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IMPACT OF MIGRATION

on Income Levels in Advanced Economies

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Editor's note

(December 23, 2016)

The online version of this note has been revised as follows:

- Some changes have been made to the final paragraph on page 1, and to the final bullet point on page 3, to incorporate information regarding a related study.
- The related study has been added to the References list on page 20.

IMPACT OF MIGRATION ON INCOME LEVELS IN ADVANCED ECONOMIES

This note 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 1 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.

Introduction

Migration has become a macro-critical policy issue. While the recent refugee surge has brought attention to this issue, there is already a large and growing population of migrants living in advanced economies, and migration continues to be on the rise. This suggests migrants have a potentially significant impact on their host countries' economic well-being. However, migration is a politically difficult issue and the rhetoric surrounding it has turned more negative in recent years, with speculations that migration can be an unfavorable phenomenon for the receiving economies. A careful examination of the impact of migration on host economies is thus critical.

Focusing on the economic impact, most of the academic discussion has centered on the effect of migration on labor markets and public finances. On the one hand, young and dynamic migrants can add to the labor force and help sustain the public finances in the face of aging populations in advanced economies (Clements and others, 2015). On the other hand, migrants may not be able to integrate into the labor market at the same rate as natives or they might displace native workers. This could add pressure on social security systems and possibly create social tensions, related to differences in culture and language, which may prompt a political backlash against immigration.[1]

Much less is known about the long-term impact of immigration on the GDP per capita (or the standard of living) of host economies. Immigration can impact GDP per capita in two ways. *First*, it can increase the share of working-age people in the total population, because migrants tend to be predominantly of working age. This effect will be the largest where migrants integrate quickly into the labor market (Aiyar and others, 2016). *Second,* it can impact productivity per worker. Most countries wish to attract highly educated migrants because the benefits associated with their high productivity seem straightforward. But low- and medium-skilled migrants could potentially also contribute to aggregate productivity, to the extent that their skills are complementary to those of natives. Existing microeconomic studies point to complementarities and positive productivity effects from both high- and low-skilled migrants. Estimating the effects at the macroeconomic level is more difficult due to endogeneity issues, but a few macroeconomic studies suggest large benefits for the income per capita of host economies, including through a more diverse workforce (Alesina, Harnoss, and Rapoport, 2016; Ortega and Peri, 2014). A positive long-term impact of immigration on GDP per capita would be a strong argument in favor of immigration, in particular for countries undergoing population aging, where increasing dependency ratios (that is, the number of people ages 65 and older relative to the number of working-age people who produce income) put downward pressures on per capita income and public finances.

This note estimates the longer-term impact of immigration on GDP per capita. It uses a restricted sample of advanced economies rather than a mixed sample of higher- and lower-income host countries. Given that income differences are much smaller between advanced economies (than in samples including both higher- and lower-income countries), this provides a more demanding test of whether immigration affects GDP per capita. This also provides results that are more directly relevant to advanced economies, where the number of migrants has been larger relative to the native population and income levels are higher. Compared with existing studies, our note makes three contributions. *First*, it examines the impact of immigration on income levels in advanced economies, confirming previous findings in the literature (for example, Aleksynska and Tritah, 2015). *Second*,

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[1] See for instance Card, Dustmann, and Preston (2009) on the importance of compositional concerns in shaping views about immigration.

the note examines whether the GDP per capita impact varies for different skill levels of migrants. To answer this question, it uses a new panel database, which provides the stock of adult migrants by country of origin and by level of education for 18 advanced economies every five years from 1980 to 2010. *Third*, the note goes beyond the aggregate impact of migration on GDP per capita to examine how broadly the gains are shared across the population. In particular, it examines whether migration impacts the income levels of those both at the top and at the bottom of the earnings distribution, or whether gains are instead concentrated in a small group of high earners.

The empirical approach stresses robustness. The note carefully addresses the risk of various endogeneity biases, including those related to reverse causality, namely that high income levels in host countries attract migrants, rather than migrants contributing positively to GDP per capita. To address endogeneity issues, it follows Alesina, Harnoss, and Rapoport (2016) and Ortega and Peri (2014) and uses 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 largely independent of host countries' income levels.

The main findings can be summarized as follows:

- Immigration significantly increases GDP per capita in advanced economies. While there is some sensitivity to the choice of instruments, our estimates suggest that a 1 percentage point increase in the share of migrants in the adult population (the average annual increase is 0.2 percentage point) can raise GDP per capita by up to 2 percent in the longer 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. While the magnitude of the effect is much smaller than that estimated over wider samples including lower-income countries, the effect remains large, especially by advanced economies' standards. It is important to note, however, that the magnitude of this effect could be sensitive to a number of country-specific factors, such as the type of migration (refugees versus economic migrants), the organization of the labor market, and the extent of complementarities between migrants and natives.
- Both high- and lower-skilled migrants can raise labor productivity, suggesting that the complementarities uncovered in the microeconomic literature are also relevant at the macro level. 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. We present some evidence of one possible channel of complementarity: an increase in the share of low-skilled migrants tends to increase the labor force participation rate of native women, likely through greater availability of household and childcare services. Where there is a lack of complementarity, however—for instance, if the demand is mainly for low-skilled migrants in a rapidly growing low-skilled sector like, for example, construction—it is unlikely that labor productivity will increase as a result.
- An increase in the migrant share benefits the average income per capita of both the bottom 90 percent and the top 10 percent earners, suggesting the gains from immigration are broadly shared, even though high-skilled migration contributes to raise the income share of the top 10 percent earners. The Gini coefficient, a broad measure of income inequality, is not affected by the migrant share.

The rest of the note is organized as follows. In the first section, we review the conceptual framework and the literature on the relationship between migration and GDP per capita or productivity. The second section presents some stylized facts, while the third section presents the methodology and results. The fourth section concludes and discusses policy recommendations.

Conceptual Framework and Literature Review

The literature has identified various channels through which migration can impact GDP per capita. For instance, GDP per capita can be decomposed into three 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:

$$\ln\frac{GDP_{dt}}{POP_{dt}} = \ln\frac{GDP_{dt}}{EMP_{dt}} + \ln\frac{EMP_{dt}}{WAPOP_{dt}} + \ln\frac{WAPOP_{dt}}{POP_{dt}}. \quad (1)$$

We briefly explain each of these channels:

Working age-to-total population ratio. Immigration typically increases 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, provided the increase in working-age population translates into increased employment.

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 if migrants are not able to integrate into 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 (IMF, 2015). The entry of migrants may lead natives to either (1) exit the labor force for unemployment or social welfare benefits (substitutes) or (2) 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 (for example, Card, 1990; Ottaviano and Peri, 2012; Peri and Sparber, 2009; Peri, Shih, and Sparber, 2015) and some finding a negative impact (for example, Jean and Jimenez, 2007; Ho and Shirono, 2015).

Labor productivity. Labor productivity can be further decomposed into contributions from capital-to-labor ratio, average human capital per worker, and total factor productivity (TFP).[2] 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. Available studies seem to confirm this prediction (for example, Ortega and Peri, 2009; Alesina, Harnoss, and Rapoport, 2016; Ortega and Peri, 2014). The impact of immigration on average human capital will depend on whether migrants to a specific host country are on average more or less educated than natives. The impact on TFP is also an empirical matter, as discussed below.

