longer-term impact of migration on the GDP per capita of receiving advanced economies. Addressing carefully the risk of reverse causality, it finds that immigration increases the GDP per capita of host economies, mostly by raising labor productivity. The effect—while smaller than in earlier estimates—tends to be significant: a one percentage point increase in the share of migrants in the adult population can raise GDP per capita by up to 2 percent in the long run. Both high- and low-skilled migrants contribute, in part by complementing the existing skill set of the population. Finally, the gains from immigration appear to be broadly shared*.

JEL Classification: E24, E25, F22, F62, J15, J24, J61

Keywords: international migration, productivity, inequality, skilled migration

1. Introduction

Immigration has taken center stage in the western political dialogue recently, even though labor is the least mobile factor of production. In 2010, migrants constituted only 3 percent of the world population, while trade in goods accounted for about 30 percent of world GDP and capital 15 percent of total world investment. Immigration has also long been a controversial topic among economists (Card, 2009). A long-standing literature analyzes the impact of immigrants on labor market outcomes (i.e. wages and employment) for natives. For instance, Borjas (2003, 2006) and Aydemir and Borjas (2007, 2011) document a negative impact on low-skilled natives' wages in the U.S. labor market, while Card (1990) finds no impact on wage and employment of native U.S. workers. In contrast, studies examining the macroeconomic impact of migration suggest gains can be large. Research shows that immigrants can raise productivity in host countries (Alesina, Harnoss, and Rapoport, 2016; Ortega and Peri, 2014) and emigration of less than 5 percent of the population of poor regions would lead to greater global gains than those that would result from the total elimination of policy barriers to merchandise trade and capital flows (Clemens, 2011).[2]

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At least part of the reason why studies reach different results on the impact of immigration is differences in the treatment of immigrants vis-à-vis the natives in economic models and in econometric specifications (see Peri, 2016; Card and Peri, 2016).[3] The partial equilibrium canonical models of the 1980s and 1990s assumed static labor demand and supply: they considered immigrants as a homogenous group, increasing the labor supply along a fixed downward sloping demand curve. Hence, their sole impact was reducing wages in the short run. The new general equilibrium frameworks expand the channels through which migrants can affect the receiving economy. First, they allow the economy to expand in response to the arrival of immigrants, through an increased demand for goods and services, and by investing in capital in response to a rise in the marginal product of capital. Second, they view immigrant workers as providing differentiated inputs into production (e.g., the level of education and the tasks) and offering complementarities in skills and tasks to those of natives (e.g., Peri, 2016). Natives can also adjust to the inflow of migrants either by moving toward complementary tasks/skills (e.g., supervisory or communication-intensive jobs) when migrants take up more manual or routine tasks, or by moving geographically (although empirical support for this channel is scant). Immigrants can also benefit recipient economies by enhancing innovation at the local level when immigrants are highly educated; increasing the variety of ideas and hence of goods and services supplied, reflecting the diversity of birth places of immigrants; and improving the labor force participation, especially of females, by reducing the price of non-tradable services such as childcare and housekeeping.

While the impact of immigration on the labor market has been explored extensively, studies of the macroeconomic impact of immigration on income levels of host economies are more scarce. Conceptually, immigrants can impact GDP per capita through the share of working age population in the total population (immigrants are usually younger than natives), the employment rate, and labor productivity. The main challenge of working at the macroeconomic level is addressing endogeneity issues, including those related to reverse causality. For instance, a positive correlation between immigration and GDP per capita could reflect that high income levels in host countries attract migrants, irrespective of whether migrants contribute positively to GDP per capita. Alesina, Harnoss, and Rapoport (2016) and Ortega and Peri (2014) [henceforth, AHR and OP, respectively] have pioneered work at the macroeconomic level by using a pseudo-gravity model to construct an instrument for migration. Using this approach, they find large benefits from immigration for the income per capita of host economies in a large cross-section of countries, including through a more

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[2] Besides economic arguments, Card, Dustmann, and Preston (2009) show that non-economic factors – such as concerns over compositional effects of migration – are also important in shaping perceptions of migrants. Mayda (2006) finds that wealthier, better-educated, and less-nationalistic individuals in rich countries have more favorable attitudes toward immigration.

[3] See also Dustmann, Schoenberg, and Stuhler (2016) for an explanation of the mixed results obtained by the empirical literature estimating wage effects of migration.

diverse skilled workforce where diversity is measured by country of birth. Adopting a similar approach, Aleksynska and Tritah (2015) examine the impact of the age of immigrants in a panel of 20 OECD countries. While they find that a higher share of immigrants among prime-aged workers has a positive impact on the host countries' aggregate income, a higher share of immigrants among the youth has a negative impact.

In this paper, we exploit a new panel database for advanced economies giving migrants by country of origin and level of education to re-examine the impact of immigration on income per capita. As in Aleksynska and Tritah (2015), but unlike AHR and OP, we focus on advanced economies rather than a mixed sample of advanced and lower-income host countries and use a panel data framework. Given that advanced economies are more homogenous and we control for country fixed effects, this provides a more demanding test of whether immigration affects GDP per capita. This also provides results which are more directly relevant to advanced economies, where the number of migrants has already been larger relative to the native population and income levels are higher. We address endogeneity issues by following the existing literature and use a pseudo-gravity model to predict the migration caused by "push" factors from the source economies, such as socio-economic and political conditions and by bilateral costs of migration—factors that are typically independent of host countries' income levels. We expand the standard pseudo-gravity model to generate within-country exogenous variation in the migration share, to allow identification of the effect of migration in a fixed effects panel setting. *Second*, this new panel database which has information on the level of education of migrants allows us to better test for separate impacts of high- and lower-skilled migrants on GDP per capita of host economies. *Third*, we examine the extent to which average income per capita effects are distributed across the population. Combining national accounts data on income per capita with data from the World Wealth and Income database (Alvaredo, Atkinson, Piketty and Saez), we examine the impact of migration on the income per capita of the top 10 percent earners and of the bottom 90 percent earners. We also estimate the impact on the Gini coefficient, which is a broader measure of inequality.

Our main findings can be summarized as follows. *First*, we find confirming evidence that immigration increases GDP per capita in advanced countries. The effect is significant in both statistical and economic terms. While smaller than estimates of AHR and OP, the magnitude of the effect is large: a one percentage point increase in the share of migrants in the adult population raises GDP per capita by up to two percent in the long run. This effect comes mainly through labor productivity and to a lesser extent through an increase in the ratio of working-age to total population. *Second*, both high- and lower-skilled migrants raise labor productivity, suggesting – in the case of lower-skilled migrants – that complementarity effects between immigrants and natives can be large enough to impact aggregate GDP per capita.[4] We find evidence of one possible channel of complementarity, namely that an increase in the share of low-skilled migrants tends to increase the labor force participation rate of native women, likely through greater affordability of household and childcare services. Finally, gains from immigration appear to be broadly shared in the population: an increase in the migrant share raises the average income per capita of both the bottom 90 percent and the top 10 percent earners, even though high-skilled migration raises the income share of the top 10 percent earners. The Gini coefficient, a broad measure of income inequality, is unaffected by the migrant share.

The rest of the paper is organized as follows. In the second section, we review the conceptual framework and the literature on the relationship between migration and GDP per capita and productivity. The third section documents data sources and presents some stylized facts, while the formal econometric techniques are presented in section 4. Section 5 discusses the results and section 6 concludes with policy recommendations.

