NBER WORKING PAPER SERIES

A GLOBAL VIEW OF CROSS-BORDER MIGRATION

Julian di Giovanni
Andrei A. Levchenko
Francesc Ortega

Working Paper 20002
http://www.nber.org/papers/w20002

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2014

We are grateful to the editor (Fabrizio Zilibotti), anonymous referees, Antonio Ciccone, Frederic Docquier, Luca Opromolla, Giovanni Peri, and seminar and conference participants at various institutions for helpful suggestions, and to Lin Ma and Rishi Sharma for excellent research assistance. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

A Global View of Cross-Border Migration
Julian di Giovanni, Andrei A. Levchenko, and Francesc Ortega
NBER Working Paper No. 20002
March 2014
JEL No. F12,F15,F22,F24

ABSTRACT

This paper evaluates the global welfare impact of observed levels of migration using a quantitative multi-sector model of the world economy calibrated to aggregate and firm-level data. Our framework features cross-country labor productivity differences, international trade, remittances, and a heterogeneous workforce. We compare welfare under the observed levels of migration to a no-migration counterfactual. In the long run, natives in countries that received a lot of migration – such as Canada or Australia – are better off due to greater product variety available in consumption and as intermediate inputs. In the short run the impact of migration on average welfare in these countries is close to zero, while the skilled and unskilled natives tend to experience welfare changes of opposite signs. The remaining natives in countries with large emigration flows – such as Jamaica or El Salvador – are also better off due to migration, but for a different reason: remittances. The welfare impact of observed levels of migration is substantial, at about 5 to 10% for the main receiving countries and about 10% in countries with large incoming remittances. Our results are robust to accounting for imperfect transferability of skills, selection into migration, and imperfect substitution between natives and immigrants.

Julian di Giovanni
Department of Economics and Business
Universitat Pompeu Fabra
Ramon Trias Fargas 25-27
08005 Barcelona
Spain
julian.digiovanni@upf.edu

Andrei A. Levchenko
Department of Economics
University of Michigan
611 Tappan Street
Ann Arbor, MI 48109
and NBER
alev@umich.edu

Francesc Ortega
Queens College CUNY
Economics department,
300A Powdermaker Hall,
65-30 Kissena Blvd
Flushing, New York 11367
fortega@qc.cuny.edu

1 Introduction

International migration has risen steadily over the last three decades. By the 2000s, substantial fractions of the total population in many receiving countries were foreign-born. For instance, immigrants account for 8−12% of the population in several G7 countries such as the United States, the United Kingdom, and France, and some 20% of the population in other wealthy countries such as Australia, Canada, and New Zealand. By the same token, some developing countries have lost a substantial fraction of their population to emigration. Emigrants account for some 10% of the population of Mexico, and as much as 20−30% in smaller countries such as El Salvador or Jamaica.

The sheer scale of the cross-border movements of people has led to a growing interest in understanding their welfare effects. However, compared to the attention paid to the welfare analysis of international trade, very few estimates of the welfare effects of international migration are available. This paper provides a quantitative assessment of the global welfare impact of the observed levels of migration on both origin and destination countries, taking explicitly into account the consequences of international trade and remittances. Our multi-country general equilibrium model is calibrated to match the world income distribution and world trade patterns. It incorporates several first-order features of the world economy that are important for obtaining reliable estimates of the welfare impact of migration. First, we calibrate labor productivity differences between and within countries. In order to develop reliable estimates of migrants' impact on the host economies, our framework accounts for a great deal of worker heterogeneity, with worker productivity varying by skill level, country of origin, and country of residence. In addition, we match the levels of remittances observed in the data. Remittances transfer some of the gains from the increased productivity of migrants back to the natives that remained in the home country.

Second, our model incorporates the insights of the recent literature on firm heterogeneity under monopolistic competition (e.g., Melitz, 2003). In recent years, a great deal of evidence has shown that these models are highly successful at replicating both the key macro features (total trade flows, the gravity relationship) and key micro features (firm size distributions, systematically larger exporters) of the economy, making them especially suitable for quantitative analysis. Economically, the key mechanism linking migration and welfare in this framework is product variety. Inflows of immigrants increase market size, and thus the range of varieties available for consumption and as intermediate inputs. Importantly, in the presence of large labor productivity differences between countries, the impact of migration on equilibrium variety depends not only on changes in population, but also the size of the productivity gap between source and destination countries.

Third, we take explicit account of the role of goods trade in affecting the gains from migration. In our model an increase in a country's market size due to immigration will affect other countries through an increase in export variety. To capture the quantitative importance of this effect, the model features both traded and non-traded sectors with intermediate input linkages between the two, and matches the overall levels of goods trade relative to GDP. The model is solved on a sample of 60 developed and developing countries comprising some 98% of world GDP, taking into account all the multilateral trade relationships between them.

Finally, we distinguish between the short-run and the long-run impact of migration. In the short run equilibrium, the set of potential varieties available in the economy is fixed, and thus it corresponds to the framework of Chaney (2008) and Eaton et al. (2011). In this case, migration has an impact on product variety by affecting the entry and exit decisions of only the marginal firms (i.e. those near the productivity cutoff for operating a firm). Since these are the least productive firms in the economy, their economic impact is very limited. In the long run equilibrium, the set of potential varieties will change in response to migration to dissipate net aggregate profits (free entry) as in Krugman (1980) and Melitz (2003). Because some of those new firms will be quite productive, they can have a large impact on welfare. Thus, the difference in the welfare impact of migration between the short and the long run depends crucially on the relative productivity of the marginal firms compared to the inframarginal ones. Our quantitative analysis calibrates the key parameters of the model that determine equilibrium variety in both the short and the long run: relative country size and the firm size distribution.[1]

The main use of our calibrated model is to compute welfare in the baseline under the observed levels of bilateral migration and in the counterfactual scenario in which global migration is undone. Our findings can be summarized as follows. In the long run the average natives in practically every receiving country would have been worse off in the absence of migration, and this welfare loss increases in the observed share of the non-native population. Natives in the countries with the largest stocks of immigrants relative to population such as Australia, New Zealand, and Canada, have $5-10\%$ higher welfare under the current levels of migration compared to the no-migration counterfactual. This welfare effect is driven by the general equilibrium response of domestic variety. A lower population in the absence of migration implies a smaller equilibrium mass of varieties available in the home market, and thus lower per-capita welfare.

In the short run, the welfare impact of immigration on the receiving countries is much smaller, at less than 0.5% on average, and not always positive. This is because the general equilibrium effect of increased variety is only of limited importance in the short run. At the same time, the welfare impacts of migration on the skilled and the unskilled are frequently of opposite signs, and

[1] Our quantitative framework features a (long-run) scale effect. That is, other things equal, a larger labor force increases per capita welfare in the long run. Appendix B.3 presents a detailed treatment of both the relevance and the quantitative importance of the scale effect in our model. First, it reviews the existing empirical literature on the scale effect, and provides a comparison of the size and nature of the scale effect implied by our model to the available empirical estimates. Though our model is not calibrated to match the observed magnitude of the scale effect, the model-implied scale effect is in line with the existing empirical estimates. Second, it reports alternative welfare results under a weaker scale effect corresponding to the bottom of the range of estimates found in the literature.

tend to be an order of magnitude larger than the overall impact. Thus, in the short run the main welfare impact of migration on receiving countries is distributional, and driven by the changes in the relative supply of skills associated with migration. This distributional impact is limited in the long run, as the increased variety effect predominates and the welfare changes of the two skill groups tend to be similar.

For the sending countries, the welfare impact on the staying natives depends on a trade-off. Symmetrically to the main migration receiving countries, these source countries would *ceteris paribus* be better off without emigration because a larger labor force implies greater variety in production and consumption. On the other hand, absent emigration there would be no remittances. For countries such as El Salvador or the Philippines, where remittances account for more than ten percent of GDP, the latter effect dominates and the average native stayer is about 10% better off under the current levels of migration. Underlying these results is the fact that the typical migrant moves from a low to a high TFP region, leading to an overall increase in the efficiency units of labor worldwide. Part of the welfare benefit of that reallocation is enjoyed by the native stayers through remittances. However, the remittance effect is not always larger than the general equilibrium variety effect. Some important emigration countries, such as Mexico, Trinidad and Tobago, and Turkey, would actually be 1−5% better off in the no-migration counterfactual.

For the sending countries, the short-run impact tends to be similar to the long-run impact. This is because for these countries welfare changes are driven primarily by the loss of remittances, which is the first-order effect in both the short and the long run. By the same token, the distributional impact of migration is also limited in the sending countries, as the impact of emigration on the skill premium is small compared to the remittance effect.

The finding that the receiving countries are better off with immigration may seem unappealing because it appears at odds with the widespread opposition to immigration in high-income countries. However, observed opposition to migration is not evidence against our approach. First of all, even within the model, the receiving countries are better off only in the long run. In the short run, there is nothing in our model that guarantees gains from immigration. Thus, it could be that political opposition is driven by the short-run considerations. Second, our framework features distributional effects, that are especially pronounced in the short run. In many countries, the unskilled experience short-run welfare losses due to immigration, and thus would be expected to oppose it.[2] Finally, the fact that restrictive migration policies are observed in the data is by no means evidence that those policies are welfare-improving, much less optimal. Indeed, there is generally no presumption that observed economic policies are optimal, in any area of economic activity.

The seminal early treatment of the welfare consequences of migration is Berry and Soligo (1969).

[2]For work on the determinants of immigration restrictions see Benhabib (1996), Ortega (2005, 2010), Facchini et al. (2011), or Facchini and Steinhardt (2011). For empirical work on individual attitudes toward immigration see Mayda (2006) and Facchini and Mayda (2009), and Ortega and Polavieja (2012) in the European context.