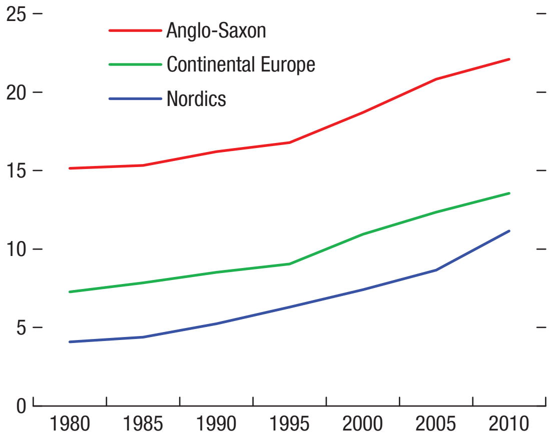
A growing literature suggests that immigration can raise total factor productivity. While much of the literature on migration is microeconomic and focuses on one particular channel (for example, employment, innovation, productivity), two macroeconomic studies also find evidence that migration increases GDP per capita, mostly through TFP.

- *High-skilled migrants.* Empirical studies generally find that high-skilled migrants tend to increase productivity in the host country, directly through increased innovation (for example, patents) and indirectly through positive spillovers on native workers' wages (Hunt and Gauthier-Loiselle, 2010; Peri, Shih, and Sparber, 2015). However, in some cases high-skilled migrants may have substituted for native high-skilled workers at lower wages (Doran, Gelber, and Isen, 2014).
- *Low-skilled migrants.* The literature also provides evidence that *low-skilled 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 (for example, abstract and communication) skills, while immigrants take up manual-intensive types of jobs (Cattaneo, Fiorio, and Peri, 2015; D'Amuri and Peri, 2014; Foged and Peri, 2016). Another related channel is that 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 child-care services and reducing their price (Farré, González, and Ortega, 2011; Cortes and Tessada, 2011). Finally, the skills of migrants can also be complementary to those of natives, for instance when there are labor shortages in non-traded services (for example, nursing) and imports cannot substitute for the lack of domestic supply. On the other hand, a large entry of low-skilled immigrants could change the sectoral specialization of the economy, for instance toward lower-productivity sectors such as construction, lowering TFP.
- *Wage studies.* The evidence of a small positive impact of immigration on the wages of natives in some studies also suggests that the quality of natives' jobs can improve with immigration (Card, 1990; Peri, Shih, and Sparber, 2015; Friedberg, 2001; Hunt, 1992; Ottaviano and Peri, 2012; Docquier, Özden, and Peri, 2014; Foged and Peri, 2016). Some studies, though, find a negative impact on wages of low-skilled workers (for example, Borjas, 2003; Borjas and Katz, 2007; Dustmann, Frattini, and Preston, 2013).
- *Macro studies.* Alesina, Harnoss, and Rapoport (2016) and Ortega and Peri (2014) found that a higher share of immigrants tends to increase GDP per capita, after controlling for other determinants of GDP per capita (for example, geography) and the possibility of a reverse causality between GDP per capita and immigration using a gravity model to predict migration. The effect of migration appears to operate through an increase in total factor productivity, reflecting an increased diversity in productive skills and, to some extent, a higher rate of innovation. Looking at OECD countries, Aleksynska and Tritah (2015) found a positive effect of immigration on income per capita and productivity of host countries, especially for prime-age immigrants.

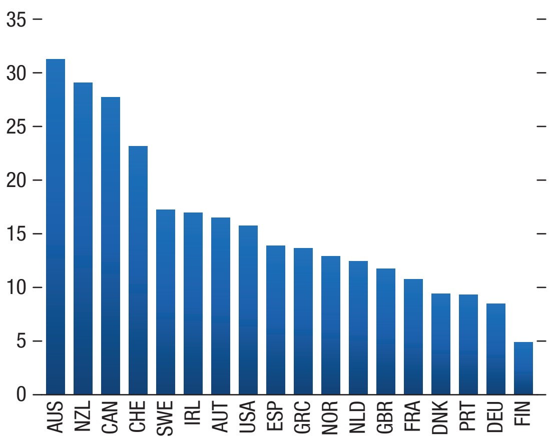
[2] For instance, assuming a standard Cobb-Douglas production function of the form $GDP_{dt} = A_{dt}(HC_{dt}EMP_{dt})^{\alpha}(K_{dt})^{1-\alpha}$, we can derive $\ln(\frac{GDP_{dt}}{EMP_{dt}}) = \alpha \ln HC_{dt} + (1-\alpha)\ln(\frac{K_{dt}}{EMP_{dt}}) + \ln A_{dt}$, where HC_{dt} is the stock of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

Figure 1. Size of Migration

1. Stock of Migrants by Region, 1980–2010
(Percent of population; simple average)



2. Stock of Migrants, 2010
(Percent of population)



Sources: Institute for Employment Research; United Nations, World Population Prospects, The 2015 Revision; and IMF staff calculations.
Note: Migrants and population refer to individuals ages 25 and older. Data labels in the figure use International Organization for Standardization (ISO) country codes.

Our note builds on these studies and makes several contributions. It examines the impact of immigration on GDP per capita and aggregate labor productivity of advanced economies where immigration has grown more controversial. The note also extends the analysis by examining more closely whether the GDP per capita impact varies for different skill levels of migrants, using a new panel database that provides the stock of adult immigrants by level of education and country of origin for advanced economies. Finally, the note analyzes how the potential gains in GDP per capita are distributed. Specifically, it estimates the impact of immigration on the income per capita of both the top 10 percent earners and the bottom 90 percent earners, and on various income distribution measures.