2. Conceptual Framework

The literature has identified various channels through which migration can impact GDP per capita. For instance, GDP per capita can be decomposed into 3 components: labor productivity, the employment-to-working age population ratio, and the working age-to-total population ratio (with the latter two representing a simple decomposition of the employment ratio) as follows:

$$\ln\frac{GDP_{dt}}{POP_{dt}} = \ln\frac{GDP_{dt}}{EMP_{dt}} + \ln\frac{EMP_{dt}}{WA\,POP_{dt}} + \ln\frac{WA\,POP_{dt}}{POP_{dt}} \tag{1}$$

Rearranging (1):

$$\ln\frac{GDP_{dt}}{POP_{dt}} = \ln\frac{WA\,POP_{dt}}{POP_{dt}} + \ln\frac{EMP_{dt}}{WA\,POP_{dt}} + \ln\frac{GDP_{dt}}{EMP_{dt}} \tag{1'}$$

We briefly explain each of these channels:

Working age-to-total population ratio. Immigration tends to increase the ratio of working-age population to total population because migrants tend to be predominantly of working age. This in turn reduces the dependency ratio and increases GDP per capita, all else equal.

Employment-to-working age population ratio. Economic theory suggests immigration should have no effect in the long run on the average employment rate of the working-age population, because the additional demand associated with the expanded economy would offset the additional supply of workers. However, the employment rate could be lower in the short run

[4] In the context of accounting for income level differences across countries, Jones (2014) shows that complementarities between workers with different education levels can add up to large aggregate effects.

if migrants are not able to integrate in the labor market at the same rate as natives or if migrants displace native workers. The latter effect depends on the strength of substitution and complementarity effects between migrants and natives. The entry of migrants may lead natives to either (i) exit the labor force for unemployment or social welfare benefits (substitutes); or (ii) move toward more complex tasks as migrants fill in manual routine jobs (complements). The empirical evidence is mixed, with many studies finding that changes in immigration policy have no effect on the likelihood of employment for native workers (e.g., Card, 1990; Ottaviano and Peri, 2012; Peri and Sparber, 2009; Peri, Shih, and Sparber, 2014), and some finding a negative impact (e.g., Jean and Jimenez, 2007 and Ho and Shirono, 2015).

Labor productivity. Labor productivity can be further decomposed into contributions from the capital-to-labor ratio, average human capital per worker, and total factor productivity (TFP).[5] Immigration is expected to have no effect in the long run on the capital-to-labor ratio, as the initial decline in capital per worker raises the return to capital, prompting more investment until the capital-to-labor ratio returns to its long-run level (supported by findings in Ortega and Peri, 2009, AHR, and OP). The impact of immigration on average human capital will depend on the level of education of migrants relative to natives—if migrants are less educated than natives, the level of average human capital could go down as a result of migration. As for the impact of immigration on total factor productivity, a growing literature suggests that immigration can raise total factor productivity.

Both high and low skilled migrants can improve TFP, albeit through different channels. High-skill migrants tend to increase productivity in the host country, directly *through increased innovation* (e.g., patents) and indirectly through positive spillovers on native workers' wages (Hunt and Gauthier-Loiselle, 2010; Peri, Shih, and Sparber, 2014).[6] Low-skill migrants can increase productivity *through occupational reallocation and task specialization* among both immigrant and native populations (Peri and Sparber, 2009). For instance, native workers tend to move to occupations associated with more complex (e.g., abstract and communication) skills and higher status when immigrants take up the manual-routine type of jobs (Cattaneo, Fiorio, and Peri, 2015; D'Amuri and Peri, 2014). An increase in the supply of low-skilled female immigrants tends to *raise the labor supply of high-skilled native women*, by increasing the local availability of household and childcare services and reducing their price (e.g., Kremer and Watt, 2009; Farré, González, and Ortega, 2011; Cortés

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[5] For instance, assuming a standard Cobb-Douglas production function of the form $GDP_{dt} = A_{dt}(HC_{dt}EMP_{dt})^{\alpha}(K_{dt})^{1-\alpha}$, we can derive $\ln\frac{GDP_{dt}}{EMP_{dt}} = \alpha\ln HC_{dt} + (1-\alpha)\ln\frac{K_{dt}}{EMP_{dt}} + \ln A_{dt}$, where HC_{dt} is the stock human capital, K_{dt}/EMP_{dt} is the capital to labor ratio, A_{dt} is total factor productivity (TFP), and α is the labor share.

[6] However, in some cases they may have substituted for native high-skilled workers at lower wages (Doran, Gelber, and Isen, 2014).

and Tessada, 2011).[7] While much of the literature is microeconomic and focuses on one particular channel (e.g., innovation, resource reallocation), a few macroeconomic studies (e.g., AHR and OP) find evidence of a positive impact of immigration (especially of skilled workers) on GDP per capita, operating through an increase in total factor productivity, reflecting an *increased diversity in productive skills* and, to some extent, a higher rate of innovation. Aleksynska and Tritah (2015) find contrasting income effects across age groups, with prime-aged immigrants contributing to lift the host country's income per capita, but youth immigrant having a negative impact.

Building on these studies, we exploit a new panel database for advanced economies on the number of immigrants by country of origin and level of education to re-examine the impact of immigration on aggregate income per capita and the differentiated impact by skill level of immigrants. Finally, we also analyze how the potential gains in GDP per capita are distributed across the population.

3. Data

We use a new panel database for 18 advanced economies from the Institute of Employment Research (IAB) which provides information on immigrants aged 25 years and older by gender, country of origin, and educational level over the years 1980–2010 (at 5-year intervals).[8] Migration is defined according to country of birth rather than foreign citizenship since foreign citizenship changes with naturalization, and the legislation regulating the acquisition of citizenship typically differs among countries and within the same country over time. In this paper, unless otherwise indicated, migrants and population refer to individuals aged 25 and older, and the migrant share is defined as the share of adult migrants (25 and older) in adult population (25 and older). The database allows to distinguish three educational levels of immigrants: *primary* (low-skilled: includes lower secondary, primary and no schooling); *secondary* (medium-skilled: high-school leaving certificate or equivalent); and *tertiary* education (high-skilled: higher than high-school leaving certificate or equivalent).

Other data come from the Penn World Tables v8.1 (real GDP per capita, labor productivity defined as real GDP per worker, and the employment-to-population ratio); U.N. Population Projections (population by age groups); CEPII (cross-sectional variables for the pseudo-gravity model, like, distance, contiguity, official or ethnic minority common language,[9] past colonial ties); Correlates of War (civil wars); IFS (currency crises constructed

[7] Note that a large entry of low-skill immigrants could change the sectoral specialization of the economy, for instance toward lower productivity sectors, such as construction, lowering TFP.

[8] The database also has information on Chile and Luxembourg. We excluded Chile, because it is not an advanced economy, and Luxembourg because it behaved like an outlier and has less than one million inhabitants.

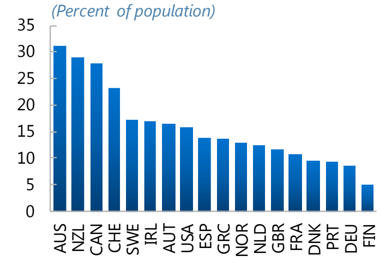
[9] Two countries are defined to have a common ethnic language if it is spoken by more than 9 percent of the population.

from a combination of exchange rate depreciation and loss in foreign exchange reserves); and Barro-Lee dataset (educational attainment of a country's population aged 25 years and older).

A few stylized facts follow from the data:

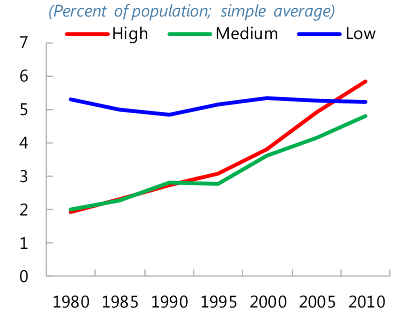
- *There is a considerable stock of migrants in advanced economies*—much larger than the small share of migrants in the world population would suggest.[10] In 2010, migrants accounted for 10 to 15 percent of the working-age population in many economies, and up to 30 percent in some Anglo-Saxon countries (Figure 1).[11]

Figure 1. Stock of Migrants, 2010
(Percent of population)



Sources: Institute for Employment Research; United Nations, World Population Prosects, The 2015 Revision; and authors' calculations.
Note: Migrants and population refer to individuals ages 25 and older.