The existing literature on the quantitative welfare impact of migration has focused almost exclusively on the implications of cross-country labor productivity differences in a neo-classical framework with a fixed set of goods. Hamilton and Whalley (1984), Klein and Ventura (2007, 2009), Benhabib and Jovanovic (2012), and Docquier et al. (2012) develop analyses of this type in one-sector models without international trade. Davis and Weinstein (2002) and Kennan (2013) investigate the welfare effects of migration in the presence of labor-augmenting productivity differences in Ricardian and Heckscher-Ohlin models of trade, respectively. The key consequence of employing a neo-classical framework is that immigration always weakly reduces the welfare of the native workers (i.e., suppliers of the labor input) in the receiving countries.

Our framework incorporates the driving force in these studies – labor productivity differences. The main departure of our analysis from the neo-classical migration literature is endogeneous product variety. This is the key feature qualitatively as well as quantitatively, because it opens the possibility that immigration may improve the native workers' welfare. To our knowledge, the only existing study of migration with endogenous product variety is Iranzo and Peri (2009a), who explore migration between Eastern and Western Europe in a two-country model. Our paper shares with Iranzo and Peri (2009a) the emphasis on market size and endogenous variety, but differs from it in several important respects. First and foremost, our model features bilateral remittances, which we show to be crucial for evaluating the overall welfare effect of migration in a number of sending countries. While both studies find that welfare in the emigration country is higher in the migration equilibrium, the mechanism is different: in Iranzo and Peri (2009a) the main reason is the increase in imported varieties, in our analysis it is mainly due to remittances. Second, our framework is implemented on 60 countries, and incorporates many important aspects of the world economy, such as heterogeneous country-pair specific trade costs, a non-traded sector, and two-way input-output linkages, among others. This allows for both greater realism, as well as a range of outcomes on how migration affects a wide variety of countries depending on their characteristics. And third, our analysis distinguishes between the short-run and the long-run effects of migration.

More broadly, our paper complements the small but growing empirical literature on the firm-level responses to migration and remittances. Lewis (2011) finds that unskilled immigration led to significantly lower rates of adoption of new automation techniques that substitute for unskilled labor. Using data on the universe of German firms, Dustmann and Glitz (2011) find that migration led to an increase in the size of firms that use the abundant factor more intensively, to a greater adoption of production technologies that rely on the more abundant factor, and to firm entry. Yang (2008) finds a positive effect of remittances on the number of household entrepreneurs in the Philippines. Our analysis shares with these papers the emphasis on the interaction between migration and firm decisions, but focuses on the general equilibrium perspective in which migration affects firm entry and exit through changes in overall size of the market and the labor force.

The rest of the paper is organized as follows. Section 2 introduces the migration and remittance data sources, and describes the basic patterns. Section 3 presents the theoretical framework, while Section 4 discusses the quantitative implementation of the model economy. Section 5 presents counterfactual experiments and the main welfare results. Section 6 discusses extensions and sensitivity, and Section 7 concludes.

2 Migration and Remittances: Data Sources and Basic Patterns

To construct the labor force disaggregated by skill level, origin, and destination country we rely on two sources: the aggregate migration stocks for the year 2006 from the OECD International Migration Database and the data for the year 2000 on the labor force for each country in the world by education level, origin, and destination produced by Docquier et al. (2009) and Docquier et al. (2010a). The OECD International Migration Database contains information on the stocks of immigrants by both destination and origin country. We use data for 2006, the most recent year these data are available with comprehensive coverage. An important feature of these data is that they only contain information on 26 OECD destination countries. Thus, while we have data on nearly all origin countries, we only have immigration information for rich country destinations. As a result, strictly speaking, our counterfactual exercise analyzes the consequences of undoing migration to developed countries. Any migration to developing countries will be left unchanged.[3]

The shares of skilled individuals among migrants in 2000 (for ages 25 and above) by origin and destination country are sourced from Docquier et al. (2010a), and the shares of skilled among the native stayers from Docquier et al. (2009). These shares are then applied to the 2006 aggregate migration stocks for each origin-destination country pair. Skilled individuals are those that completed at least one year of college.[4] Remittances data are sourced from Ratha and Shaw (2007).

To calibrate the parameters governing the relative demand for skilled labor in production in each country we estimate skill premia following the approach of Docquier et al. (2010b). First, we use the Barro and Lee (2010) data to compute the average years of education in the two skill groups (individuals with some college education and individuals without) for each country in our sample for the year 2005.[5] Second, to compute the country skill premium we multiply the gap in average

[3] The OECD DIOC-E database contains information on immigrants to both developing and developed countries. The disadvantage of these data is that they are only available up to the year 2000. We made the choice to use the most recent data, at the cost of not being able to evaluate migration into the non-OECD. The reason we took this route was the large migration inflows experienced by the European countries post-2000. For Europe in particular, using data for 2000 would mean that we are missing a large share of current migration. In the 2000 data, the receiving countries in our analysis account for 47% of the global stock of cross-border migrants. The new borders erected after the collapse of the Soviet Union are partly responsible for the high observed migration into the non-OECD. Excluding the former Soviet Union our receiving countries account for 55% of the global migrant stock.

[4] There is a small discrepancy in how the two datasets define a skilled individual. Namely, a skilled native stayer is defined in Docquier et al. (2009) as someone who completed college, rather than had some college. We do not believe this discrepancy to have a material impact on the results.

[5] There is a great deal of variation in the average years of schooling among the unskilled workers across countries.

years of schooling between the two groups by the country-specific return to a year of schooling. Hendricks (2004) has collected Mincerian returns to schooling for a large set of countries that were estimated from micro data.[6] The median return per year of schooling in these data is 7.3%, and the 10th and 90th percentiles are 4.2% and 12.6%. The 10th, 50th, and 90th percentiles for the wage skill premium we obtain are 26%, 43%, and 106%.

We carry out the analysis on the sample of the largest 49 countries in the world by total GDP, plus a selection of 11 smaller countries that have experienced migration outflows of 10% or more of the native labor force. These 60 countries together cover 98% of world GDP. There is a 61st rest of the world category. We exclude the entrepôt economies of Hong Kong and Singapore, both of which have total trade well in excess of their GDP due to significant re-exporting activity, and place them into the rest-of-the-world category. The sources and details for the other data used in the quantitative exercise are described when we discuss the calibration.

Table 1 lists the OECD countries in the sample and reports the share of immigrants (foreign-born), the share of emigrants, the counterfactual population change, the size of net remittances relative to GDP, and the share of skilled workers among stayers, immigrants, and emigrants. These are the countries for which data on immigrant stocks for 2006 are available.[7] Table 2 reports the shares of emigrants and remittances as a share of GDP for the non-OECD countries. The population change in the counterfactual in the non-OECD coincides with the share of emigrants.

Several points are worth noting. First, the data reveal a great deal of dispersion in immigration and emigration shares. At one extreme there are countries such as Australia and New Zealand, where 25% of the population are foreign-born. At the other, El Salvador, Trinidad and Tobago, and Jamaica display emigration shares in the 20−30% range.[8] Second, some of the OECD countries have large gross stocks of both immigrants and emigrants. As a result, if migration had never taken place their population would be roughly the same (the third column). Ireland is the clearest example: its share of immigrants is 13%, but the share of emigrants is 16%. In a world without migration, its population would only be 3% higher.

The table also reports the net remittances in each country as a share of GDP. Negative values

In the U.S. the average years of schooling among individuals that did not attend college was 10.95. The cross-country variation in this variable is from 1.01 (Mali) to 12.80 years (Czech Republic). By contrast, among the skilled the cross-country variation in the years of schooling is much smaller, ranging from 14.15 to 15.94 in the Barro and Lee (2010) data.

[6]We try to use estimates based on 1995 data, which is the most recent period reported by Hendricks (2004). If the Mincerian coefficient estimate is not available for a country we follow Docquier et al. (2010b) and impute that value on the basis of estimates from neighboring countries with similar levels of income per capita.

[7]Throughout the paper we use the shorthand "OECD" to refer to the group of the 26 countries for which immigration data are available in our database, and "non-OECD" to describe the rest of the country sample. The "OECD" group is predominantly the wealthy, net immigration countries. Formally, the Organization for Economic Cooperation and Development has additional member countries, such as Mexico and Turkey.

[8]Once again, for these countries we are reporting data on emigration to OECD countries only. In the counterfactual these countries only experience a return of their emigrants, but not the exit of the immigrants residing in these countries.

mean that a country is a net sender of remittances. Clearly, most OECD countries send more remittances than they receive, but the total net remittances are only a small share of GDP, ranging from −1% (Australia) to +1% (Portugal). In contrast, remittances are large relative to GDP for several non-OECD countries. For instance, Colombia, India, Mexico, and Nigeria report remittances of 3% of GDP. However, these are small compared to Jamaica (20%), Serbia and Montenegro (19.1%), El Salvador (17.8%), Philippines (15.5%) and the Dominican Republic (14.3%). Hence, for these countries it will be important to take remittances into account when evaluating the welfare impact of migration.

Across all origin-destination pairs, the share of skilled is 0.25, with a standard deviation of 0.24. There is large heterogeneity in the share of skilled among immigrants relative to the natives of the host country. For instance, U.S. immigrants are relatively unskilled, by our measure of educational attainment: 52% of U.S.-born stayers are skilled, compared to 42% of immigrants into the U.S.. By contrast, in Canada immigrants are relatively skilled (58%) compared to native stayers (49%).

3 Theoretical Framework

Our framework augments an otherwise standard multi-country heterogeneous-firm model of production and trade with three elements that are crucial for a global quantitative assessment of the gains from migration: cross-country labor productivity differences, worker heterogeneity (across skills as well as between natives and immigrants), and remittances. We consider a monopolistically competitive setup with endogenous product variety and fixed costs of production and exporting. Production uses skilled and unskilled labor and intermediate inputs.