Stylized Facts

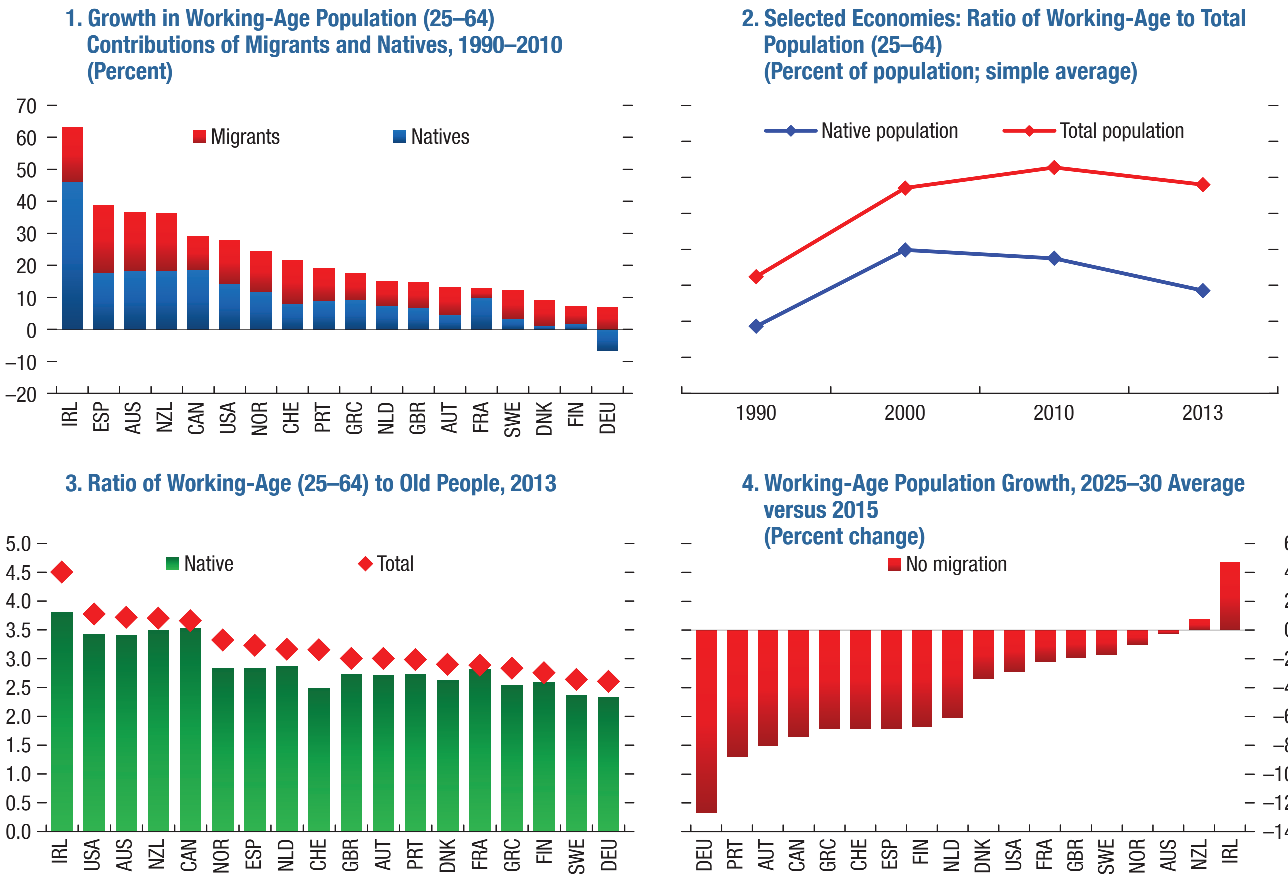
The note uses a new panel database that provides information on the education level of immigrants—a key dimension to examine their impact on GDP per capita and productivity. The database is from the Institute for Employment Research and reports the immigrant population ages 25 years and older by gender, country of origin, and educational level for Organisation for Economic Co-operation and Development (OECD) countries over the years 1980–2010 (at five-year intervals). 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 note, unless otherwise indicated, migrants and population refer to individuals ages 25 and older, and the migrant share is defined as the share of adult migrants (25 and older) in the adult population (25 and older). The database allows distinguishing 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 (high skilled—higher than high school leaving certificate or equivalent). The national accounts data, including real GDP per capita, labor productivity (real GDP per worker), and the employment-to-population ratio are from the Penn World Tables v8.1. Finally, population by age groups is from the UN Population Projections, and the educational attainment of the population ages 25 years and older is from the Barro-Lee data set. Our sample includes 18 advanced economies.

The stock of immigrants in advanced economies is considerable—much larger than the small share of migrants in the world population would suggest.[3] In 2010, it 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).[4] Important factors affecting the choice of destination

[3] 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.

[4] For the analysis of stylized facts, we split the countries into three groups: Anglo-Saxon (Australia, Canada, Ireland, New Zealand, United Kingdom, and United States); continental Europe (Austria,

Figure 2. Contribution of Migrants to Working-Age Population



Sources: United Nations, World Population Prospects, The 2015 Revision; and IMF staff calculations.
Note: Selected Economies = Australia, Austria, Canada, Denmark, Finland, France, Germany, Greece, Ireland, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Data labels in the figure use International Organization for Standardization (ISO) country codes.

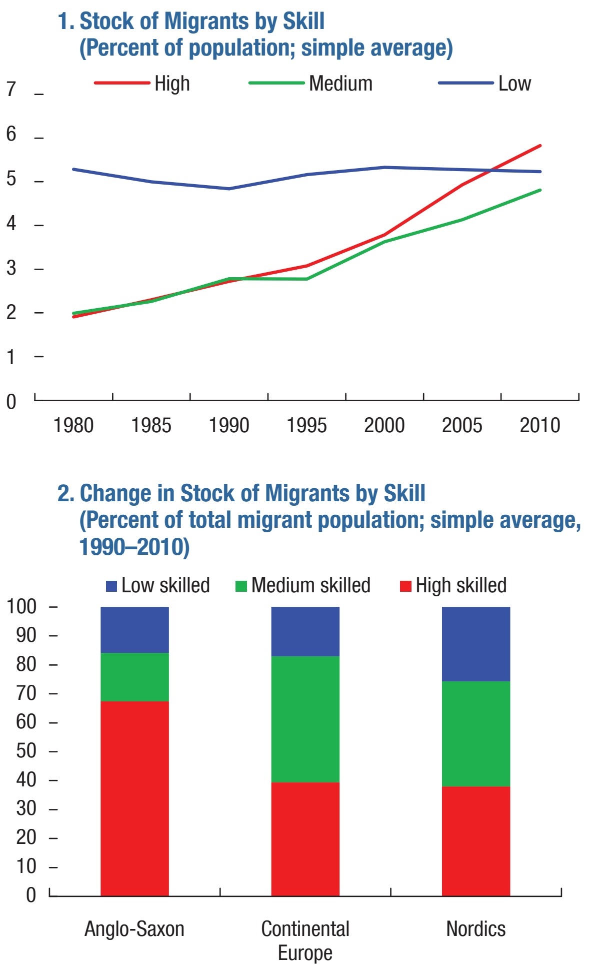
country include a common official language, a colonial link, a common border, and being part of the Schengen states or the European Union. Emerging markets have also become a growing source of migration to advanced economies, prompting a continuous increase in immigration to advanced economies since the 1980s.

Immigration increases working age-to-total population ratios, providing a substantial source of labor force. Between 1990 and 2010, immigrants constituted about half of the growth in working-age population in many countries, boosting and offsetting the decline in the working-age population ratio (Figure 2). On average, GDP per capita would be 5 percent lower in the absence of migrants (holding other things, including emigration, constant), on account of a lower working-age population ratio (see equation (1)). Immigrants also increased the ratio of working age to old people (inverse of the old-age dependency ratio), which should help ease the public financing of old-age spending. Their role in maintaining a sustainable demographic structure is likely to be even more important in the next decade, when—the United Nations projects—the labor force in most advanced economies would decline in the absence of immigration. Surprisingly, however, immigration has tended to be smaller in countries with weaker native population growth and larger in countries with stronger native population growth.[5]

France, Germany, Greece, Netherlands, Portugal, Spain, and Switzerland); and Nordics (Denmark, Finland, Norway, and Sweden).