Figure 2. Stock of Migrants by Skill
(Percent of population; simple average)



Sources: Institute for Employment Research; and authors' calculations.

- *Immigration is increasingly high- and medium-skilled*. Most of the growth in the stock of immigrants has come from high- and medium-skilled migrants over the last few decades (Figure 2), reflecting the global rise in education levels. In 2010, high-skilled migrants constituted about 6 percent of the adult population in advanced economies, while medium-skilled and low-skilled migrants each accounted for about 5 percent of the population.

- *Heterogeneity across countries among skills of migrants*. Anglo-Saxon countries tend to have a higher proportion of high-skilled migrants than continental European and Nordic countries. This likely reflects the skill-based immigration policies of several Anglo-Saxon countries, such as for example Australia and Canada (Czaika and Parsons, 2015) and possibly also the attraction of their tertiary education institutions which many migrants go to attend. In contrast, the shares of low-skilled migrants in continental Europe and medium-skilled in Nordic countries remain the highest, although high-skilled migrants have also been on the rise.

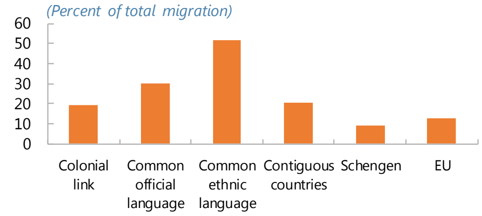
[10] Although the countries in our sample also experience emigration, including within the advanced economies in the sample, in net terms they are largely receivers, with a few exceptions, such as Ireland and Portugal, where emigration is also important. Additionally, bilateral emigration data are not available by skill level. Therefore, we focus on the impact of total immigration. Emigration can, however, be important for other countries. For instance, Atoyan and others (2016) examine the impact of emigration on Eastern Europe.

[11] For the analysis of stylized facts, we split the countries into 3 groups: Anglo-Saxons (Australia, Canada, Ireland, New Zealand, United Kingdom, and United States); Continental Europe (Austria, France, Germany, Greece, Netherlands, Spain, Portugal and Switzerland); and Nordics (Denmark, Finland, Norway, and Sweden).

- Significant *factors* affecting the choice of destination country include a common official or ethnic language, a past colonial link, a common border, and being part of the Schengen states or the European Union (Figure 3).

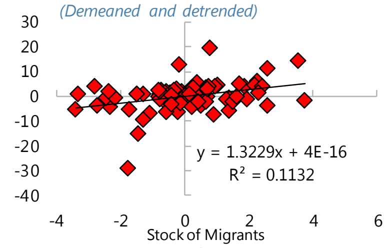
- *GDP per capita and the stock of migrants are positively correlated* (Figure 4). The two variables show a positive correlation across time and countries, even after removing country means and time fixed effects to control for possible third factors specific to the country or the time period which could create a spurious correlation.

Figure 3. Determinants of Destination Choice
(Percent of total migration)



Source: IMF, *World Economic Outlook; October 2016, Chapter 4.*

Figure 4. Log GDP per capita versus Migrant Share
(Demeaned and detrended)



Source: Institute for Employment Research; United Nations, World Population Prosects, The 2015 Revision; and authors' calculations.

Next, we investigate formally the impact of immigration on GDP per capita using econometric analysis and addressing the risk of reverse causality.

4. Empirical approach

Specification

Our empirical specification for GDP per capita is shaped by OP who motivate this specification with a multi-country model in which an increase in the variety of goods and of labor inputs increases productivity. Migration and trade can therefore increase productivity by increasing the variety of inputs in the production function. Moreover, because migration and trade across countries are costlier than migration and trade across different regions within the same country, the size of the country can potentially also increase productivity reflecting greater access to more varied inputs in larger countries. The steady-state of the model generates an empirical specification in which GDP per capita is a function of the trade and migration shares, the size of the country, and possibly other factors. We follow OP and AHR in estimating the long-run relationship between income levels and migration, using the following specification:

$$\ln y_{dt} = \beta_0 + \beta_M MSH_{dt} + \beta_S \ln S_{dt} + \beta_C Controls_{dt} + \mu_d + \theta_t + \varepsilon_{dt} \qquad (2)$$

where d is destination, t is time, MSH_{dt} is the migration share (total stock of foreign born relative to adult population), S_{dt} is the total adult population of the destination country (controlling for country size), $Controls_{dt}$ include other variables which can affect income per capita (such as the share of domestic population with high and medium skills, trade openness, and technological development, proxied here by the share of information and communication technology in the capital stock), μ_d are the destination country fixed effects, θ_t are the common time fixed effects, and ε_{dt} is the error term. We estimate equation (2) for the total share of migrants, and also differentiate between migrants with different levels of skills proxied by their educational attainment. High-skilled migrants are defined as those with tertiary education (college degree), medium-skilled with secondary school education, and low-skilled with primary or no education.

Gravity-based instrumental variables approach

To reduce the risk of reverse causality and other biases, we use a gravity model to construct instruments for migration. An ordinary least squares (OLS) estimator of equation (2) will suffer from several possible biases: (a) *endogeneity* stemming from migrants preferring richer countries; (b) *omitted variable bias*, related to unobserved determinants of the migration share correlated with income per capita; (c) *measurement error*, related to unobserved determinants of the migration share which are not correlated with income per capita. While the endogeneity bias goes in the direction of finding a larger coefficient in the OLS regression, the other two could potentially go in the opposite direction. One possible example of a bias that goes in the opposite direction is if countries tend to have stricter immigration rules or are better able to control their borders when their incomes per capita are higher, which would associate higher income per capita with lower immigration shares. Another example could be labor demand shocks, which are not observed by the econometrician, but can affect the migration share and also be directly correlated with GDP per capita (see, for instance, OP).

To construct an instrument for the migration share, we build on the approach in OP and AHR, and others, which use a gravity model for bilateral migration stocks and exploit variation in migration based on migration costs, captured by bilateral geographic and cultural characteristics.[12] This approach assumes that such costs affect GDP per capita only by affecting migration, but not directly.

A good instrument for the endogenous regressor should be strongly correlated with the migration share and uncorrelated with the error term in the second stage equation. OP and AHR mostly use cross-sectional variation of the migration share across countries to identify the impact on GDP per capita, while we exploit time variation of the migration share within each country, which is somewhat more demanding on the instrument. Therefore, we augment the OP specification with:

- a number of "push" factors, which are specific to the origin country and vary over time;

[12] Aleksynska and Tritah (2015) use census data in year 2000 and assumptions on when migration decisions were taken (before 30 years old) to match migration and origin-country data in order to construct a gravity-based instrument by cohort. Our paper uses a novel bilateral migration dataset, which allows us to specify a gravity model for overall migration stocks without any assumptions on the timing of migration decisions.

- and with interactions between the “push” factors and migration costs (specific to each origin-destination pair), which creates variation by destination country over time.

The vector of *“push” variables* includes origin country growth, dummies for currency crises and civil wars, the share of young population (25–34 years old) to capture demographic pressures on labor markets, the shares of population with tertiary and high school education, and a dummy variable for being an EU member.[13] The *migration costs* include distance between the countries, dummies for contiguity, speaking a common official or ethnic minority language, shared past colonial ties, and membership in the EU. We do not include any time-varying “pull” factors, specific to the destination country, because they could be correlated with GDP per capita at destination, invalidating our instruments.