3.1 Preferences, Welfare, and Love for Variety

The world is comprised of $\mathcal{C}$ countries, indexed by $i, j = 1, \ldots, \mathcal{C}$. In each country there are two broad sectors, the tradeable T and the non-tradeable N. In country i, a consumer with income y_i maximizes

$$\max_{\{y_i^N(k), y_i^T(k)\}} \left(\int_{J_i^N} y_i^N(k)^{\frac{\varepsilon_N - 1}{\varepsilon_N}} dk \right)^{\alpha \frac{\varepsilon_N}{\varepsilon_N - 1}} \left(\int_{J_i^T} y_i^T(k)^{\frac{\varepsilon_T - 1}{\varepsilon_T}} dk \right)^{(1-\alpha)\frac{\varepsilon_T}{\varepsilon_T - 1}}$$

$$s.t.$$

$$\int_{J_i^N} p_i^N(k)\, y_i^N(k)\, dk + \int_{J_i^T} p_i^T(k)\, y_i^T(k)\, dk = y_i,$$

where $y_i^s(k)$ is consumption of good k belonging to sector $s = N, T$ in country i, $p_i^s(k)$ is the price of this good, J_i^s is the mass of varieties available in sector s in country i coming from all countries, and ε_s is the elasticity of substitution between varieties in s. Standard steps yield an expression for welfare – that is, the indirect utility function – of an individual with income y_i living in country i:

$$W_i(y_i) = \frac{y_i}{\left(P_i^N\right)^{\alpha}\left(P_i^T\right)^{1-\alpha}}, \tag{1}$$

where P_i^s is the ideal price index in sector $s = N, T$ in country i:

$$P_i^s = \left[\int_{J_i^s} p_i^s(k)^{1-\varepsilon_s} dk\right]^{\frac{1}{1-\varepsilon_s}}. \tag{2}$$

Welfare is thus simply equivalent to real income. In our model, an individual's nominal income y_i may be composed of (i) labor income, (ii) profits of firms, and (iii) remittances, though some of these may be zero in some cases. Thus migration will have an impact on welfare through nominal income to the extent that it affects any of these three terms for an individual, either directly or through general equilibrium effects.

Welfare falls in the consumption price level $\left(P_i^N\right)^{\alpha}\left(P_i^T\right)^{1-\alpha}$. We assume that $\varepsilon_s > 1$, $s = N, T$ (Dixit and Stiglitz, 1977). The key consequence of this assumption is that preferences exhibit love for variety: holding nominal expenditure and individual goods prices fixed, the agent attains higher utility when the set of goods J_i^N and J_i^T available for consumption increases. Thus, to the extent that migration affects the equilibrium set of varieties available in economy i, it will have a welfare impact through that channel as well.

In our framework, incomes differ across individuals within each country. However, preferences are identical and homothetic, and thus admit a representative consumer. Total income Y_i in country i is the sum of labor income $w_i L_i$, net profits (if any) in the two sectors $\Pi_i^N + \Pi_i^T$, and net remittances received from abroad R_i: $Y_i = w_i L_i + \Pi_i^N + \Pi_i^T + R_i$. Since consumer preferences are Cobb-Douglas in the CES aggregates of N and T, it is well known that consumption expenditure on sector N is equal to αY_i, and on T sector, $(1-\alpha)Y_i$.

3.2 Migration, Productivity, and Labor Force Composition

Each country's labor force is composed of natives and immigrants, who can be unskilled or skilled, indexed by $e = \ell, h$ respectively. Denote by N_{ji}^e the number of workers with skill level e born in country i that live in country j (throughout the paper, we adopt the convention that the first subscript denotes the destination country, and the second subscript, the source). As in Trefler (1993, 1995), the effective labor endowment is a combination of the number of people that live in a country and their efficiency units. We build on this approach by taking explicit account of migration. Workers of skill level e born in country i and working in country j have A_{ji}^e efficiency units of labor. Skilled and unskilled labor are imperfect substitutes in production. Specifically, the total effective labor in country j, L_j, is given by the CES aggregate:

$$L_j = \left[\left(\sum_{i=1}^{\mathcal{C}} A_{ji}^{\ell} N_{ji}^{\ell} \right)^{\frac{\sigma-1}{\sigma}} + \zeta_j \left(\sum_{i=1}^{\mathcal{C}} A_{ji}^{h} N_{ji}^{h} \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad (3)$$

where σ is the elasticity of substitution between skilled and unskilled labor, ζ_j captures the relative importance of skilled labor in production, and, of course, the endowments of labor of each type include the native workers and their efficiency, $A_{jj}^{e} N_{jj}^{e}$, $e = \ell, h$.

This approach to modelling the labor force is flexible enough to capture a number of features that are important for evaluating the impact of migration. First and foremost, the framework accommodates the (large) observed cross-country labor productivity differences through differences in the A_{ji}^{e}'s. Second, skilled workers are more productive than unskilled workers. And third, conditional on skill level, immigrants may differ from native workers in how many efficiency units of labor they possess. To streamline notation and link the productivity parameters more transparently to observed wages, it is useful to denote the *skilled-unskilled productivity gap* among natives by

$$\frac{A_{jj}^{h}}{A_{jj}^{\ell}} \equiv \mu_j \geq 1, \quad (4)$$

and *native-immigrant productivity gaps* for immigrants of origin $i \neq j$ and skill level e by

$$\frac{A_{ji}^{e}}{A_{jj}^{e}} \equiv \phi_{ji}^{e}. \quad (5)$$

The latter feature allows us to account for native-immigrant wage differences conditional on educational attainment. The quantitative implementation uses several empirically relevant parameterizations of the productivity differential ϕ_{ji}^{e}, that can capture a number of reasons for migrant-native productivity differences, such as imperfect skill transferability or selection into migration.

Combining (3), (4), and (5), L_j can be rewritten as:

$$L_j = A_{jj} \left[\left(\sum_{i=1}^{\mathcal{C}} \phi_{ji}^{\ell} N_{ji}^{\ell} \right)^{\frac{\sigma-1}{\sigma}} + \zeta_j \left(\mu_j \sum_{i=1}^{\mathcal{C}} \phi_{ji}^{h} N_{ji}^{h} \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad (6)$$

where to simplify notation we relabelled the unskilled native productivity as $A_{jj}^{\ell} = A_{jj}$, which can be interpreted as the economy-wide productivity level.

In this framework, immigrants are not the same as natives in two ways that will condition the impact of immigration. First, the share of skilled among immigrants can differ from the share of skilled among the natives. Since the skilled and the unskilled are imperfect substitutes in production, the skill composition of the immigrant population will have an effect on both the aggregate supply of labor, and on the relative wages of the skilled compared to the unskilled. Second, immigrants may have different productivity than the natives within the same skill category.

This distinction has an impact on how much a given stock of foreign-born individuals changes the effective supply of labor of a particular skill level.

The baseline framework makes a number of simplifying assumptions, some of which will be relaxed in the extensions. First, immigrant and native labor of the same skill level are perfect substitutes. Appendix B.2 develops an extension in which immigrants and natives are imperfectly substitutable in production (Manacorda et al., 2012; Ottaviano and Peri, 2012), and shows that the main results are robust. Second, the productivity terms A^e_{ji}, while calibrated to data, are exogenous. Appendix B.4 relaxes this assumption and allows worker productivity to be a function of the share of skilled in the population (see, e.g., Jones, 2002).

3.3 Technology

Importantly in our framework, the sets of available goods J^T_i and J^N_i will differ across countries due to trade costs, and will be affected by migration. The market structure is monopolistic competition as in Melitz (2003). Each country j is populated by a mass n^s_j of entrepreneurs in sector s. Each entrepreneur k in each sector $s = N, T$ and $j = 1 \ldots, \mathcal{C}$ has the ability to produce a unique variety and thus has some market power. Productivity is heterogeneous: entrepreneur k needs $a(k)$ input bundles to produce one unit of its good (thus more productive firms have *lower* $a(k)$). Since each entrepreneur is able to produce only one good with a particular productivity, we use the terms "entrepreneur" and "project" interchangeably.

Each entrepreneur in country j and sector s must incur a fixed cost f^s_{jj} to start production, and as a result not all entrepreneurs decide to produce. We reserve the term "firm" for those entrepreneurs that actually undertake production. In sector T, to start exporting from country j to country i, a firm must pay a fixed cost f_{ij}, and an iceberg per-unit cost of $\tau_{ij} > 1$, with the iceberg cost of domestic sales normalized to one: $\tau_{jj} = 1$. We assume that trade costs are infinite in the non-traded sector, and thus firms in sector N only sell domestically.

Production uses skilled labor, unskilled labor, and intermediates from sectors N and T. The production function is Cobb-Douglas in the labor, T, and N composites. The labor composite is a CES aggregate of skilled and unskilled workers as in (3). The sector $s = N, T$ composites are CES aggregates of sector s varieties available in the country. The minimized cost of one unit of the input bundle in country j is given by

$$c^s_j = w^{\beta_s}_j \left[\left(P^N_j\right)^{\eta_s} \left(P^T_j\right)^{1-\eta_s} \right]^{1-\beta_s}, \tag{7}$$

where w_j is the composite wage (i.e., the price of one unit of L) in country j, and P^s_j is the price of sector s CES composite, given by (2). Parameters β_s and η_s correspond, respectively, to the share of labor in total sales and the share of non-tradeable inputs in total input usage in each sector s.

Thus, firm k in sector s from country j has a marginal cost $\tau_{ij} c^s_j a(k)$ of serving market i. Firms and consumers in country i have a demand for an individual variety k from sector s that is given by

$$x_i^s(k) = \frac{X_i^s}{(P_i^s)^{1-\varepsilon_s}} p_i^s(k)^{-\varepsilon_s}, \tag{8}$$

where X_i^s denotes the total spending – final plus intermediate – on sector s in country i.