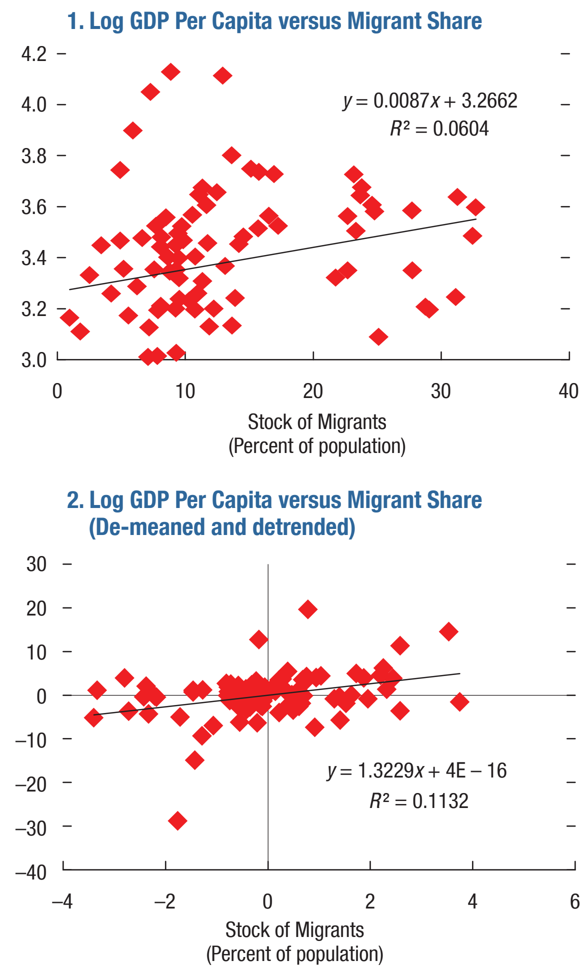
[5] This is unlikely to reflect the fact that immigrants tend to have more children, boosting native population growth, because our data on immigrants and natives refer to adult population in both cases. However, the fact that immigrants tend to have more children than natives, contributing down the road to additional native population growth, is another potential benefit of immigration, especially if those children are well integrated and receive quality education.

Figure 3. Stock of Migrants by Skill



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

Figure 4. Simple Correlations



Source: IMF staff calculations.

Migrants are also 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, reflecting the global rise in education levels (Figure 3). In 2010, high-skilled migrants constituted about 6 percent of the population, while medium-skilled and low-skilled migrants each accounted for about 5 percent of the population on average across advanced economies. In many countries, migrants are more high skilled than natives, suggesting that the hypothesis that immigration might be associated with human capital dilution (because migrants would be on average less skilled) does not necessarily hold anymore. But there is heterogeneity across countries: 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 many Anglo-Saxon countries, such as Australia and Canada (Czaika and Parsons, 2015) and possibly also the attraction of their tertiary education institutions, which many migrants attend. In contrast, the shares of low-skilled migrants in continental Europe and medium-skilled migrants in Nordic countries remain the highest, although high-skilled migrants have also been on the rise.

Taking a first look at the relationship between immigration and real GDP per capita, the correlation is positive. Without drawing inferences about causality, it is interesting to note that the migrant share and GDP per capita are positively correlated across time and countries (Figure 4). This positive association also remains after we remove 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. The next section investigates more formally the impact of immigration on GDP per capita using formal econometric analysis and addressing the risk of reverse causality.

Methodology and Results

Our econometric approach to explore more formally the impact of immigration on GDP per capita stresses robustness. Specifically, we use techniques that allow us to address the risk of reverse causality and to test robustness to other possible determinants of GDP per capita and productivity, such as the education level of the population, trade, technology, and population aging. This section also examines the impact of high-skilled and lower-skilled migration separately, as the education level of migrants is potentially important to determine the economic gains from immigration. Finally, it examines how these gains are distributed, by estimating the impact of migration on income per capita for high- and low-income earners, as well as on inequality measures.

Specification and Methodology

The specification for GDP per capita is derived from a model in which migration and trade can increase total factor productivity. We model our empirical work on Ortega and Peri (2014), which uses 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 with other countries are more costly than migration and trade across different regions within the same country, the size of the country can potentially also increase productivity. 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 Ortega and Peri (2014) and Alesina, Harnoss, and Rapoport (2016) in estimating the long-run relationship between income levels and migration, using the following specification:

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

where d is destination, t is time, MSH_{dt} is the migration share (total stock of adult foreign born relative to adult population), S_{dt} is the total adult population of the destination country (controlling for country size), $Controls_{dt}$ includes other control variables (such as the share of population with high and medium skills, trade openness, and the share of information and communications technologies [ICT] 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 education attainment). High-skilled migrants are defined as those with tertiary education (college degree), while low- and medium-skilled migrants have only secondary school or less.

To reduce the risk of reverse causality and other biases, we use a gravity model to construct instruments for migration. An ordinary least squares estimator of equation (2) will suffer from several possible biases: (1) endogeneity stemming from migrants preferring richer countries; (2) omitted variable bias, related to unobserved determinants of the migration share correlated with income per capita; (3) 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 ordinary least squares regression, the other two biases 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 to lower immigration shares. Another example, mentioned in Ortega and Peri (2014), is labor demand shocks, which are not observed to the econometrician, but can affect the migration share and also be directly correlated with GDP per capita. To reduce these biases, we use a gravity model to predict the (bilateral) migration shares, which would result from push factors specific to origin countries, such as economic, political, and social factors, and from bilateral migration costs determined by geography and culture, as well as from their interactions:[6]

[6] The predictor for the bilateral migration share between origin country o and destination country d at time t is based on the following equation: $\ln MSH_{odt} = \gamma_0 + \gamma_1 \ln pop_{d1980} + \gamma_2 \ln pop_{o1980} + \gamma_3 \ln MSH_{od1980} + \gamma_4 X_{ot} + \gamma_5 Z_{od} + \gamma_6 X_{ot} Z_{od} + \delta_t + \mu_{odt}$, where pop_{d1980} and pop_{o1980} are 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 potential network effects with current migrants from the same origin, 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 μ_{odt} is the error term. Time effects are not used for prediction, except for the share of high-skilled immigrants, which shows an exponential behavior.

- The vector of push variables from origin countries includes origin country growth, dummies for currency crises and civil wars, the share of the young population (25–34 years old) to capture demographic pressures on labor markets, the shares of the population with tertiary and high school education, and a dummy variable for being an EU member.[7]
- The factors influencing migration costs include distance between the countries, as well as dummy variables for a common border, speaking a common official or ethnic minority language, shared past colonial ties, common membership in the EU (which captures the impact of EU enlargement), and the initial stock of migrants from a given origin at a given destination (which captures network effects).[8]
- We interact push factors with migration costs to create variation of the instrument across time and destination countries, which in our case is key to identify the effect of migration on GDP per capita since our second-stage regression includes country and time fixed effects. This specification is an augmented version of Ortega and Peri (2014), who mostly use cross-sectional variation in the data and therefore don't require the instrument to vary over time.

We estimate the gravity model using two alternative methods: a standard ordinary least squares estimator (OLS) for the log-linear model and a Poisson pseudo-maximum likelihood estimator (PPML) proposed by Silva and Tenreyro (2006). The Poisson pseudo-maximum likelihood 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 Ortega and Peri (2014), 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.

Push factors and bilateral migration costs are strong predictors of the migration share. Our gravity model estimates find coefficient signs mostly as expected: push factors associated with worse economic, political, or demographic conditions at the origin tend to increase the migration share, and so do lower geography- and culture-based migration costs (see Annex 1). We also estimate the gravity model for migrants with different skill levels. Some gravity coefficients are similar across different skill levels, while others vary between higher and lower skilled, suggesting that the relative importance of various push factors and migration costs varies by skill. Based on the similarity of low- and medium-skilled migration coefficients, we aggregate the low- and medium-skilled migration shares into one variable. The gravity-based predictors for bilateral migration are then aggregated over the origin countries to obtain an instrument for the total migration share at destination. Overall, we find a strong positive correlation between the actual stock of migrants and the gravity-predicted variable, both for the total stock and by skill level, suggesting that gravity-based instruments are successful in explaining migration, as also evidenced in formal tests below (Figure 5). Having constructed instruments for the migration share, we turn to estimating the impact of the migration share on the log of GDP per capita.