Specifically, we estimate the following equation, which relates the bilateral migration share between origin country *o* and destination country *d* at time *t* to migration costs and “push” factors:

$$\ln MSH_{odt} = \gamma_0 + \gamma_1 \ln pop_{d1980} + \gamma_2 \ln pop_{o1980} + \gamma_3 \ln MSH_{od1980} + \gamma_4 X_{ot} + \gamma_5 Z_{od} + \gamma_6 X_{ot} Z_{od} + \delta_t + u_{odt} \quad (3)$$

where pop_{d1980} and pop_{o1980} is the initial population size at destination and origin respectively, MSH_{od1980} is the initial stock of migrants from a given origin at a given destination and captures network effects, X_{ot} is the vector of push factors, Z_{od} is the vector of geography- and culture-based migration costs, δ_t is the time fixed effects, and u_{odt} is the error term.[14]

We estimate the gravity model using two alternative methods: a standard OLS estimator for the log-linear model and a Poisson pseudo-maximum likelihood (PPML) estimator proposed by Silva and Tenreyro (2006). The PPML estimator addresses the bias arising from the log-linear transformation in the presence of heteroscedasticity (which can come from the non-negativity of migration stocks) and has the further advantage of retaining zero observations, which are omitted when applying the log transformation. Following OP, in one of the specifications we include destination country fixed effects to reduce the possible omitted variable bias in the gravity equation (since we do not include any pull factors). However, these fixed effects are not included in the prediction as they can be correlated with income in the destination country. We estimate equation (3) for the bilateral migration share including migrants of all skill levels, as well as separately for each skill level.

In the last step, we build our instruments by aggregating the gravity-based predictors

[13] The growth rate, share of young population, and share of educated population are lagged by 5 years to limit reverse causality.

[14] The time fixed effects are not used for the prediction of the migration share, except for the share of high-skilled immigrants, which shows an exponential behavior.

for bilateral migration shares over the origin countries:

$$\widehat{MSH}_{dt} = \sum_{o \neq d} \exp(\widehat{\gamma_M} M_{odt}) \qquad (4)$$

where M_{odt} is the vector of explanatory variables in equation (3) (excluding time and destination fixed effects) and $\widehat{\gamma_M}$ is the vector of estimated coefficients.

Instruments from the gravity model

The estimation of the pseudo-gravity model confirms that more adverse socio-economic conditions at the origin and lower migration costs increase the share of migrants. Table 1 reports estimates for the gravity model based on bilateral migration shares. For parsimony, the estimated coefficients on the interaction terms are not presented, but they are available on request. Columns 1-3 present estimates for the total migration share from the log-linear OLS regression, PPML and PPML with destination country fixed effects. Qualitatively the estimates are consistent between the three columns. The number of observations is quite similar in the log-linear and PPML regressions, meaning that there are few zero observations in our sample, and therefore the main differences between the OLS and PPML estimates must come from heteroscedasticity bias. The coefficient signs are mostly as expected: “push” factors associated with worse economic, political, or demographic conditions at the origin increase the migration share, as do lower geography- and culture-based migration costs. The PPML estimates with and without destination country fixed effects are quite similar, indicating that the bias coming from misspecification of the gravity model due to omitted “pull” factors is not strong.

The relative importance of various “push” factors and migration costs differs between high skilled and low and medium skilled migrants. Columns 4–6 present PPML regression estimates of the bilateral migration share by skill for high, medium and low skilled separately. Some coefficients are similar across different skill levels of migrants, like the migration share in 1980 (network effect), distance and the share of young population. Other coefficients however vary across different skill levels, suggesting that the relative importance of various “push” factors and migration costs varies by skill. For example, per capita income in 1980 reduces significantly medium and low skilled migration, but is not important in predicting high skilled migration. In a similar manner, common border (contiguity), colonial ties, EU membership, and the share of population with high education at origin seem to have a stronger impact on low and medium skilled migration, while for high skilled common language matters more. Based on the similarity of low and medium skilled coefficients, we aggregate the low and medium skilled migration shares into one variable when constructing predicted migration shares by destination.

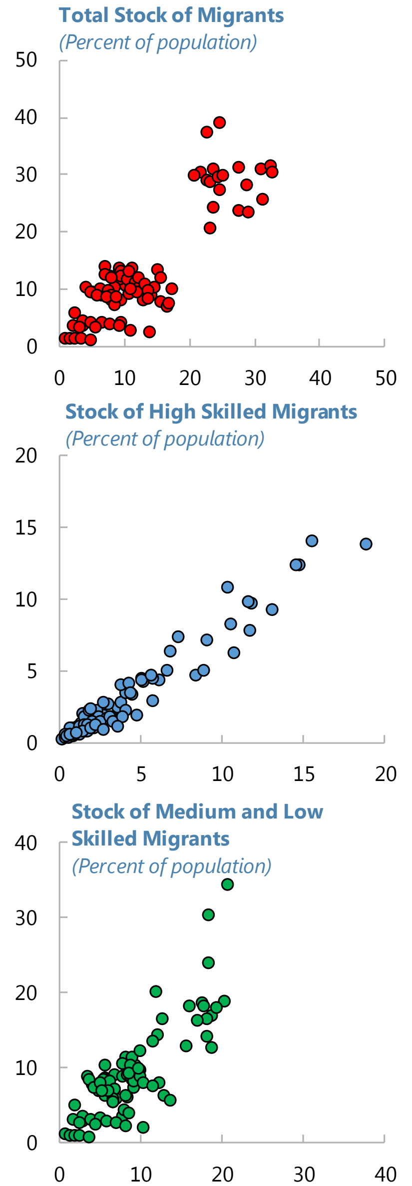
Table 1
Gravity model for bilateral migration share

	(1)	(2)	(3)	(4)	(5)	(6)
	Total MSH	Total MSH	Total MSH	High skilled MSH	Medium skilled MSH	Low skilled MSH
	OLS	PPML	PPML FE	PPML	PPML	PPML
Ln pop at dest 1980	-0.52***	-0.55***	-0.16	-0.56***	-1.03***	-0.27
	(-4.967)	(-4.301)	(-1.095)	(-3.753)	(-6.392)	(-1.580)
Ln pop at origin 1980	-0.08	-0.78***	-0.63***	-0.67***	-1.22***	-0.38**
	(-0.926)	(-6.155)	(-4.483)	(-4.584)	(-6.868)	(-2.015)
Ln income pc at origin 1980	-0.60**	-1.51***	-1.48***	-0.59	-2.64***	-2.30***
	(-2.335)	(-3.544)	(-3.999)	(-1.579)	(-4.686)	(-5.585)
Ln MSH in 1980	0.75***	0.77***	0.80***	0.72***	0.74***	0.85***
	(89.874)	(74.864)	(66.451)	(62.873)	(37.121)	(69.432)
Contiguity	1.44***	0.66	0.47	-0.12	0.63	1.17***
	(4.407)	(1.572)	(1.444)	(-0.367)	(1.145)	(2.901)
Ln distance	-0.33***	-0.36***	-0.35***	-0.33***	-0.62***	-0.25***
	(-11.930)	(-7.950)	(-7.289)	(-7.135)	(-9.316)	(-4.924)
Common ethnic language	0.43***	0.15**	0.08	0.21***	0.16	-0.02
	(11.513)	(2.080)	(1.119)	(2.985)	(1.358)	(-0.232)
Colony	0.24***	-0.12	0.01	0.15*	-0.43***	-0.10
	(4.282)	(-1.383)	(0.110)	(1.951)	(-2.808)	(-0.870)
EU origin	-0.11***	-0.26***	-0.40***	-0.16***	-0.09	-0.32***
	(-2.781)	(-4.878)	(-7.031)	(-2.817)	(-1.264)	(-4.318)
EU origin&destination	-0.00	-0.22	0.08	-0.77***	-0.83**	0.14
	(-0.015)	(-0.974)	(0.381)	(-3.338)	(-2.356)	(0.624)
Cumul 5-year growth (lag)	0.11	0.09	0.11	0.04	0.17	0.16
	(1.169)	(0.539)	(0.699)	(0.276)	(0.896)	(0.845)
Share of young pop (lag)	0.05***	0.03***	0.03***	0.03***	0.03***	0.04***
	(8.299)	(3.133)	(3.591)	(2.990)	(2.898)	(4.238)
Currency crisis	-0.01	-0.09	-0.11	0.01	0.02	-0.13
	(-0.108)	(-1.258)	(-1.553)	(0.172)	(0.253)	(-1.234)
Civil war	0.45***	0.12	0.23**	-0.21*	0.11	0.16
	(6.709)	(1.276)	(2.427)	(-1.708)	(0.820)	(1.320)
Ln of high skilled sh (lag)	0.04*	-0.12**	-0.10*	-0.09*	-0.20**	-0.32***
	(1.681)	(-2.153)	(-1.744)	(-1.673)	(-2.428)	(-4.903)
Ln of med skilled sh (lag)	0.13***	-0.00	-0.01	0.08**	0.02	-0.12***
	(4.979)	(-0.044)	(-0.366)	(2.188)	(0.361)	(-3.012)
Interaction terms:						
"push" factors*migr costs	Yes	Yes	Yes	Yes	Yes	Yes
Destination fixed effects	No	No	Yes	No	No	No
Observations	5,640	5,689	5,689	5,401	5,382	5,502
R-squared	0.887					