Productivity heterogeneity combined with fixed costs of production and trade imply that not all firms will decide to serve all markets. As is well known, profit maximization yields a price that is a constant markup $\varepsilon_s/(\varepsilon_s - 1)$ over marginal cost, and the total ex-post variable profits from selling to market i are a constant multiple $1/\varepsilon_s$ of revenue. Given the price level and total spending, there is a cutoff unit input requirement a_{ij}^s above which firms in country j do not serve market i. This cutoff is found as the unit input requirement at which the firm obtains zero profits from serving market i, and is given by:

$$a_{ij}^s = \frac{\varepsilon_s - 1}{\varepsilon_s} \frac{P_i^s}{\tau_{ij} c_j^s} \left(\frac{X_i^s}{\varepsilon_s c_j^s f_{ij}^s} \right)^{\frac{1}{\varepsilon_s - 1}}. \tag{9}$$

We adopt the standard assumption that firm productivity in sector s, $1/a$, follows a Pareto(b_s, θ_s) distribution: $\Pr(1/a < y) = 1 - (b_s/y)^{\theta_s}$, where b_s is the minimum value labor productivity can take, and θ_s regulates dispersion. It is then straightforward to show that the unit input requirement, a, has a distribution function $G(a) = (b_s a)^{\theta_s}$. Under this distributional assumption, we can combine (2) and (9) to derive expressions for the price indices:

$$P_i^s = \left\{ \sum_{j=1}^{\mathcal{C}} \int_{J_{ij}^s} \left[\frac{\varepsilon_s}{\varepsilon_s - 1} \tau_{ij}^s c_j^s a(k) \right]^{1-\varepsilon_s} dk \right\}^{\frac{1}{1-\varepsilon_s}} = \left(\sum_{j=1}^{\mathcal{C}} n_j^s \int_0^{a_{ij}^s} \left[\frac{\varepsilon_s}{\varepsilon_s - 1} \tau_{ij}^s c_j^s a \right]^{1-\varepsilon_s} dG(a) \right)^{\frac{1}{1-\varepsilon_s}} \tag{10}$$

$$= \frac{1}{b_s} \left[\frac{\theta_s}{\theta_s - (\varepsilon_s - 1)} \right]^{-\frac{1}{\theta_s}} \frac{\varepsilon_s}{\varepsilon_s - 1} \left(\frac{X_i^s}{\varepsilon_s} \right)^{-\frac{\theta_s - (\varepsilon_s - 1)}{\theta_s(\varepsilon_s - 1)}} \left(\sum_{j=1}^{\mathcal{C}} n_j^s \left(\tau_{ij}^s c_j^s \right)^{-\theta_s} \left(c_j^s f_{ij}^s \right)^{-\frac{\theta_s - (\varepsilon_s - 1)}{\varepsilon_s - 1}} \right)^{-\frac{1}{\theta_s}}, \tag{11}$$

where J_{ij}^s is the set of varieties from country j that gets exported to country i.[9]

Trade is not balanced because of remittances. Let R_i denote the net remittances *received* by country i, which can be positive (for countries receiving remittances), or negative (for countries sending them).[10] Remittance-receiving countries will be able to afford imports above the value of their exports, while the opposite will be true for countries with negative net remittances.

[9] It is understood that in the non-traded sector $\tau_{ij}^N = \infty \; \forall i \neq j$, and thus the summations are in effect over one non-zero element, $j = i$.

[10] Of course, for the world as a whole, remittances sum to zero: $\sum_i R_i = 0$. The data on remittances used below to implement the model satisfy this requirement.

3.4 Short-Run and Long-Run Equilibria

In assessing the welfare impact of migration, we consider two types of equilibria. The two equilibria differ in their assumptions on the mass of projects n_i^s in each country and sector.

The short-run equilibrium assumes that the set of projects n_i^s is fixed in each country and sector, as in Chaney (2008) and Eaton et al. (2011), and thus it cannot adjust to changes in the labor force. A *short-run monopolistically competitive equilibrium* is a set of prices $\left\{w_i, P_i^N, P_i^T\right\}_{i=1}^{\mathcal{C}}$, and factor allocations such that (i) consumers maximize utility; (ii) firms maximize profits; and (iii) all goods and factor markets clear, given country endowments L_i and n_i^s.

In the long-run equilibrium, the set of projects n_i^s is an equilibrium outcome that responds to changing economic conditions, in our case migration. Each country has a potentially infinite number of entrepreneurs (projects) with zero outside option. In order to become an entrepreneur, an agent must pay an "exploration" cost f_E. Upon paying this cost, the entrepreneur k discovers her productivity, indexed by a unit input requirement $a(k)$, and develops an ability to produce a unique variety of N or T valued by consumers and other firms. The equilibrium number of projects n_i^s is then pinned down by the familiar free entry condition in each sector and each country, as in Krugman (1980) and Melitz (2003). A *long-run monopolistically competitive equilibrium* is a set of prices $\left\{w_i, P_i^N, P_i^T\right\}_{i=1}^{\mathcal{C}}$, equilibrium masses of projects $\left\{n_i^N, n_i^T\right\}_{i=1}^{\mathcal{C}}$, and factor allocations such that (i) consumers maximize utility; (ii) firms maximize profits; (iii) all goods and factor markets clear; and (iv) the net profits in the economy equal zero, given country endowments L_i $\forall i$.

Appendix A.1 presents the complete equations defining both types of equilibria.

3.5 Mechanisms

Immigration into country i increases L_i. In addition to its impact on nominal wages, immigration will affect the natives' welfare by changing equilibrium product variety. The vectors of n_j^s's and the array of cutoffs (9) together determine the set of varieties offered in each country.[11] An increase in the set of varieties available in country i implies a lower price level and, other things equal, higher utility/real income. Consumers benefit directly from the variety-induced reduction in the price level, as well as indirectly through cheaper intermediate inputs available to firms.

However, in the presence of firm heterogeneity not all varieties are equally valuable: an unproductive variety (higher $a(k)$) raises welfare by less than a more productive one. Thus, changes in equilibrium variety due to movements in a_{ij}^s's have a smaller welfare impact than those coming from changes in the n_j^s's. This is because movements in the a_{ij}^s's correspond to entry/exit of the least productive firms in the economy, whereas movements in n_j^s's result in entry/exit along the entire firm size distribution.

[11] For instance, the measure of *domestic* varieties available in sector s in country i is equal to $n_i^s G(a_{ii}^s)$. Of course, the total variety in the T sector is the sum of domestic and imported varieties.

In this respect, the critical difference between the long run and the short run is that in the long run, n_j^s's will change in response to migration. In the short run, the set of projects n_j^s is fixed. However, even in the short run the set of *actual* firms that serve the market – and thus the equilibrium product variety in the economy – will still change due to migration. This is because generically, not all projects are implemented in equilibrium, and migration changes the cutoffs a_{ii}^s/a_{ij}^s for producing and exporting. Entry and exit do occur in the short run, but they are confined to the marginal firms, which are the least productive in the economy.

By contrast, in the long run entry/exit of firms will occur along the entire productivity distribution, rather than only among the least productive firms. A well-known property of monopolistic competition models with free entry is that n_i^s increases in L_i: larger countries have a greater set of projects.[12] Migration thus affects welfare in the long run by changing n_i^s. Natives in countries that end up with larger L_i because of immigration will be better off, all else equal, because immigration will lead to greater equilibrium variety (see the expressions for the price indices (11)).

International trade will mitigate this effect because changes in the availability of foreign varieties also have a welfare impact. For instance, suppose that country i loses workers to country j. As a result, product variety will fall in i and rise in j.[13] From Equation (11), it is clear that an increase in foreign n_j^T will also have a positive impact on welfare in country i due to an increase in the set of varieties imported from j. However, due to trade costs increases in foreign n_j^T are less valuable for country i than increases in its own n_i^T and n_i^N. Thus, while greater imported variety will counteract the impact of migration on domestically available variety, it will not do so fully, and the size of this mitigation effect is ultimately a quantitative question. We answer it below by calibrating the size of the non-traded sector and the trade costs in the traded sector, and by comparing the main results to an alternative counterfactual exercise in which the trade channel is turned off.

By contrast, input-output linkages embodied in the cost function (7) will raise the welfare impact of changes in domestically available varieties, and will thus amplify the welfare impact of migration. The magnitude of this effect is a quantitative question, and thus we calibrate the parameters β_s and η_s that regulate the strength of input-output linkages based on observed Input-Output tables.

Finally, though capital is not explicitly in the model, one can follow the interpretation suggested by Ghironi and Melitz (2005) and Bergin and Corsetti (2008) that the set of projects available to entrepreneurs is a form of the capital endowment. Similarly, the creation of new firms is a form of capital investment. This interpretation is natural in the sense that these projects are in effect a factor of production without which workers cannot generate output. Thus, the short-run

[12]While the full-fledged, multi-sector model with unbalanced trade in this paper cannot be used to show this relationship analytically, di Giovanni and Levchenko (2010, 2012) show the positive relationship between L_i and n_i^s in somewhat simpler models with symmetric countries.

[13]The exact change in variety in each country will depend on the labor productivity parameters A_{ii} and A_{jj}. If we assume that the origin country has lower labor productivity than the destination – as is typically the case – then there may be a net increase in worldwide product variety.

equilibrium corresponds to a case in which the other factors of production – n_j^s here – have not had a chance to adjust to the new endowment of labor, whereas the long-run equilibrium is the one that obtains after the adjustment of other factors.