Long-Run Impact of Migration on GDP per Capita

Effect on GDP per Capita

Our empirical approach is to estimate the model from equation (2) in levels—following Ortega and Peri (2014) and Alesina, Harnoss, and Rapoport (2016)—because we are interested in the long-run relationship between income per capita and migration. We have a small time dimension in the panel (five time periods) and our observations are spaced at five-year intervals, which should attenuate the problem of serial correlation. We report standard errors with the standard correction for heteroscedasticity, but our results do not change much when using a correction for autocorrelation of error terms or for within-country correlation.

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

[8] Two countries are defined as having a common ethnic language if it is spoken by more than 9 percent of population. Cross-sectional variables for gravity regressions are from the Centre d'Études Prospectives et d'Informations Internationales (CEPII); data on the level of education of the population are from the Barro-Lee data set; data on civil wars are from the Correlates of War data set, and data on currency crises are from Laeven and Valencia's (2012) data set.

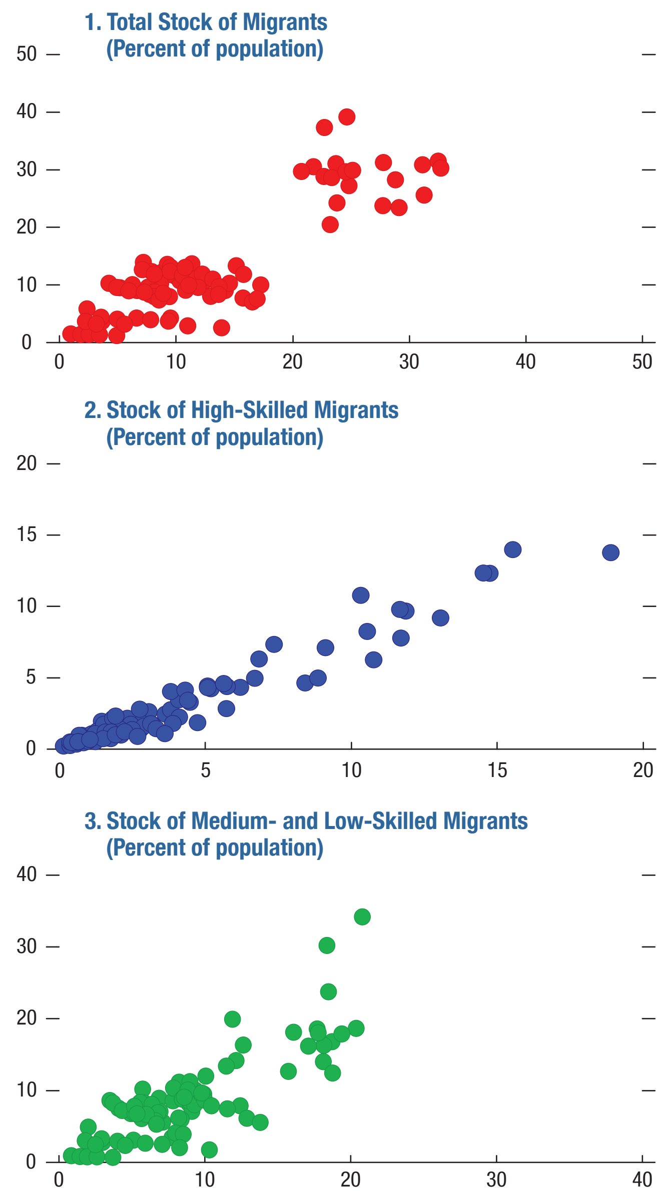
A key objective is to ensure the best possible identification of the effects of migration. All specifications include country and time fixed effects, the education level of the host country's population, and population size at the destination country. Because, by construction, the latter includes migrants, it also suffers from a potential endogeneity bias and is instrumented with native population, in addition to our instrument for the migrant share. Table 1 reports estimates of equation (2). Column (1) shows the ordinary least squares estimate, while columns (2) to (10) report two-stage least squares estimates (IV). The coefficient on the migration share is significantly positive and robust across all specifications, with the exception of the ordinary least squares estimate. The fact that the coefficient increases and becomes significant with two-stage least squares in column (2) suggests that the omitted variable and measurement error biases discussed earlier might be stronger than the endogeneity bias.

The empirical instruments used to identify the migration impact are valid and strong, and the results are robust to additional control variables. Below, we discuss each aspect in turn.

Valid Instruments

- Column (2) reports the estimate using the Poisson pseudo-maximum likelihood gravity instrument for the migrant share, and native population to instrument for population size. The pseudo-gravity instrument for the migrant share was constructed using exclusively factors which are independent of the host country's income levels, therefore minimizing the risk that the instrument is correlated with the error term.
- One component of our instrument that could be of particular concern is the lagged growth in source countries, which, 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. The regression suggests that this variable explains very little of the variation in our instrument, after country and time fixed effects are controlled for, dispelling concerns.

Figure 5. Instrumental Variables versus Stock of Migrants



Source: IMF staff calculations.

- To test more formally for the validity of instruments through a Hansen statistic, we need more instruments than endogenous variables. Therefore, we introduce in column (3) a second instrument for the migrant share, a dummy for the Maastricht treaty, which allows us to test for over-identifying restrictions. The Hansen statistics fails to reject the null hypothesis, confirming that our instruments are not correlated with the error term in equation (2).

Table 1. Impact of Migration on GDP per Capita

	(1) Log GDP per capita Baseline OLS	(2) Log GDP per capita Baseline IV	(3) Log GDP per capita Overident IV	(4) Log GDP per capita FE gravity IV	(5) Log GDP per capita Log gravity IV	(6) Log GDP per capita Log FE gravity IV	(7) Log GDP per capita Weak IV test	(8) Log GDP per capita Weak IV test Overident	(9) Log GDP per capita Control for technology and trade	(10) Log GDP per capita Excl. USA, CAN, AUS, NZL
Migration share	0.78	1.79***	1.86***	1.64**	2.38***	2.19***	2.30***	2.37***	2.07**	1.61*
	(1.172)	(2.596)	(2.615)	(2.423)	(3.033)	(2.640)	(3.217)	(3.189)	(2.179)	(1.929)
Ln pop	0.43	0.50*	0.50*	0.49*	0.52*	0.51*	0.50*	0.50*	0.58**	0.33
(Ln nat pop in (7) and (8))	(1.194)	(1.738)	(1.733)	(1.719)	(1.734)	(1.743)	(1.748)	(1.747)	(2.057)	(0.930)
Share of pop high skilled	0.41	0.34	0.34	0.35	0.31	0.32	0.34	0.33	0.27	0.66*
	(1.549)	(1.564)	(1.554)	(1.620)	(1.307)	(1.368)	(1.578)	(1.568)	(1.195)	(1.924)
Share of pop medium skilled	0.07	0.14	0.14	0.13	0.17	0.16	0.13	0.13	0.17	0.12
	(0.503)	(1.066)	(1.073)	(1.009)	(1.241)	(1.193)	(1.049)	(1.061)	(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)	
Number of observations	90	90	90	90	90	90	90	90	90	70
R-squared	0.881	0.870	0.868	0.873	0.853	0.859	0.872	0.870	0.881	0.873
Number of destinations	18	18	18	18	18	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	MSH Ln nat pop	MSH	MSH Maastricht	MSH Ln nat pop	MSH Ln nat pop
Estimator for the gravity model		PPML	PPML	PPML	OLS	OLS	PPML	PPML	PPML	PPML
Underidentification test P-val		0.000984	0.00415	0.000297	0.0221	0.0202	0.00118	0.00488	0.003	0.00619
Kleibergen-Paap rk Wald F stat		13.30	8.957	12.56	10.41	9.759	26.80	13.57	7.42	13.75
Stock-Yogo 10% max IV size		7.03	13.43	7.03	7.03	7.03	16.38	19.93	7.03	7.03
Stock-Yogo 15% max IV size		4.58	8.18	4.58	4.58	4.58	8.96	11.59	4.58	4.58
Hansen J stat P-val			0.434					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]		