Note: All models include a constant term and a full set of interactions between the "push" factors and migration costs (reported in the Appendix). The migration share (MSH) is defined as the number of foreign born in the country over total population over 25 years old. The fixed-effects specification includes destination country fixed effects (not reported), which are not used however in building the predicted MSH. Robust t-statistics are reported in parentheses. Confidence levels: *** p<0.01, ** p<0.05, * p<0.1.

Overall, we find a strong positive correlation between the actual stock of migrants and the gravity-predicted variable (constructed based on equation 4), both for the total stock and by skill level, suggesting that gravity-based instruments are successful in explaining migration (Figure 5).

Figure 5. Instrumental Variables versus Stock of Migrants



Source: Institute for Employment Research; United Nations, World Population Prosects, The 2015 Revision; and authors' calculations.

5. **Empirical results**:

Effect on GDP per capita

Our empirical approach is to estimate the model from equation (2) in levels—following OP and AHR—because we are interested in the long-run relationship between income per capita and migration. We have a short time dimension in the panel—5 time periods—and our observations are spaced at five-year intervals, which should attenuate the problem of serial correlation. We report t-statistics with the standard correction for heteroscedasticity, but our results do not change when using a correction for autocorrelation of error terms or for within-country correlation.

All specifications include country and time fixed effects, the education level of host country's population, and population size at the destination country. Because, by construction, the latter includes migrants, it also suffers from a potential endogeneity bias and is instrumented with native population, in addition to our instrument for the migrant share. Table 2 reports estimates of equation (2). Column 1 shows the OLS estimate, while columns 2 to 5 report two-stage least squares (2SLS) estimates. The coefficient on the migration share is significantly positive and robust across all specifications using instrumental variables. The OLS estimate, while positive, is not statistically significant and is smaller than 2SLS estimates. The fact that the coefficient increases and becomes significant with 2SLS suggests that the omitted variable and measurement error biases discussed earlier might be stronger than the endogeneity bias.

Table 2
The effect of migration on GDP per capita

	(1) Log GDP per capita	(2) Log GDP per capita	(3) Log GDP per capita	(4) Log GDP per capita	(5) Log GDP per capita
	Baseline OLS	Baseline IV	Overident IV	Control for technology and trade	Excl. USA, CAN, AUS, NZL
Migr share	0.78	1.79***	1.86***	2.07**	1.61*
	(1.172)	(2.596)	(2.615)	(2.179)	(1.929)
Ln pop	0.43	0.50*	0.50*	0.58**	0.33
	(1.194)	(1.738)	(1.733)	(2.057)	(0.930)
Share of pop high skilled (BL)	0.41	0.34	0.34	0.27	0.66*
	(1.549)	(1.564)	(1.554)	(1.195)	(1.924)
Share of pop medium skilled (BL)	0.07	0.14	0.14	0.17	0.12
	(0.503)	(1.066)	(1.073)	(1.158)	(1.063)
Trade openness (lagged)				0.31**	
				(2.316)	
Ln of the share of ICT in the capital stock				0.08*	
				(1.727)	
Observations	90	90	90	90	70
R-squared	0.881	0.870	0.868	0.881	0.873
Number of destinations	18	18	18	18	14
First stage regression					
Excluded instruments		MSH Ln nat pop	MSH Ln nat pop Maastricht	MSH Ln nat pop	MSH Ln nat pop
Underidentification test P-val		0.000984	0.00415	0.0034	0.00619
Kleibergen-Paap rk Wald F stat		13.30	8.957	7.42	13.75
Stock-Yogo 10% max IV size		7.03	13.43	7.03	7.03
Stock-Yogo 15% max IV size		4.58	8.18	4.58	4.58
Hansen J stat P-val			0.434		

Robust t-statistics are reported in parentheses. Confidence levels: *** p<0.01, ** p<0.05, * p<0.1. MSH denotes the gravity-predicted migration share. ICT denotes information and communication technologies. All regressions include country and time fixed effects. Instrument for MSH is based on a gravity model estimated with PPML estimator.

Statistical tests confirm that the PPML pseudo-gravity instrument is strongly positively correlated with the migrant share. The under-identification test rejects the null hypothesis that the equation is under-identified, i.e. that the matrix of first-stage slope coefficients is not full-rank. In addition, the Kleinbergen-Paap (KP) F statistics is above the Stock and Yogo critical values, suggesting that the instruments are strong. To test the overidentifying restrictions—i.e. that the instruments are not correlated with error term in equation (2)—we need more instruments than endogenous variables. Therefore, we introduce in column 3 a second instrument for the migrant share, a dummy variable which captures the years in which the Maastricht treaty was in force in each country. The Hansen statistics fails to reject the null hypothesis, confirming that our instruments are valid. We discuss in the robustness section below further tests of the validity of our instruments.

The magnitude of the estimated effect of the migration share on GDP per capita is economically sizable. Our estimates suggest that an increase in the migration share by 1 percentage point can raise GDP per capita in the long run by up to 2 percent. While large in economic terms, our estimate is comparable to a study by the U.S. President's Council of Economic Advisors (CEA, 2014)[15] but considerably lower than those found in the previous literature. For example, OP, in a cross-sectional setting, find that a country with a migration share 10 percentage points higher than in another country would have twice as high a long-run level of income. Factors possibly explaining these differences include our more homogeneous group of countries with smaller differences in GDP per capita and—even more importantly—that we focus on within-country variation in the migration share over time rather than cross-country variation. Indeed, the use of country fixed effects embedded in our panel approach offers a very powerful additional control for any time-invariant country characteristic that might otherwise impact the estimated migration effects.

Robustness of the main result

The results are robust to additional control variables and alternative instruments. We further explore the strength and validity of the main instrument. Below, we discuss each aspect in turn.

Robustness to additional control variables:

- In addition to the controls in the main specification, column 4 of Table 1 includes additional control variables which can have a significant impact on GDP per capita. These variables include the share of information and communication technologies (ICT) in the total capital stock used as a proxy for technological development and the sum of a country's imports and exports in percent of GDP, corrected for the country's population size, as a measure of trade openness (another dimension of a country's openness which could be correlated to the migration share).[16] We find evidence that both technology and trade openness contribute positively to GDP per capita, but the result for the migration share remains robust.

- The result on migration is also robust to the inclusion of other controls capturing policy variables, such as a financial reform index, union density, employment

[15] This study finds estimates of the semi-elasticity of output per worker to high-skilled immigration that are of a similar magnitude to ours, based on a bottom-up approach relying on the literature's estimates of the effects of high-skilled immigration on TFP, hours supplied per workers, skill composition of the workforce and capital intensity.