4 Quantitative Implementation and Model Fit

We numerically implement the model laid out in Section 3. We use information on country sizes, fixed and variable trade costs, and bilateral migration flows and remittances to solve the model in the baseline scenario, that is, under the observed levels of migration and remittances. Then in Section 5 we simulate the effects of un-doing the migration flows observed in the data. That is, we repatriate all immigrants in the OECD countries back to their countries of origin. Table 3 summarizes the calibrated parameter values of the model, and Appendix A.2 discusses the details of how the parameters are chosen.

4.1 Labor Productivity Parameters

To complete the implementation of the baseline scenario requires finding the values of L_j, or equivalently, A_{jj}. While we have actual data on the numbers of natives and immigrants N_{ji}^e in each origin and destination, L_j is not population *per se*, but a combination of the number of workers and the efficiency units – or labor productivity – possessed by workers in country j (Section 3.2).

To find L_j we follow the approach of Alvarez and Lucas (2007). Starting with an initial guess for L_j for all $j = 1, \ldots, \mathcal{C}$, we solve the full model in the long run equilibrium. Given the solution for w_j, we update our guess for L_j for each country in order to match the nominal US\$ GDP ratio between each country j and the U.S.. Using the resulting values of L_j, we solve the model again to obtain the new set of wages, and iterate to convergence. Thus, our procedure generates vectors w_j and L_j in such a way as to match exactly the relative total GDPs of the countries in the sample while imposing that the model world economy is in the long-run equilibrium.

Having obtained the total efficiency-adjusted labor endowments L_j, and using the data on bilateral immigrant stocks by skill for each destination and origin country, we obtain country-specific productivity A_{jj} for every country j from (6):

$$A_{jj} = \frac{L_j}{\left[\left(\sum_{i=1}^{\mathcal{C}} \phi_{ji}^{\ell} N_{ji}^{\ell}\right)^{\frac{\sigma-1}{\sigma}} + \zeta_j \left(\mu_j \sum_{i=1}^{\mathcal{C}} \phi_{ji}^{h} N_{ji}^{h}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}}. \quad (12)$$

Intuitively, this procedure infers productivity from total country GDPs and the labor force composition of each country. Section 4.2 checks that the resulting productivity estimates are plausible. A notable consequence of this approach is that, controlling for population, countries with higher labor productivity A_{jj} will tend to have a greater number of entrepreneurs n_j^s, all else equal, since our procedure will give them a higher L_j.[14]

The calculation above requires assigning values to (i) the term $\zeta_j \mu_j^{\frac{\sigma-1}{\sigma}}$, and (ii) ϕ^e_{ji}. We calibrate $\zeta_j \mu_j^{\frac{\sigma-1}{\sigma}}$ using skill premia. Optimal factor usage implies the following relationship:

$$\frac{w^h_j}{w^\ell_j} = \zeta_j \mu_j^{\frac{\sigma-1}{\sigma}} \left(\frac{\sum_{i=1}^{\mathcal{C}} \phi^h_{ji} N^h_{ji}}{\sum_{i=1}^{\mathcal{C}} \phi^\ell_{ji} N^\ell_{ji}} \right)^{-\frac{1}{\sigma}},$$

where w^e_j is the wage of the worker of skill level $e = \ell, h$. Using country-specific data on the skill premium w^h_j / w^ℓ_j described in Section 2 as well as the population composition by skill $\sum_{i=1}^{\mathcal{C}} \phi^h_{ji} N^h_{ji}$ and $\sum_{i=1}^{\mathcal{C}} \phi^\ell_{ji} N^\ell_{ji}$ allows us to back out the combination $\zeta_j \mu_j^{\frac{\sigma-1}{\sigma}}$ of the skill share parameter and the skilled worker's productivity advantage. This procedure ensures that the baseline equilibrium matches perfectly the observed skill premium in each country.

On ϕ^e_{ji}, we adopt three approaches. The first is to assume that $\phi^\ell_{ji} = \phi^h_{ji} = 1$, common across all countries. In this case, the average equilibrium wages of natives and immigrants with the same skill level will be equal within each country (although they will of course differ across countries). This will be our baseline scenario as we find it helpful in conveying the main mechanisms driving our results. It corresponds to the broad pattern in the data that the wages of migrants are well approximated by the wages of the natives in the host country, and are often an order of magnitude larger than wages of similar workers in the source country (Pritchett, 2006).

We check the robustness of the results to two alternative calibrations of $\{\phi^e_{ji}\}$. The first captures a plausible amount of imperfect cross-border transferability of skills. The second allows for origin-specific native-immigrant productivity gaps that reflect migrant selection (positive or negative), or differences in the quality of education across countries. The results and a more detailed discussion are in Section 6 and Appendix B.1.

4.2 Model Fit

Before describing the counterfactual results, we assess the model fit on overall and bilateral trade, as well as on how the total labor productivities implied by the model compare to GDP per capita at the country level. The baseline is solved as the long-run equilibrium given the population compositions, total GDPs, and remittances in all countries as they are in the data in 2006.

Table 4 compares the bilateral and overall trade volumes in the model and in the data. Note that since in the data we only have bilateral trade as a share of GDP, not of total sales, we compute the same object in the model: $\pi_{ij} = X_{ij}/w_i L_i$.[15] This captures both the distinction between trade, which is recorded as total value, and GDP, which is recorded as value added; as well as the fact that there is a large non-traded sector in both the model and in the data.

[14] That is, population and efficiency enter symmetrically and multiplicatively in determining market size, which in turn determines equilibrium variety. This approach is common in the literature. For instance, Alvarez and Lucas (2007) and Chaney (2008) assume that the number of productivity draws is a constant multiple of L_j.

[15] Since the baseline is solved as the long-run equilibrium, total profits are zero and GDP is simply labor income.

The top panel of the table compares the share of domestically produced goods in GDP, π_{ii}, which is one minus imports/GDP, and can be thought of as the opposite of trade openness. It is clear that the overall trade volumes implied by the model match the actual data well. The means and medians are similar, and the correlation between π_{ii} calculated from the model and those in the data for this sample of countries is around 0.57. The bottom panel compares bilateral trade shares π_{ij}, $i \neq j$. The average levels are quite similar, and the correlation between model and data bilateral trade shares is actually higher at 0.78. Since we use estimated gravity coefficients together with the actual data on bilateral country characteristics to compute trade costs, it is not surprising that our model fits bilateral trade data quite well given the success of the empirical gravity relationship. Nonetheless, since the gravity estimates we use come from outside of our calibration procedure, it is important to check that our model delivers outcomes similar to observed trade volumes.

The model delivers a vector of implied baseline labor productivities A_{jj} for each country, and we would like to compare these estimates to the data. Unfortunately, as a model object A_{jj} reflects the physical productivity of a worker, which we cannot measure in the data. In addition, in the model wages of a single efficiency unit of labor, w_j, will differ across countries to ensure global market clearing. To match the model precisely with the data, we calculate in the model the real PPP-adjusted per capita income for an individual living in j, which is given by $\frac{w_j L_j}{P_j \sum_i \sum_{e=\ell,h} N_{ji}^e}$, with $P_j = (P_j^N)^\alpha (P_j^T)^{1-\alpha}$ the consumption price level, and $\sum_i \sum_{e=\ell,h} N_{ji}^e$ simply the total population of country j. This object is then directly comparable to income data from the Penn World Tables. Figure 1 presents the scatterplot of the real PPP-adjusted per capita income for 2006 from the Penn World Tables on the x-axis against the corresponding object in the model, along with the 45-degree line. The model matches the broad variation in per capita income in our sample of countries quite well. The countries line up along the 45-degree line, though it appears that the model tends to underpredict the relative income levels of poorer countries, and slightly over-predict the relative income levels of the richest countries. Overall, however, both the simple correlation and the Spearman rank correlation between the model and the data are 0.94.[16]

5 Counterfactuals

Our counterfactual experiments evaluate the welfare effects of sending all foreign-born individuals currently living in the OECD countries back to their countries of birth. In the counterfactual

[16] The plots and the correlations are reported dropping the United Arab Emirates, for which the model underpredicts real per capita income by about a factor of 2. The U.A.E. is a very small, special economy for which we do not have immigration data, and thus the poor performance of the model regarding the U.A.E. is highly unlikely to affect any of the substantive results in the paper. Including the U.A.E., the simple correlation between the model and the data is 0.91, and the Spearman correlation is still 0.94.

scenario effective labor endowments of each country j will be:

$$\widetilde{L}_j = A_{jj}\left[\left(\sum_{i=1}^{\mathcal{C}} N_{ij}^{\ell}\right)^{\frac{\sigma-1}{\sigma}} + \zeta_j\left(\mu_j \sum_{i=1}^{\mathcal{C}} N_{ij}^{h}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}. \quad (13)$$

That is, all the workers native to j that ever migrated to any destination country i are returned home. Their labor productivity is assumed to be the same as for their compatriots with the same skill, regardless of whether and where they migrated.[17]

Our main measure of welfare is the average utility of native stayers, taking into account the distribution of skill levels among them.[18] Individual welfare is given by (1). In the baseline equilibrium the welfare of the native stayers (born and residing in j) is given by

$$W_{jj} = \frac{(1-\omega_{jj})w_j^{\ell} + \omega_{jj}w_j^{h} + (\Pi_j^N + \Pi_j^T)/\sum_{e=\ell,h}\sum_{k=1}^{\mathcal{C}} N_{jk}^{e} + R_j^{in}/N_{jj}}{(P_j^N)^{\alpha}(P_j^T)^{1-\alpha}},$$

where, as above, w_j^e is the wage of a native-born individual of skill level e, $\omega_{jj} \equiv N_{jj}^h/(N_{jj}^{\ell} + N_{jj}^h)$ is the share of skilled among the natives, $N_{jj} = N_{jj}^{\ell} + N_{jj}^h$ is the total population of natives, $\sum_{e=\ell,h}\sum_{k=1}^{\mathcal{C}} N_{jk}^e$ is the total population of country j, and R_j^{in} is the total gross amount of remittances received by country j.[19]

This expression for welfare thus makes an assumption on remittances and an assumption on the distribution of firm profits. On remittances, we assume that (i) outgoing remittances are sent by the migrants only, that is, natives living in their home country are not transferring any of their income abroad; and that (ii) incoming remittances are received by the native stayers only, that is, remittances from abroad coming into the country go to natives, and not to immigrants living in that country.[20] On profits, we assume that all residents of a country have an equal number of shares in domestic profits, regardless of their skill level or country of birth.[21] This is a strong assumption, but it only matters in the short run. In the long run, profits are zero due to free entry.