Source: IMF staff estimates.
Note: Robust t-statistics are reported in parentheses. MSH denotes the gravity-predicted migration share. ICT denotes information and communication technologies. All regressions include country and time fixed effects.
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Strong Identification

- Statistical tests confirm that the Poisson pseudo-maximum likelihood gravity instrument is strongly positively correlated with the migrant share. The under-identification test rejects the null hypothesis that the equation is under-identified—that is, that the matrix of first-stage slope coefficients is not full rank. In addition, the Kleibergen-Paap F-statistic is above the Stock and Yogo critical values, suggesting that the instruments are strong.
- In addition, columns (4)–(6) use alternative instruments based respectively on a Poisson pseudo-maximum likelihood estimator with destination country fixed effects (FE), an ordinary least squares estimator for the gravity model, and an ordinary least squares estimator with destination country fixed effects. These instruments are also strong, and the coefficient of the migrant share remains similar in size and statistically significant.
- However, because Stock and Yogo critical values are valid only when the error terms are identically and independently distributed (which they may not be), we also construct weak-instrument consistent confidence sets. Having just one endogenous variable

makes this easier to do. In columns (7) and (8), we replace population size—which was instrumented by the native-born population—directly by the native-born population. Weak-instrument consistent confidence intervals (that is, confidence intervals based on the Anderson Rubin statistic, conditional likelihood ratio statistic, and a combination of the Lagrange multiplier test and the over-identification test) are reported at the bottom of the table and are all strictly positive, confirming the positive effect of migration on GDP per capita.

Robustness to Additional Control Variables

- In addition to the controls mentioned before, column (9) includes additional time-varying control variables, which could have a significant impact on GDP per capita, namely the share of ICT in the total capital stock (a proxy for technological development) and trade openness (another dimension of a country's openness, which could be correlated to the migration share).[9] We find evidence that both technology and trade openness contribute positively to GDP per capita and the result for the migration share remains robust.
- The result on migration was also found to be robust to the inclusion of other controls capturing policy variables, such as a financial reform index, union density, employment protection, the level of unemployment benefits, and the marginal tax rate for top earners (available upon request).
- Finally, following Ortega and Peri (2014), column (10) tests robustness to excluding the four "young" and rich countries (Australia, Canada, New Zealand, and the United States)—that is, the countries that were created through migration and have high income levels. The coefficient on the migration share is similar in magnitude and is significant.

The magnitude of the estimated effect of the migration share on GDP per capita is 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. The effect is broadly comparable to the results reported in a study examining the economic effects of administrative action on immigration by the U.S. President's Council of Economic Advisors. 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 (CEA, 2014).

While large in economic terms, our estimate is considerably lower than those found in the previous literature. For example, Ortega and Peri (2014), 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. Key among the factors explaining these differences are that we look at a more homogeneous group of countries with smaller differences in GDP per capita and—even more important—that we focus on within-country variation in the migration share over time. Indeed, the use of country fixed effects implied by our panel approach offers a very powerful additional control for any time-invariant country characteristic that might otherwise impact the estimated migration 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 comes directly from the differences in demographic structures of natives and migrants). Columns (1) and (2) in Table 2 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 not statistically significant. The remaining columns 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 Poisson pseudo-maximum likelihood estimator with destination country fixed effects.

The positive productivity effect of migration suggests that no major physical or human capital dilution effects are at work, at least for the majority of countries. While the capital stock is notoriously difficult to measure,

[9] 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 *World Economic Outlook*, while data for the share of ICT capital in the total capital stock is from Jorgenson and Vu (2011).

Table 2. Impact of Migration on Productivity versus Employment

	(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	Control for age structure	FE gravity IV
Migration share	–0.86	1.95***	1.59**	2.97***	3.20***	1.77***
	(–1.500)	(2.791)	(2.530)	(3.046)	(2.952)	(2.591)
Ln pop	0.07	0.06	–0.17	–0.07	0.18	0.05
	(0.330)	(0.216)	(–0.616)	(–0.242)	(0.683)	(0.186)
Share of pop high skilled	–0.00	0.32	0.74**	0.37	0.16	0.33
	(–0.008)	(1.336)	(1.975)	(1.413)	(0.479)	(1.407)
Share of pop medium skilled	–0.05	0.12	0.10	0.06	0.35**	0.11
	(–0.658)	(1.016)	(1.049)	(0.426)	(2.282)	(0.943)
Additional controls				ICT in capital Trade open (lag)	Age structure	
Number of observations	90	90	70	85	90	90
R-squared	0.148	0.821	0.847	0.788	0.783	0.830
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
Estimator for the gravity model	PPML	PPML	PPML	PPML	PPML	PPML
Underidentification test *P*-val	0.000984	0.000984	0.00619	0.00338	0.00797	0.000297
Kleibergen-Paap rk Wald *F* stat	13.30	13.30	13.75	7.420	5.489	12.56
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

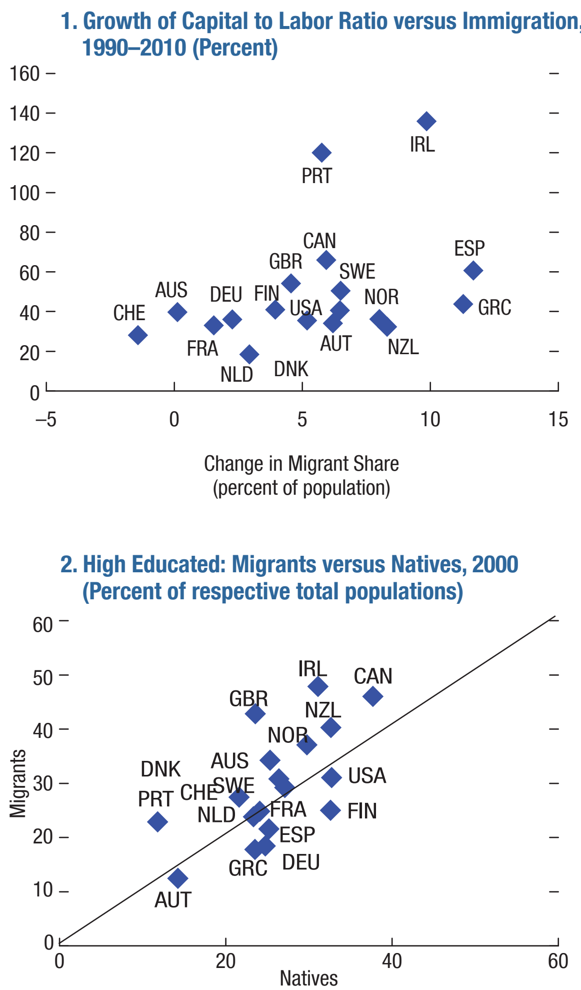
Source: IMF staff estimates.
Note: Robust t-statistics are reported in parentheses. MSH denotes the gravity-predicted migration share. ICT denotes information and communication technologies. All regressions include country and time fixed effects.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

Figure 6 suggests that there is no relationship between the long-term growth in the capital-to-labor ratio and the change in the stock of migrants, consistent with investment adjusting over time to a larger pool of potential workers. In addition, the share of high-skilled migrants in many countries is higher than the share of high-skilled natives, suggesting that migration is not systematically associated with human capital dilution, though this could be the case in some countries. The literature 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 (forthcoming) show that population aging is associated with declines in 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 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 (5) of Table 2).