[16] Trade openness is measured as the residual from a regression of the trade ratio (the sum of exports and imports divided by GDP) on total population (a measure of country size). Data for trade are from the IMF's World Economic Outlook, while data for the share of ICT capital in the total capital stock are from Jorgenson and Vu (2011).

protection, the level of unemployment benefits, and the marginal tax rate for top earners (available upon request).

- Finally, following OP, column 5 tests robustness to excluding the four "young" and rich countries (US, Canada, Australia, and New Zealand). These are also the countries which were created through migration and have high income levels. The coefficient on the migration share is similar in magnitude to the baseline 2SLS specification and is significant.

Robustness to additional instrument tests and alternative instruments:

- Because Stock Yogo critical values are valid only when the error terms are identically and independently distributed (which may not be the case), we construct weak-instrument consistent confidence sets for robustness. Having just one endogenous variable makes this easier to do. Therefore, we replace population size – which was instrumented by the native-born population – directly by the native-born population. Results are presented in columns 1 and 2 of Table 3. Weak-instrument consistent confidence intervals based on the Anderson Rubin (AR) statistic, conditional likelihood ratio (CLR) statistic, and a combination of the Lagrange multiplier test and the over-identification test (K-J) are reported at the bottom of the table and are all strictly positive, confirming the positive effect of migration on GDP per capita.

- The pseudo-gravity instrument for the migrant share was constructed exclusively using factors which are independent of host country's income levels, therefore minimizing the risk that the instrument is correlated with the error term. However, one component of our instrument could be of concern—lagged growth in source countries in principle, could be correlated with current or past shocks to the host country's income level, for example, if the host and source countries share a common business cycle. To gauge the relevance of this possible effect, we run a regression of the instrument on lagged source country growth interacted with geographical and cultural distance between host and source countries (not reported). It suggests that this variable explains very little of the variation in our instrument, after country and time fixed effects are controlled for, dispelling concerns.

- Columns 3–5 of Table 3 use alternative instruments based respectively on a PPML estimator with destination country fixed effects (included in the pseudo-gravity model but not in the prediction of bilateral migration shares), an OLS estimator for the gravity model in logs, and an OLS estimator for the log-model with destination country fixed effects (included in the pseudo-gravity model but not in the prediction of bilateral migration shares). These instruments are also strong, and the coefficient of the migrant share remains similar in size and statistically significant.

Table 3
The effect of migration on GDP per capita: robustness

	(1) Log GDP per capita Weak IV test	(2) Log GDP per capita Weak IV test overident	(3) Log GDP per capita FE gravity IV	(4) Log GDP per capita Log gravity IV	(5) Log GDP per capita Log FE gravity IV
Migr share	2.30***	2.37***	1.64**	2.38***	2.19***
	(3.217)	(3.189)	(2.423)	(3.033)	(2.640)
Ln pop (Ln nat pop in (1) and (2))	0.50*	0.50*	0.49*	0.52*	0.51*
	(1.748)	(1.747)	(1.719)	(1.734)	(1.743)
Share of pop high skilled (BL)	0.34	0.33	0.35	0.31	0.32
	(1.578)	(1.568)	(1.620)	(1.307)	(1.368)
Share of pop medium skilled (BL)	0.13	0.13	0.13	0.17	0.16
	(1.049)	(1.061)	(1.009)	(1.241)	(1.193)
Observations	90	90	90	90	90
R-squared	0.872	0.870	0.873	0.853	0.859
Number of destinations	18	18	18	18	18
First stage regression					
Excluded instruments	MSH	MSH Maastricht	MSH Ln nat pop	MSH Ln nat pop	MSH Ln nat pop
Estimator for the gravity model	PPML	PPML	PPML	OLS	OLS
Underidentification test P-val	0.00118	0.00488	0.000297	0.0221	0.0202
Kleibergen-Paap rk Wald F stat	26.80	13.57	12.56	10.41	9.759
Stock-Yogo 10% max IV size	8.96	19.93	7.03	7.03	7.03
Stock-Yogo 15% max IV size	4.58	11.59	4.58	4.58	4.58
Hansen J stat P-val		0.443			
Weak IV 95% confindence set					
AR-based confidence set	[0.80, 4.32]	[0.22, ...]			
CLR-based confidence set		[0.46, 4.75]			
K-J-based confidence set		[0.39, 5.05]			

Robust t-statistics are reported in parentheses. Confidence levels: *** p<0.01, ** p<0.05, * p<0.1. MSH denotes the gravity-predicted migration share. ICT denotes information and communication technologies. All regressions include country and time fixed effects.

Effect on productivity and employment

In line with equation (1), we decompose the log of GDP per capita into the employment-to-working age population ratio and labor productivity—ignoring the impact on the working age-to-total population ratio, which is mechanical and comes directly from the differences in demographic structures of natives and migrants. Columns 1 and 2 in Table 4 summarize the results for the decomposition into the employment ratio and productivity. The positive effect of the migration share on GDP per capita operates mainly through labor productivity. The migration share has a positive and significant effect on labor productivity, while the impact on employment is negative but statistically insignificant. The next columns (3 to 5) present further robustness checks. The positive impact of the migration share on productivity is robust to excluding the four "young," rich countries, controlling for technology and trade openness, and using a PPML estimator with destination country fixed effects.

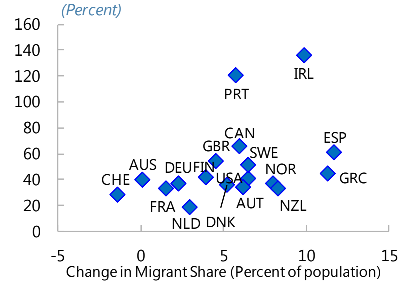
Table 4
The effect of migration on employment ratio and labor productivity

	(1)	(2)	(3)	(4)	(5)	(6)
	Log Employment per WA pop	Log Labor Productivity	Log Labor Productivity	Log Labor Productivity	Log Labor Productivity	Log Labor Productivity
	Baseline IV	Baseline IV	Excl. USA, CAN, AUS, NZL	Control for technology and trade	FE gravity IV	Control for age structure
Migr share	-0.86	1.95***	1.59**	2.97***	1.77***	3.20***
	(-1.500)	(2.791)	(2.530)	(3.046)	(2.591)	(2.952)
Ln pop	0.07	0.06	-0.17	-0.07	0.05	0.18
	(0.330)	(0.216)	(-0.616)	(-0.242)	(0.186)	(0.683)
Share of pop high skilled (BL)	-0.00	0.32	0.74**	0.37	0.33	0.16
	(-0.008)	(1.336)	(1.975)	(1.413)	(1.407)	(0.479)
Share of pop medium skilled (BL)	-0.05	0.12	0.10	0.06	0.11	0.35**
	(-0.658)	(1.016)	(1.049)	(0.426)	(0.943)	(2.282)
Additional controls	No	No	No	ICT in capital Trade open (lag)	No	Age structure
Observations	90	90	70	85	90	90
R-squared	0.148	0.821	0.847	0.788	0.830	0.783
Number of destinations	18	18	14	17	18	18
First stage regression						
Excluded instruments	MSH Ln nat pop	MSH Ln nat pop	MSH Ln nat pop	MSH Ln nat pop	MSH Ln nat pop	MSH Ln nat pop
Underidentification test P-val	0.000984	0.000984	0.00619	0.00338	0.000297	0.00797
Kleibergen-Paap rk Wald F stat	13.30	13.30	13.75	7.420	12.56	5.489
Stock-Yogo 10% max IV size	7.03	7.03	7.03	7.03	7.03	7.03
Stock-Yogo 15% max IV size	4.58	4.58	4.58	4.58	4.58	4.58

Robust t-statistics are reported in parentheses. Confidence levels: *** p<0.01, ** p<0.05, * p<0.1. MSH denotes the gravity-predicted migration share. ICT denotes information and communication technologies. All regressions include country and time fixed effects. Instrument for MSH is based on a gravity model estimated with PPML estimator.