[17] In reality, return migrants may bring back skills learned at the destination country. However, there are very few estimates available for the rates of return to those skills. For more details see Dustmann (2003, 2008), and Dustmann et al. (2011). See also Rauch and Trindade (2002, 2003) for estimates of the effects of migration on enhancing trade flows via the information conveyed through ethnic networks.

[18] Appendix B.6 reports estimates of the welfare changes for the migrants themselves.

[19] Recall that R_j was used to denote the total *net* remittances received by country j from the rest of the world, which can take both positive and negative values.

[20] For example, remittances from Mexicans working in the United States are received by native Mexicans living in Mexico, and not by Guatemalan immigrants living in Mexico or by Mexicans living in Spain. We lack data to evaluate the plausibility of this assumption but it appears reasonable and unlikely to bias the results.

[21] We are not aware of a good empirical benchmark that directly speaks to the question of the immigrants' share of a country's total profits. However, it is helpful to compare the entrepreneurship rates of natives and immigrants. Fairlie (2012) reports a higher business ownership rate among immigrants (10.5%) than among natives (9.3%) in the U.S.. Likewise the start-up rate is also higher for immigrants than for non-immigrants (0.62% versus 0.28%). However, these figures are likely to overestimate the share of profits accruing to immigrants because immigrant-owned businesses tend to be smaller than native-owned ones. According to Fairlie (2012) immigrant-owned businesses have about 30% lower revenue. In light of these numbers it appears reasonable to allocate aggregate profits to natives and immigrants in proportion to their population shares.

In the counterfactual scenario each country's population is composed of the individuals that were born in that country, including both those that never left and returnees. The expressions for individual welfare in the counterfactual equilibrium are analogous to the expressions above, with the proviso that there are no longer any remittances. Hence, the counterfactual individual welfare of a native stayer in country j is given by

$$\widetilde{W}_{jj} = \frac{(1-\omega_{jj})\widetilde{w}_j^{\ell} + \omega_{jj}\widetilde{w}_j^{h} + (\widetilde{\Pi}_j^N + \widetilde{\Pi}_j^T)/\sum_{k=1}^{\mathcal{C}} N_{kj}}{(\widetilde{P}_j^N)^{\alpha}(\widetilde{P}_j^T)^{1-\alpha}}, \tag{14}$$

where the tilde denotes the counterfactual equilibrium values.

The change in the average welfare of natives between the baseline and the no-migration scenarios is closely related to the concept of the *immigration surplus*, defined as the change in the real average income of natives caused by an inflow of immigrants (Berry and Soligo, 1969; Borjas, 1995). Virtually all studies that quantify the immigration surplus employ a one-good framework and a standard neoclassical production function. In our framework each firm produces a different good and product variety is endogenous. In this context income is deflated by the ideal price index, which encapsulates the impact of changes in product variety on firms and consumers. But it is still the case that real income per native, our main welfare criterion, coincides with the immigration surplus also in per-native terms.

5.1 The Long Run

Table 5 reports our main results. For each country, we report the percent change in the real average income of native stayers (across the two skill levels) in the no-migration counterfactual relative to the benchmark scenario. Negative values thus represent welfare losses from undoing international migration. We break up the sample into the OECD and the non-OECD countries. Roughly, we can think of the OECD group (left panel) as the migrant-receiving countries and the non-OECD group (right panel) as the migrant-sending countries, though keeping in mind that there is substantial migration within the OECD as well.

The first important observation is that in the long run the large majority of OECD countries would be worse off in the absence of migration. The average OECD country would experience a welfare change of -2.38%, with substantial dispersion in outcomes (standard deviation of 3.07%). In this group, the largest losses are experienced by the natives of the countries with the largest observed shares of the foreign-born in the population: Australia (-11.63%), Canada (-7.07%), and New Zealand (-6.89%). However, it is worth noting that a handful of OECD countries would experience welfare gains: Greece, Korea, and Portugal would all be about $1.1-1.4\%$ better off in the no-migration counterfactual. As Table 1 shows, these are the OECD countries with noticeable net out-migration. In the no-migration counterfactual these countries' population would rise by 5.2%, 2.8%, and 11.1%, respectively.

Second, the majority of non-OECD countries also have lower welfare in the no-migration counterfactual, although dispersion in country outcomes is substantial. The average welfare change is −2.00% with an associated standard deviation of 3.55%. The highest welfare losses are to native stayers in El Salvador, the Dominican Republic, Jamaica, and the Philippines, at around −7−10%. Interestingly, a handful of non-OECD countries experience welfare gains: mainly, Trinidad and Tobago (5.70%), Mexico (1.32%), and Turkey (1.07%). A quick glance at Table 2 shows that these countries are characterized by substantial emigration rates but small incoming remittances relative to their GDP and to their emigration rates. For instance, while Mexico has an emigration rate over 10%, remittances amount to only 3.1% of its GDP. In contrast, the emigration rate of the Philippines is around 3% but their incoming remittances are equal to 15.5% of its GDP.[22]

Thus, both developed and developing countries tend to gain from the observed levels of migration. In the OECD, net immigration leads to a larger market size. In the presence of positive trade costs, this implies higher equilibrium variety and thus higher per capita welfare. For the native stayers in the non-OECD, the losses from lower variety due to emigration are in most cases more than offset by the fact that their emigrants experience large increases in earnings, and a fraction of those is being shared with the native stayers through remittances.

We now isolate the roles played by changes in population size, international trade, and remittances. Figure 2 presents these results using scatterplots. On the horizontal axis is the percentage change in the total population in the counterfactual relative to the baseline (column 3 of Table 1 and column 1 of Table 2), with positive values corresponding to increases in population. On the vertical axis is the percentage change in welfare in the no-migration counterfactual relative to the baseline. Solid dots depict the long-run welfare change (the first column of Table 5). As discussed above, most countries in the OECD suffer a population loss as migrants return to their home countries, while most non-OECD countries gain population. Among the OECD countries there is a clear positive association between the population change and the percentage change in long-run welfare: the countries with the largest population losses suffer the largest welfare losses. For instance, Australia would lose 22.6% of its population, leading to a −11.63% welfare change for its native stayers. The picture is much less clear for the non-OECD countries. Most of these countries experience net population gains. However, some suffer large welfare losses while others even experience (small) welfare gains. It is particularly interesting to compare the predictions for El Salvador and Trinidad and Tobago. These two countries would experience similar population gains due to return migration, at 19% and 17.9% respectively. But while the former would suffer a

[22] However, it is also important to qualify the impact of cross-country variation in incoming remittances. In our framework remittances are exogenous and taken directly from the data. As such, our analysis is silent on why remittances, conditional on emigrant stocks, vary across countries. It could be that in some countries entire families emigrate, while in others families are split and only one family member goes abroad. These patterns have clear implications for remittance flows (Merkle and Zimmermann, 1992), but will also presumably have a direct and unmodelled impact on the disutility from emigration if people value living in the same location as their family.

welfare loss of −8.72%, the latter would experience a welfare gain of 5.70%. As we now show, the diverging effects of return migration on these two countries are explained by the role of remittances.

Figure 2 plots the results from two additional counterfactual scenarios. Hollow dots report the welfare changes that would result assuming there are no remittances. Strikingly, the relationship between population and welfare changes becomes roughly monotonically increasing, with a concave shape. In particular, we note that El Salvador and Trinidad and Tobago would now experience practically the same welfare gain (about 5%). The key is that remittances are a very large share of income in El Salvador, but not in Trinidad and Tobago. Note also that for the OECD the welfare impact remains practically unchanged. This is because the remittances originating in these countries are very small relative to the countries' GDPs, and the native stayers are not the ones sending them abroad.

Next, we examine the scenario where both remittances and international trade are assumed away. The corresponding welfare changes are depicted by hollow triangles. The relationship between population and welfare changes becomes practically linear (with a slope of 0.5), and steeper than under trade. This is because when a developing country experiences net population growth it will respond by producing a wider set of varieties. In autarky, consumers in that country clearly benefit from the increase in variety. However, in the presence of trade the resulting welfare gain is moderated by the reduction in the number of varieties that are available through imports, implying a smaller marginal welfare gain.

5.2 The Short Run

The native stayers' welfare changes in the short run are reported in the second column of Table 5. Welfare for natives in the OECD is practically unchanged in the short run (an average change of −0.46%, compared to −2.38% in the long run). In the non-OECD, all countries would experience a welfare loss (with the exception of Saudi Arabia). Furthermore, the short-run loss is uniformly larger than the long-run loss (−3.28%, compared to −2.00% in the long run). The intuition for the difference between the short and long run effects is as follows. The typical OECD country experiences a net reduction in its labor force. As a result, some of the firms operating in the OECD shut down. In the short run, the set of projects available in the economy is fixed. Hence, the reduction in the number of firms/varieties is attained by an increase in the productivity cutoff for operating a firm. As a result, the firms that exit are those with the lowest productivity. Losing these marginal varieties has practically no effect on the welfare of natives in the OECD. At the other end, developing countries receive a net inflow of workers. This increase in the labor force will induce a reduction in the productivity cutoff for operating a firm there, and new firms will be established. However, these are firms that did not find it worthwhile to operate before the inflow of new workers. Thus, their positive contribution to welfare-adjusted equilibrium variety is minor.