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 (Poisson pseudo-maximum likelihood) are reported in columns

Figure 6. No Evidence of Capital Dilution



Sources: Institute for Employment Research; United Nations, World Population Prospects, The 2015 Revision; Penn World Tables v.8.1; Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

(1)–(4) of Table 3.[10] 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 but have a positive impact on labor productivity of similar magnitude. Results for productivity are broadly robust when using the Poisson pseudo-maximum likelihood instrument with destination dummy fixed effects. There is some country heterogeneity in the effects of high- and lower-skilled migrants on labor productivity, possibly reflecting the fact that such effects may vary with the initial skill distribution of the native population.[11]

The fact that the effect of high-skilled workers on productivity is not significantly larger than the effect of low-skilled workers, contrary to expectation, could be due to different factors. The lack of a significant difference could reflect country heterogeneity, for instance if the effect of high- and low-skilled migrants varies with the initial skill composition of the native population. But it could also reflect an "overqualification" of migrants, to the extent that a larger fraction of high-skilled migrants works in lower-skilled occupations compared with high-skilled natives.[12] 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) employed in less-skilled occupations, in addition to having lower shares of high-skilled migrants (Figure 7). 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 better skill recognition. While these discrepancies between high-skilled migrants and natives may partly reflect a lack of equivalence of degrees between origin and

[10] Our main instruments are strongly correlated with the respective migration shares as indicated by tests presented at the bottom of Table 3. To test the null hypothesis of jointly weak instruments, one would typically use the Kleibergen-Paap *F*-test. The *F*-statistic from this test is compared with the Stock and Yogo 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 Kleibergen-Paap *F*-statistic 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.

[11] In particular, countries that 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.

[12] Lower-skilled occupations include: (1) 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 (2) 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.

Table 3. Impact of Migration by Skill Level of Migrants

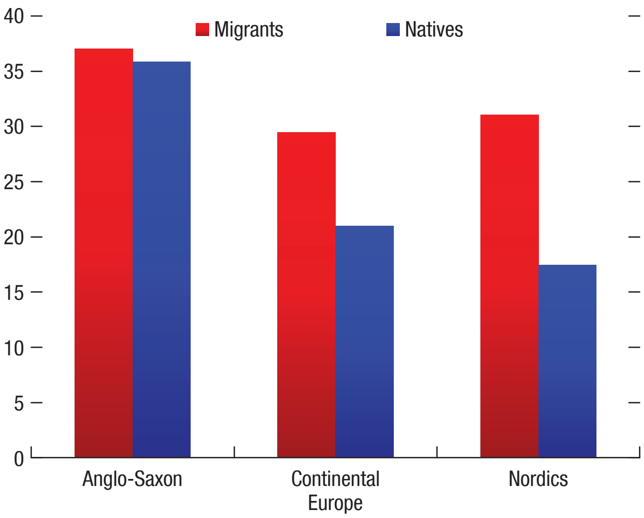
	(1) Log GDP per capita	(2) Log employment per WA pop	(3) Log labor productivity	(4) Log labor productivity	(5) Natives female LF participation	(6) Natives female LF participation
	Baseline IV	Baseline IV	Baseline IV	FE gravity IV	Baseline IV	FE gravity IV
Migration share, high skilled	2.10	0.13	2.53*	2.20	–0.15	–0.11
	(1.610)	(0.168)	(1.869)	(1.473)	(–0.141)	(–0.080)
Migration 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	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	0.14	–0.03	0.12	0.11	–0.04	–0.03
	(1.170)	(–0.390)	(1.171)	(1.118)	(–0.527)	(–0.511)
Number of 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
Estimator for the gravity model	PPML	PPML	PPML	PPML	PPML	PPML
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

Source: IMF staff estimates.
Note: Robust *t*-statistics are reported in parentheses. MSH denotes the gravity-predicted migration share. All regressions include country and time fixed effects.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

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.

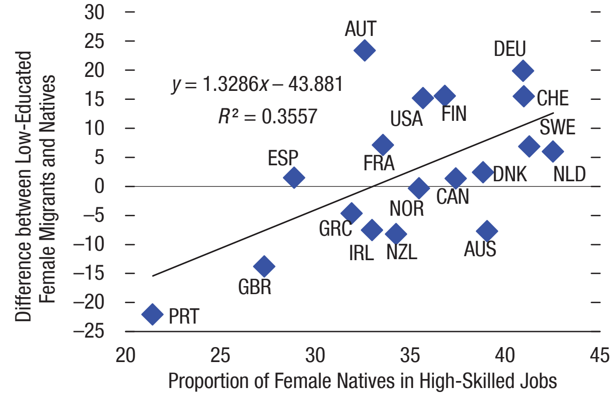
At the same time, low- and medium-skilled migrants can contribute to labor productivity through skill complementarity. Lower-skilled migrants may also increase productivity if their skills are complementary to those of natives, if they encourage natives to add to their own education and seek higher-skilled employment, or if they raise the labor supply of high-skilled native women by increasing the availability of household and childcare services (Figure 8). We test this last hypothesis with a formal regression analysis, which is presented in columns (5) and (6) of Table 3. The results support a positive impact of low-skilled migration on the female labor force participation of natives. 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 that already has a large share of low-skilled natives may not contribute to raise labor productivity, consistent with a lack of complementarity between the skills of migrants and natives. For example, Spain, which appears to be one

Figure 7. High-Educated Workers in Lower-Skilled Jobs, 2000: Regional
(Percent of respective high-educated populations; simple average)



Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.

Figure 8. Native Female Labor Force Participation and Low-Educated Migration: Low Education versus High Skilled, 2000
(Percent of respective total populations)



Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

of the outliers in our sample, had one of the largest fractions of low-skilled population and nevertheless attracted a large influx of low-skilled migrants in the construction sector. We next study how the gains from migration in terms of per capita GDP are distributed.

Distribution of Gains

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.[13] Results are presented in Table 4. Column 1 replicates the baseline instrumental variables estimation, controlling for trade and technology, on the sample for which data on the income shares are available, confirming our previous results. Using the same regression model, the impact of the migrant shares on GDP per capita for the bottom 90 and the top 10 percent is estimated and presented in columns (2) and (4), respectively. Migration increases income per capita for both the top 10 and bottom 90 percent 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 positively impacts 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 the population.[14] 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 significantly impacted. Figure 9 summarizes the estimated effects of the migrant share on aggregate GDP per capita, as well as on average income per capita of the top 10 and bottom 90 percent of earners.

Our findings lend support to the complementarity effect of migration. The results that low- and medium-skilled migration equally increases income per capita for the bottom 90 percent and the top 10 percent suggests that this benefits the population at large, along the complementarity channels high-

[13] 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.