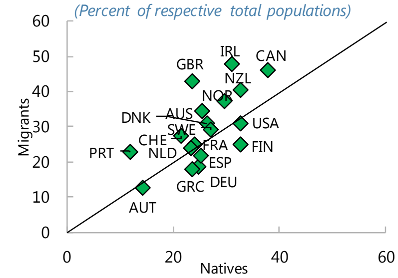
The positive productivity effect of migration suggests no major physical or human capital dilution effects are at work *on average*. While the capital stock is notoriously difficult to measure, Figure 6 suggests that there is no relationship between the long-term growth in the capital-to-labor ratio and the change in the migrant share, consistent with investment adjusting over time to a larger pool of potential workers. In addition, the share of high-skilled migrants is higher than the share of high-skilled natives in many countries, suggesting that migration is not systematically associated with human capital dilution (Figure 7). The literature discussed in section 2 suggests that the positive productivity effect comes from increased TFP through diversity of skills and ideas, and skill complementarity. An alternative hypothesis would be that migrants increase productivity because they are typically younger than natives, on the assumption that younger people have more new ideas or are more open to change. For example, Aiyar, Ebeke, and Shao (2016) show that population aging is associated with declines in

Figure 6. Growth of Capital to Labor Ratio versus Immigration, 1990-2010
(Percent)



Sources: Institute for Employment Research; United Nations, World Population Prosects, The 2015 Revision; Penn World Tables v. 8.1; Organisation for Economic Co-operation and Development; and authors' calculations.

Figure 7. High Educated: Migrants versus Natives, 2000
(Percent of respective total populations)



Sources: Institute for Employment Research; United Nations, World Population Prosects, The 2015 Revision; Penn World Tables v. 8.1; Organisation for Economic Co-operation and Development; and authors' calculations.

productivity. On the other hand, Feyrer (2007) finds that it is the very young workforce that might be associated with low productivity levels. To control for potential demographic effects, we include the age structure of the population in the regression for labor productivity and find that the results are robust, suggesting that the positive impact of migrants goes beyond their impact on the age structure of the population (column 6 of Table 4).

Effect by skill level of the migrants

To further explore the transmission channels of migration, we look at the impact of migrants by skill level. Results using our main instruments (PPML) are reported in columns 1–4 of Table 5.[17] Both high- and low-skilled migrants contribute to raising productivity. The coefficient for the impact of high-skilled migrants on GDP per capita is similar to the coefficient for low-skilled migrants and statistically there is no difference between the two, even though the high-skilled coefficient is imprecisely estimated. Both types of migrants have no significant impact on the employment ratio (column 2) but have a positive impact on labor productivity of similar magnitude (column 3). Results for productivity are broadly robust when using the PPML instrument with destination dummy fixed effects (column 4). There is some country heterogeneity in the effects of high- and lower-skilled migrants on labor productivity, possibly reflecting that these effects can vary with the initial skill composition of the native population.[18]

The lack of a statistically significant difference between the impact of high- and low-skilled workers on productivity could be due to different factors. For instance, it could reflect country heterogeneity if the effect of high- and low-skilled migrants varies with the initial skill composition of the native population—some countries might be more in need of high-skilled migrants while others might have shortages of low-skilled workers. But it could also reflect an “over-qualification” of migrants, to the extent that a larger fraction of high-skilled migrants works in lower-skilled occupations compared to high-skilled natives. Benchmarking against natives (to account for country-specific effects), Continental Europe and Nordic countries, in particular, have a higher proportion of highly educated migrants (relative to natives) that are employed in less-skilled occupations, in addition to having lower shares of

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[17] Our main instruments are strongly correlated with the respective migration shares as indicated by tests presented at the bottom of Table 5. To test the null hypothesis of jointly weak instruments, one would typically use the Kleinbergen-Paap F test. The F statistic from this test is compared to the Stock and Yogo (2005) critical values. Since these values are not available for the case of three endogenous variables and three excluded instruments, we cannot do a formal test of jointly weak instruments. However, for our main instruments the KP F stat is above the rule-of-thumb value of 10. The Angrist-Pishke test evaluates whether each endogenous regressor is identified. The F statistic from this test is well above the Stock and Yogo critical values for a single regressor, indicating that our instruments for the migration share are strong.

[18] In particular, countries which had the largest increase in either high-skilled migrants (Canada) or lower-skilled migrants (Spain) appear to be outliers. However, when both are excluded, our results are broadly confirmed.

high-skilled immigrants.[19] In contrast, the opportunities for migrants and natives with high education tend to be similar in Anglo Saxon countries, likely reflecting programs to attract highly educated migrants, and hence potentially better skill recognition. While these discrepancies between high-skilled migrants and natives may partly reflect a lack of equivalence of degrees between origin and host countries, they could also reflect hurdles related to skill recognition or implicit discrimination against immigrants—all of which translate into a missed opportunity for the host country.[20]

Table 5
The effect of migration on GDP per capita, employment ratio and labor productivity by skill

	(1) Log GDP per capita Baseline IV	(2) Employment per WA pop Baseline IV	(3) Log Labor Productivity Baseline IV	(4) Log Labor Productivity FE gravity IV	(5) Natives female LF participation Baseline IV	(6) Natives female LF participation FE gravity IV
Migr share, high skilled	2.10	0.13	2.53*	2.20	-0.15	-0.11
	(1.610)	(0.168)	(1.869)	(1.473)	(-0.141)	(-0.080)
Migr share, low and medium skilled	1.90***	-0.64	1.80***	1.80***	1.68**	1.39
	(3.011)	(-1.443)	(2.702)	(2.763)	(2.210)	(1.549)
Ln pop	0.49	0.04	0.01	0.03	0.30	0.29
	(1.530)	(0.185)	(0.033)	(0.095)	(1.372)	(1.289)
Share of pop high skilled (BL)	0.32	-0.10	0.24	0.28	0.22	0.20
	(1.143)	(-0.428)	(0.784)	(0.868)	(1.237)	(0.980)
Share of pop medium skilled (BL)	0.14	-0.03	0.12	0.11	-0.04	-0.03
	(1.170)	(-0.390)	(1.171)	(1.118)	(-0.527)	(-0.511)
Observations	90	90	90	90	51	51
R-squared	0.866	0.193	0.825	0.827	0.508	0.529
Number of destinations	18	18	18	18	17	17
First stage regression						
Excluded instruments	MSH high MSH lowmed Ln nat pop	MSH high MSH lowmed Ln nat pop	MSH high MSH lowmed Ln nat pop	MSH high MSH total Ln nat pop	MSH high MSH lowmed Ln nat pop	MSH high MSH total Ln nat pop
Underidentification test P-val	0.000324	0.000324	0.000324	0.000371	0.00625	0.00413
Kleibergen-Paap rk Wald F stat	12.41	12.41	12.41	7.561	3.535	3.689
Angrist-Pishke F-test for MSH high	41.59	41.59	41.59	24.31	13.42	13.12
Angrist-Pishke F-test for MSH lowmed	40.33	40.33	40.33	28.31	15.61	27.69
Stock-Yogo 10% max IV size for single regressor	22.30	22.30	22.30	22.30	22.30	22.30
Stock-Yogo 15% max IV size for single regressor	12.83	12.83	12.83	12.83	12.83	12.83

Robust t-statistics are reported in parentheses. Confidence levels: *** p<0.01, ** p<0.05, * p<0.1. MSH denotes the gravity-predicted migration share. ICT denotes information and communication technologies. All regressions include country and time fixed effects. Instrument for MSH is based on a gravity model estimated with PPML estimator.

At the same time, it is also the case that low- and medium-skilled migrants can enhance the country's aggregate labor productivity if their skills are complementary to those of natives, if they encourage natives to add to their own education and seek higher-skilled

[19]Lower-skilled occupations include: (i) medium-skilled occupations, such as clerks, service workers, shop and market sales workers, skilled agricultural and fishery workers, crafts and related trades workers, and plant and machine operators and assemblers; and (ii) low-skilled occupations, such as selling goods in streets, door keeping, cleaning, washing, providing labor services in fields of mining, agriculture and fishing, construction, and manufacturing. High-skilled occupations include professionals and technicians that increase the existing stock of knowledge.