Quantitatively, in the short run, what matters crucially is *how much* less productive new entrants are relative to the firms that are already in the market. For this, the calibration to the observed firm size distribution (Zipf's Law) plays an important role. Essentially, the observed firm size distribution contains information on the relative productivity of the marginal firms compared to the inframarginal ones. The extremely skewed firm size distribution observed in the economy implies that the inframarginal firms are vastly more productive, and thus matter much more for welfare, than the marginal ones (for a detailed exploration of this result, see di Giovanni and Levchenko, 2010). In comparison, the main benefit in the long run from having a larger population lies in the additional net entry of entrepreneurs – a larger n_i^s. An increase in population stimulates entry everywhere in the productivity distribution. Because the long-run entry will feature some very productive firms, it will have a much larger impact on welfare.

Three OECD countries – Sweden, Switzerland, and the U.S. – gain in welfare from un-doing migration in the short run. It turns out that this outcome is due to the assumption that immigrants receive a per capita share of firm profits. If we instead assume that all the firm profits in the economy accrue to the natives, even in these three countries the natives are worse off without immigration.

Figure 3 reports the short-run results graphically and isolates the roles of remittances and international trade. As was the case in the long run, not taking into account remittances the relationship between population and welfare changes becomes roughly monotonic. As illustrated by the hollow dots, with trade but no remittances, larger population *gains* in the counterfactual lead to larger welfare *losses* among developing countries. In the OECD the relationship appears practically flat. In other words, in the short run the increase in domestic varieties experienced by developing countries is not enough to compensate for the loss in imported varieties. The main reason for this is that return migrants are leaving high-productivity OECD countries to go back to their low-productivity countries of origin, which entails a large loss in worldwide efficiency units of labor. Turning now to the role of international trade, in the counterfactual exercise without either remittances or cross-border trade, the relationship between population and welfare changes again becomes roughly linear and now features a weak *positive* slope. This reflects the fact that the increased labor force in the non-OECD will deliver a net increase in varieties available for consumption, obviously with no change in imported varieties.

5.3 Distributional Effects

Our model features imperfect substitutability between skilled and unskilled workers, and thus the potential for migration to generate distributional effects to the extent that migrants differ in skill composition from natives. To isolate those distributional effects, Figure 4 plots the welfare changes of the unskilled native stayers against the welfare changes of the skilled native stayers. If a country observation is on the 45-degree line, the skilled and the unskilled experience identical welfare changes.

The top panel presents the results for the OECD. Overall, welfare changes for the skilled and the unskilled are similar: the observations tend to be relatively close to the 45-degree line (Figure 4a). Thus, in the long run the welfare gains from new varieties dominate the changes in the skill premium. A notable exception is Australia: the unskilled stayers lose 13.6% in the no-migration counterfactual, compared to 7.8% for the skilled. This reflects the fact that immigrants to Australia are more skilled on average than natives (Table 1).

However, in the short run the distributional effects come to the fore (Figure 4b). In many OECD countries, the welfare changes for the skilled and the unskilled have opposite signs, and are an order of magnitude larger in absolute value than aggregate welfare changes. For instance, in the short run the U.S. is 0.14% better off without migration (Table 5). Separating by skill, it turns out that the unskilled are 1.03% better off in the absence of migration, but the skilled are 0.45% *worse* off. In Australia, the numbers are even larger, and the identity of winners and losers is reversed. While in the aggregate, Australia would be 0.68% worse off in the absence of migration, unskilled Australians would be 2.28% worse off, while skilled Australians 2.63% better off. The identity of winners and losers across countries corresponds closely to the relative skill levels of natives and immigrants. In the U.S., immigrants are comparatively unskilled (Table 1), and thus in the short run migration benefits the skilled at the expense of the unskilled. The opposite is true for Australia. This is a general pattern: in the short run, the correlation between welfare changes for the skilled and the unskilled is negative at −0.22. (By contrast, in the long run the welfare changes for those two groups are strongly positively correlated at 0.81.)

For the majority of non-OECD countries, the distributional effects are negligible both in the short run and in the long run. This is intuitive: as discussed above, for these countries the welfare effects are dominated by remittances, which are the same in the short and the long run. Only a couple of countries – Jamaica and Trinidad and Tobago – exhibit large distributional effects. In these countries, reversing emigration leads to large welfare losses for the skilled among the native stayers, with a much more subdued (or even a positive) impact on the unskilled. Table 2 reveals that emigrants from Jamaica and Trinidad and Tobago are overwhelmingly more skilled than the native stayers. These large disparities, coupled with large observed emigration, imply that returning emigrants home to these countries will significantly change the relative supply of skill there, leading to large distributional effects.

6 Extensions and Sensitivity

This section briefly discusses a number of extensions and sensitivity checks on the main results. Appendix B describes these exercises in detail.

6.1 Native-Immigrant Productivity Differences

Migrant productivity may differ from that of the natives of similar skill levels, for a variety of reasons. On the one hand, it is well documented that migrants suffer a reduction in human capital associated with imperfect transferability of skills across countries, at least temporarily. If this is indeed the case, the findings described above may overstate the effects of migration on the effective labor force (in efficiency units) of the host country. On the other hand, some immigrants may be permanently more productive (i.e. earn higher wages) than natives with similar schooling levels. This could be due to positive selection into migration: migrants may be above-average in terms of unobservable skills (such as talent or ability) relative to individuals that are observationally equivalent in terms of education, work experience, gender, and so on. Of course, negative selection into emigration is also possible, and the type of selection may well vary substantially by origin country.[23] Appendix B.1 presents two approaches to calibrating native-immigrant productivity gaps, and shows that the results are quite similar to the baseline.

6.2 Imperfect Substitution Between Natives and Immigrants

The baseline framework assumes that native and immigrant workers in the same skill category are perfect substitutes. Recently, several studies have questioned this assumption (Manacorda et al., 2012; Ottaviano and Peri, 2012). Appendix B.2 implements a model in which natives and immigrants of the same skill level are imperfect substitutes. As expected, assuming imperfect substitutability between immigrants and natives increases the gains from immigration for the typical host country since now natives and immigrants do not compete head to head. The cross-country pattern of welfare changes is very similar to the baseline.

6.3 Additional Sensitivity and Welfare of Migrants

We examine the sensitivity of the main results along a number of additional dimensions. First, the key mechanism through which natives in the destination countries gain from migration is increased product variety. Since equilibrium variety responds endogenously to market size, and larger markets exhibit greater equilibrium variety, individuals living in larger markets enjoy greater welfare, all else equal. This phenomenon is often referred to as the “scale effect.” Scale effects are common and well-studied in both economic growth (e.g., Romer, 1990) and international trade (e.g., Krugman, 1980). Nonetheless, it is important to justify this type of mechanism in our quantitative exercise, and to benchmark it to existing empirical estimates of scale effects. Appendix B.3 (i) compares the magnitude of the scale effect implied by our model to existing empirical estimates; (ii) implements an alternative calibration that targets a scale effect at the bottom of the range suggested in the

[23] Borjas (1987) explores the conditions for one type of selection or the other to take place.

literature; and (iii) implements a model with explicit congestion effects to counteract the positive effect of country size on income.

Second, it may be that the share of the skilled in the population has a direct effect on TFP. For instance, Jones (2002) and Benhabib and Spiegel (2005) develop theoretical models that feature a positive link between human capital and TFP growth, while Ciccone and Peri (2006), Moretti (2004), and Iranzo and Peri (2009b), among others, provide estimates of these human capital externalities based on sub-national evidence. This force may affect the welfare impact of migration because the migrants are frequently less skilled on average than the natives of their destination countries, and more skilled than the staying natives of their origin countries.

Appendix B.4 discusses the results of an extension that incorporates this effect. The results for the OECD remain qualitatively unchanged, whereas the conclusions for the non-OECD turn out to be sensitive to the assumption that TFP is not directly affected by the skilled share. Of course this outcome is very much dependent on the specific parameterization we adopted. Since there is considerable uncertainty regarding the nature of the link between the skilled share and TFP, these results should be interpreted with caution. The exercise suggests that this is an potentially important mechanism that should be explored further in future research.

In Appendix B.5, we use our baseline model to perform more realistic policy counterfactuals. Specifically, we compute the welfare effects of reducing the stock of immigrants in each country by 10 percent. We also evaluate the sensitivity of our baseline results to assuming a much lower elasticity of substitution between skilled and unskilled labor. Finally, Appendix B.6 discusses the welfare impact of migration on the migrants themselves.

7 Conclusion

The cross-border movements of people are large relative to the overall population of many countries. This paper develops a global-scale quantitative assessment of the welfare impact of migration in a large cross-section of both sending and receiving countries. Our main finding is that the long-run impact of observed levels of migration is large and positive for the remaining natives of *both* the main sending countries and the main receiving ones. Relative to the counterfactual scenario in which no migration takes place, some countries in both groups are as much as 10% better off. Interestingly, while the overall numbers are similar, the salient reason for the welfare changes is different. For the countries with the highest immigration rates (Australia, New Zealand, Canada), migration raises welfare through increased equilibrium variety. For the countries with the highest emigration rates (El Salvador, Jamaica), the staying natives are better off because of remittances. These forces are also at work for all other countries, but the relative strength of each varies substantially. Our findings also suggest that failing to account for the role of remittances would produce a welfare evaluation that would be severely biased for a number of migration-sending countries.