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

Table 4. 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)
Migration 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)
Migration 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	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	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	ICT in capital Trade open (lag)	ICT in capital Trade open (lag)	ICT in capital Trade open (lag)	ICT in capital Trade open (lag)	ICT in capital Trade open (lag)	ICT in capital Trade open (lag)
Number of 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
Estimator for the gravity model	PPML	PPML	PPML	PPML	PPML	PPML
Underidentification test *P*-val	0.001	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

Source: IMF staff estimates.
Note: Robust *t*-statistics are reported in parentheses. MSH denotes the gravity-predicted migration share. All regressions include country and time fixed effects.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

lighted in the microeconomic literature. In contrast, the finding that high-skilled migration benefits the top 10 percent more than the bottom 90 percent could reflect a higher earnings potential of high-skilled migrants who fall within the top 10 percent than that 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 (for example, Doran, Gelber, and Isen (2014) mentioned in the second section).

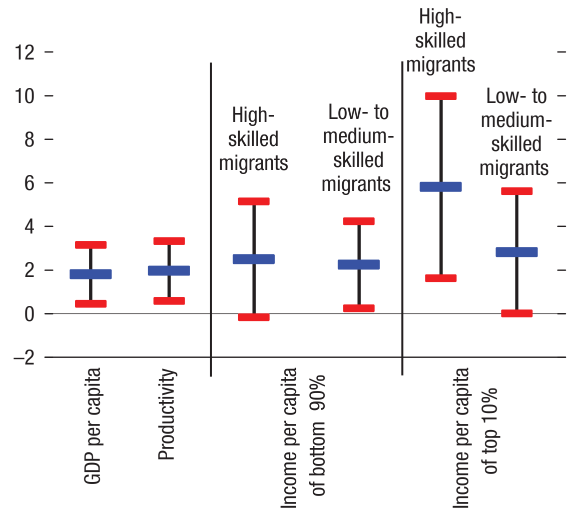
Conclusions and Policy Recommendations

While migration presents challenges for host countries, in particular the risk of societal and political strains if migrants do not integrate sufficiently or natives feel displaced, our results suggest that there are long-term benefits to immigration in terms of higher GDP per capita for recipient countries. The benefits seem to be broadly shared across the population, even though high-skilled migration contributes to increase the income share of the top 10 percent earners. Moreover, both high- and low-skilled migrants can contribute to increase GDP per capita. For lower-skilled migrants, this is particularly the case if there is a 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, in particular 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 take into consideration the indirect effects of immigration on the aggregate productivity of the economy.

The labor market integration of migrants is critical to secure GDP per capita gains and benefits for public finances. This note examines the medium- to long-run impact of migration. However, the transition/assimilation process may be difficult and slow, for instance if migrants struggle to integrate in the labor market. A number of policies can help, including language training and active labor market policies targeted to the needs of migrants; a better recognition of the skills of immigrants, through certification equivalence, so that they can be employed effectively and the still-sizable share of high-skilled migrants employed in lower-skilled occupations can be reduced; and product market reforms and other measures that lower barriers to entrepreneurship (Aiyar and others, 2016).

Finally, while the benefits from migration seem to be broadly shared, mitigating policies can help the adjustment. In addition to measures fostering the fast integration of migrants into the labor market, these include, for example, steps to help natives upgrade their skills or reduce possible congestion in the use of public services (for example, health and education). While these policies may require additional public spending, they also aid the long-term increase in GDP per capita and, thereby, help migrants increasingly contribute to the fiscal accounts.

Figure 9. Summary of Estimated Effects of Migrants' Share: Effect of Increase in Share of Migrants in Total Adult Population
(Percent change per 1 percentage point increase)



Source: IMF staff calculations.
Note: Red bands denote 95 percent confidence intervals.

Annex 1. Gravity-Based Instrumental Variables Approach

To construct an instrument for the migration share, we build on the approach of Ortega and Peri (2014), Alesina, Harnoss, and Rapoport (2016), and others,[15] which uses a gravity model for bilateral migration stocks and exploit variation in migration based on migration costs, captured by bilateral geographic and cultural characteristics. This approach assumes that such costs affect GDP per capita only by affecting migration, but not directly.

A good instrument for the migration share should be strongly correlated with the endogenous regressor and uncorrelated with error term in the second-stage equation. Ortega and Peri (2014) and Alesina, Harnoss, and Rapoport (2016) 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 Ortega and Peri (2014) specification with a number of "push" factors, which are specific to the origin country and vary

[15] Based on the approach by Frankel and Romer (1999) for trade.

over time, and interactions between the push factors and migration costs (specific to each origin–destination pair), which creates variation by destination country over time. We do not include any "pull" factors, specific to the destination country, because they could be correlated with GDP per capita at the destination and therefore could invalidate our instruments.

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:

$$\begin{aligned}\ln MSH_{odt} = {} & \gamma_0 + \gamma_1 \ln pop_{d1980} + \gamma_2 \ln pop_{o1980} \\ & + \gamma_3 \ln MSH_{od1980} + \gamma_4 X_{ot} + \gamma_5 Z_{od} \\ & + \gamma_6 X_{ot} Z_{od} + \delta_t + u_{odt},\end{aligned} \tag{A1.1}$$

where pop_{d1980} and pop_{o1980} are 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. Following Ortega and Peri (2014), 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.

The vector of push variables includes origin country growth, dummies for currency crises and civil wars, the share of the young population (25–34 years old), the shares of population with tertiary and high school education,[16] and a dummy variable for being an EU member. The migration costs include distance between the countries, dummies for contiguity, speaking a common official or ethnic minority[17] language, shared past colonial ties, and membership in the EU.

We aggregate the gravity-based predictors for bilateral migration shares over the origin countries:

$$\widehat{MSH}_{dt} = \Sigma_{0 \neq d} \exp(\widehat{\gamma_M} M_{odt}), \tag{A1.2}$$

where M_{odt} is the vector of explanatory variables in equation (A1.1) (excluding time and destination fixed effects) and $\widehat{\gamma_M}$ is the vector of estimated coefficients.

[16] Growth level, share of the young population, and share of the educated population are lagged by five years to avoid reverse causality.

[17] More than 9 percent of population.

More adverse socio-economic conditions at the origin and lower migration costs increase the share of migrants. Annex Table 1.1 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 demand. Columns (1)–(3) present estimates for the total migration share from the log-linear ordinary least squares regression, the Poisson pseudo-maximum likelihood regression, and the Poisson pseudo-maximum likelihood regression 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 Poisson pseudo-maximum likelihood regressions, meaning that there are few zero observations in our sample, and therefore the main differences between the ordinary least squares and Poisson pseudo-maximum likelihood 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 Poisson pseudo-maximum likelihood 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 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 the 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 the population with high education at the 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

Annex Table 1.1. Gravity Model for Bilateral Migration Share

	(1) Total MSH OLS	(2) Total MSH PPML	(3) Total MSH PPML FE	(4) High skilled MSH PPML	(5) Medium skilled MSH PPML	(6) Low skilled MSH 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
Number of observations	5,640	5,689	5,689	5,401	5,382	5,502
R-squared	0.887					

Source: IMF staff estimates.
Note: Robust t-statistics are reported in parentheses. All models include a constant term and a full set of interactions between the “push” factors and migration costs (reported in the annex text). The migration share (MSH) is defined as the number of adult foreign born in the country over the 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.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

medium-skilled migration shares into one variable when constructing predicted migration shares by destination.

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