[20] See Oreopoulos (2011) and Kaas and Manger (2010) for evidence of discrimination against immigrants in Canada and Germany, respectively.

employment, or if they raise the labor supply of high-skilled native women by increasing the availability of household and childcare services. We test this last hypothesis using regression analysis, which is presented in columns 5 and 6 of Table 5. The results support a positive and significant impact of low-skilled migration on the native female labor force participation of host countries. As expected, the effect of high-skilled migrants on the native female labor force participation is not significantly different from zero. The country heterogeneity mentioned above suggests, however, that we should be careful about generalizing our results to all countries, as a large entry of low-skilled migrants in a country which already has a high share of low-skilled natives may not raise labor productivity, consistent with a lack of complementarity between the skills of migrants and natives. For example, Spain, which appears to be one of the outliers in our sample, has one of the highest shares of low-skilled population and nevertheless attracted a large influx of low-skilled migrants in the construction sector.

Distribution of gains

Beyond the aggregate impact of migration on income per capita, it is also important to examine how migration affects the income per capita of various subgroups of the domestic population. Using data from the World Top Incomes Database on income shares of the top 10 percent and bottom 90 percent earners, we construct a proxy for the average income per capita of these two groups.[21] Results are presented in Table 6. Column 1 replicates the baseline instrumental variables estimation, controlling for trade and technology, on the sample for which data on the income shares is available, confirming our previous results. Using the same regression model, the results for the impact of the migrant share on GDP per capita for the bottom 90 and the top 10 percent are presented in columns 2 and 4, respectively. Migration increases income per capita for both the top 10 and bottom 90 percent of earners, even though the gain is larger for the richest decile. Low and medium skilled migration increases income per capita to a similar extent for the top earners and for the rest of the population, not affecting the respective shares of income in a significant way (columns 3 and 5). While high-skilled migration also impacts positively the income per capita of both groups, it seems to have a larger positive impact on incomes at the top, decreasing the share of income earned by the bottom 90 percent of population.[22] Finally, the effect of the migration shares on the Gini coefficient, which effectively captures changes below the 9th decile of the income distribution, is not significant, suggesting that the distribution within the bottom 90 percent is not impacted substantially.

[21] Income shares data are based on tax returns, which do not cover all the income produced in the economy. To get a sense of the impact of migration on GDP per capita for the bottom 90 and the top 10 percent earners, it is assumed that the distribution of GDP is broadly similar to that of income covered by tax returns.

[22] The results are robust to the inclusion of additional controls capturing policy variables, such as a financial reform index, union density, and the marginal tax rate for top earners.

Table 6
Distribution of gains from migration

	(1) Log GDP per capita	(2) Log GDP per capita of the bottom 90% of population	(3) Income share of the bottom 90% of population	(4) Log GDP per capita of the top 10% of population	(5) Income share of the top 10% of population	(6) Gini coeffcient (based on market income)
Migr share, high skilled	3.84***	2.48*	-1.36**	5.80***	1.96	0.81
	(2.785)	(1.830)	(-2.007)	(2.720)	(1.583)	(0.648)
Migr share, low and medium skilled	2.48**	2.23**	-0.24	2.81**	0.33	0.12
	(2.442)	(2.198)	(-0.540)	(1.965)	(0.457)	(0.184)
Ln pop	0.48	0.70**	0.22**	-0.06	-0.54**	-0.26
	(1.629)	(2.536)	(2.099)	(-0.141)	(-2.525)	(-1.251)
Share of pop high skilled (BL)	0.06	0.03	-0.04	0.22	0.16	0.34
	(0.240)	(0.096)	(-0.296)	(0.511)	(0.599)	(1.362)
Share of pop medium skilled (BL)	0.17	0.16	-0.01	0.14	-0.03	-0.06
	(1.195)	(1.053)	(-0.147)	(0.627)	(-0.211)	(-0.793)
Additional controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	79	79	79	79	79	79
R-squared	0.863	0.819	0.462	0.824	0.488	0.355
Number of destinations	16	16	16	16	16	16
First stage regression						
Excluded instruments	MSH high MSH lowmed Ln nat wa pop	MSH high MSH lowmed Ln nat wa pop	MSH high MSH lowmed Ln nat wa pop	MSH high MSH lowmed Ln nat wa pop	MSH high MSH lowmed Ln nat wa pop	MSH high MSH lowmed Ln nat wa pop
Underidentification test P-val	0.00106	0.00106	0.00106	0.00106	0.00106	0.00107
Kleibergen-Paap rk Wald F stat	6.925	6.925	6.925	6.925	6.925	6.926
Angrist-Pishke F-test for MSH high	47.61	47.61	47.61	47.61	47.61	47.61
Angrist-Pishke F-test for MSH lowmed	23.26	23.26	23.26	23.26	23.26	23.26
Stock-Yogo 10% max IV size for single regressor	22.30	22.30	22.30	22.30	22.30	22.30
Stock-Yogo 15% max IV size for single regressor	12.83	12.83	12.83	12.83	12.83	12.83

Robust t-statistics are reported in parentheses. Confidence levels: *** p<0.01, ** p<0.05, * p<0.1. MSH denotes the gravity-predicted migration share. ICT denotes information and communication technologies. All regressions include country and time fixed effects. Instrument for MSH is based on a gravity model estimated with PPML estimator. All regressions additionally control for the share of ICT in total capital stock and lagged trade openness.

Our findings lend support to the complementarity effect of migration. The results that low and medium skilled migration increases equally income per capita for the bottom 90 percent and the top 10 percent suggests that it benefits the population at large, along the complementarity channels highlighted in the microeconomic literature. In contrast, the finding that high-skilled migration benefits more the top 10 percent than bottom 90 percent could reflect a higher earnings potential of high-skilled migrants who fall within the top 10 percent than of high-skilled natives; stronger positive spillovers from high-skilled migrants to high-skilled natives than to lower-skilled natives; or, the substitution of lower-wage high-skilled migrants for high-skilled natives, which increases capital income and top earners' income (e.g., Doran, Gelber, and Isen, 2014). Disentangling these three hypotheses is, however, beyond the scope of this paper.

6. Conclusions

While influxes of migrants can present challenges for host countries, our results suggest that there are long-term benefits from immigration, in terms of higher GDP per capita for recipient countries. The benefits appear to be broadly shared across the population, even though high-skill migration tends to benefit more the top earners. Moreover, both high- and low-skilled migrants can contribute to increase GDP per capita. For lower-skilled migrants, the benefits likely stem from the complementarity with the skills of natives. Such complementarities are more likely in fast aging societies with rising education levels, where shortages are bound to occur in certain parts of the economy, for example, in non-tradable low-skilled services, for which imports cannot substitute. Our estimates of a sizable impact of immigration on GDP per capita also suggest that the fiscal benefits from immigration could be larger than typically estimated, since static estimates of net fiscal gains, which calculate the difference between immigrants' tax and social security contributions and their receipt of social security benefits and government services, typically do not consider the indirect effects of immigration on the aggregate productivity of the economy. However, the labor market integration of migrants is critical to secure GDP per capita gains and benefits for public finances.

We see several promising paths for future research. Examining the key sources of complementarities between natives and migrants at the macroeconomic level would usefully supplement the microeconomic empirical evidence and provide a better understanding of the significant productivity impact of immigration. A closer investigation of the inequality impact of immigration, for instance using data from income surveys which allow more granular distinction between different categories of income earners (e.g., by deciles), could also be a fruitful area for further research. Finally, while our data mostly cover economic migrants, a similar analysis for refugees could enhance our understanding of the economic impact of refugees vis-à-vis economic migrants.

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