All in all our analysis provides a fairly positive view of the welfare effects of international migration, both for origin and destination countries. We note, however, that our analysis does not take into account the effects that immigration may have on the provision of public goods and government-mandated redistribution. Implicitly, we are assuming that immigrants contribute to tax revenue and use public services at the same rate as the natives, and that immigrants do not alter the political equilibrium that determines the overall degree of within-country income redistribution. While this may be a reasonable assumption in some countries, it may not apply universally (Dolmas and Huffman, 2004; Ortega, 2010). Relatedly, our analysis ignores any impact of migration on social capital such as trust or social cohesion.[24] Incorporating the fiscal, political, and social channels into the quantitative welfare assessments of immigration remains a fruitful avenue for future research.

References

Alesina, Alberto and Eliana La Ferrara, "Who trusts others?," *Journal of Public Economics*, August 2002, *85* (2), 207–234.

Alvarez, Fernando and Robert E., Jr. Lucas, "General Equilibrium Analysis of the Eaton-Kortum Model of International Trade," *Journal of Monetary Economics*, September 2007, *54* (6), 1726–1768.

Anderson, James and Eric van Wincoop, "Trade Costs," *Journal of Economic Literature*, 2004, *42* (3), 691–751.

Axtell, Robert L., "Zipf Distribution of U.S. Firm Sizes," *Science*, September 2001, *293* (5536), 1818–1820.

Barro, Robert J. and Jong-Wha Lee, "A New Data Set of Educational Attainment in the World, 1950–2010," April 2010. NBER Working Paper 15902.

Benhabib, Jess, "On the political economy of immigration," *European Economic Review*, December 1996, *40* (9), 1737–1743.

_ and Boyan Jovanovic, "Optimal Migration: A World Perspective," *International Economic Review*, May 2012, *53* (2), 321–348.

_ and Mark M. Spiegel, "Human Capital and Technology Diffusion," in Philippe Aghion and Steven Durlauf, eds., *Handbook of Economic Growth*, Vol. 1 of *Handbook of Economic Growth*, Elsevier, 2005, chapter 13, pp. 935–966.

Bergin, Paul and Giancarlo Corsetti, "The Extensive Margin and Monetary Policy," *Journal of Monetary Economics*, 2008, *55* (7), 1222–1237.

Berry, R. Albert and Ronald Soligo, "Some Welfare Aspects of International Migration," *Journal of Political Economy*, September-October 1969, *77* (5), 778–794.

Borjas, George J, "Self-Selection and the Earnings of Immigrants," *American Economic Review*, September 1987, *77* (4), 531–53.

[24] De la Rica et al. (2013) provide a comprehensive survey of the economic effects of immigration in Europe, including the fiscal consequences. Alesina and La Ferrara (2002) find that within the U.S., individuals living in localities with high ethnic fractionalization and income disparities exhibit less trust. Using a large cross-section of countries, Ortega and Peri (2013) show that immigration does increase ethnic fractionalization, but any negative economic effects of increased fractionalization appear to be more than offset by other sources of gains.

Borjas, George J., "The Economic Benefits from Immigration," *Journal of Economic Perspectives*, Spring 1995, *9* (2), 3–22.

Chaney, Thomas, "Distorted Gravity: The Intensive and Extensive Margins of International Trade," *American Economic Review*, September 2008, *98* (4), 1707–1721.

Ciccone, Antonio and Giovanni Peri, "Identifying Human-Capital Externalities: Theory with Applications," *Review of Economic Studies*, 2006, *73* (2), 381–412.

Davis, Donald R. and David E. Weinstein, "Technological Superiority and the Losses From Migration," June 2002. NBER Working Paper No. 8971.

De la Rica, Sara, Albrecht Glitz, and Francesc Ortega, "Immigration in Europe: Trends, Policies and Empirical Evidence," 2013. ISA Discussion Paper.

di Giovanni, Julian and Andrei A. Levchenko, "Firm Entry, Trade, and Welfare in Zipf's World," August 2010. NBER Working Paper No. 16313.

_ and _ , "Country Size, International Trade, and Aggregate Fluctuations in Granular Economies," *Journal of Political Economy*, December 2012, *120* (6), 1083–1132.

Dixit, Avinash K. and Joseph E. Stiglitz, "Monopolistic Competition and Optimum Product Diversity," *American Economic Review*, June 1977, *67* (3), 297–308.

Docquier, Frédéric, Abdeslam Marfouk, Çağlar Özden, and Christopher Parsons, "Geographic, Gender and Skill Structure of International Migration," November 2010. mimeo, Université Catholique de Louvain, World Bank, and University of Nottingham.

_ , B. Lindsay Lowell, and Abdeslam Marfouk, "A Gendered Assessment of Highly Skilled Emigration," *Population and Development Review*, 2009, *35* (2), 297–321.

_ , Çağlar Özden, and Giovanni Peri, "The Wage Effects of Immigration and Emigration," December 2010. NBER Working Paper No. 16646.

_ , Joël Machado, and Khalid Sekkat, "Efficiency gains from liberalizing labor mobility," 2012. mimeo, UCLouvain and Université Libre de Bruxelles.

Dolmas, Jim and Gregory W. Huffman, "On The Political Economy Of Immigration And Income Redistribution," *International Economic Review*, November 2004, *45* (4), 1129–1168.

Dustmann, Christian, "Return migration, wage differentials, and the optimal migration duration," *European Economic Review*, April 2003, *47* (2), 353–369.

_ , "Return Migration, Investment in Children, and Intergenerational Mobility: Comparing Sons of Foreign- and Native-Born Fathers," *Journal of Human Resources*, 2008, *43* (2), 299–324.

_ and Albrecht Glitz, "How Do Industries and Firms Respond to Changes in Local Labour Supply," September 2011. CReAM Discussion Paper No. 18/11.

_ , Itzhak Fadlon, and Yoram Weiss, "Return migration, human capital accumulation and the brain drain," *Journal of Development Economics*, May 2011, *95* (1), 58–67.

Eaton, Jonathan, Samuel S. Kortum, and Francis Kramarz, "An Anatomy of International Trade: Evidence from French Firms," *Econometrica*, September 2011, *79* (5), 1453–1498.

Facchini, Giovanni and Anna Maria Mayda, "Does the Welfare State Affect Individual Attitudes toward Immigrants? Evidence across Countries," *The Review of Economics and Statistics*, November 2009, *91* (2), 295–314.

_ and Max Friedrich Steinhardt, "What drives U.S. immigration policy? Evidence from congressional roll call votes," *Journal of Public Economics*, August 2011, *95* (7-8), 734–743.

— , Anna Maria Mayda, and Prachi Mishra, "Do interest groups affect US immigration policy?," *Journal of International Economics*, September 2011, *85* (1), 114–128.

Fairlie, Robert W., "Immigrant Entrepreneurs and Small Business Owners, and Their Access to Financial Capital," May 2012. Small Business Administration Office of Advocacy.

Ghironi, Fabio and Marc J. Melitz, "International Trade and Macroeconomic Dynamics with Heterogeneous Firms," *Quarterly Journal of Economics*, August 2005, *120* (3), 865–915.

Gonzalez, Libertad and Francesc Ortega, "Immigration And Housing Booms: Evidence From Spain," *Journal of Regional Science*, 02 2013, *53* (1), 37–59.

Hamilton, Bob and John Whalley, "Efficiency and Distributional Implications of Global Restrictions on Labour Mobility: Calculations and Policy Implications," *Journal of Development Economics*, January-February 1984, *14* (1), 61–75.

Helpman, Elhanan, Marc Melitz, and Yona Rubinstein, "Estimating Trade Flows: Trading Partners and Trading Volumes," *Quarterly Journal of Economics*, May 2008, *123* (2), 441–487.

Hendricks, Lutz, "A Database of Mincerian Earnings Regressions," 2004. http://www.lhendricks.org/Mincer.htm.

International Monetary Fund, "Directions of Trade Statistics," 2007.

Iranzo, Susana and Giovanni Peri, "Migration and Trade: Theory with an Application to the Eastern-Western European Integration," *Journal of International Economics*, 2009, *79* (1), 1–19.

— and — , "Schooling Externalities, Technology, and Productivity: Theory and Evidence from U.S. States," *The Review of Economics and Statistics*, May 2009, *91* (2), 420–431.

Jones, Charles I., "Sources of U.S. Economic Growth in a World of Ideas," *American Economic Review*, March 2002, *92* (1), 220–239.

Kennan, John, "Open Borders," *Review of Economic Dynamics*, April 2013, *16* (2), L1–L13.

Klein, Paul and Gustavo Ventura, "TFP Differences and the Aggregate Effects of Labor Mobility in the Long Run," *B.E. Journals in Macroeconomics*, 2007, *7* (1).

— and — , "Productivity Differences and the Dynamic Effects of Labor Movements," *Journal of Monetary Economics*, 2009, *56*, 1059–1073.

Krugman, Paul, "Scale Economies, Product Differentiation, and the Pattern of Trade," *American Economic Review*, 1980, *70* (5), 950–959.

Lewis, Ethan, "Immigration, Skill Mix, and Capital Skill Complementarity," *The Quarterly Journal of Economics*, 2011, *126* (2), 1029–1069.

Manacorda, Marco, Alan Manning, and Jonathan Wadsworth, "The Impact Of Immigration On The Structure Of Wages: Theory And Evidence From Britain," *Journal of the European Economic Association*, February 2012, *10* (1), 120–151.

Mayda, Anna Maria, "Who Is Against Immigration? A Cross-Country Investigation of Individual Attitudes toward Immigrants," *The Review of Economics and Statistics*, 04 2006, *88* (3), 510–530.

Melitz, Marc J., "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, November 2003, *71* (6), 1695–1725.

Merkle, Lucie and Klaus F. Zimmermann, "Savings, remittances, and return migration," *Economics Letters*, January 1992, *38* (1), 77 – 81.

Moretti, Enrico, "Workers' Education, Spillovers, and Productivity: Evidence from Plant-Level Production Functions," *American Economic Review*, June 2004, *94* (3), 656–690.

Ortega, Francesc, "Immigration quotas and skill upgrading," *Journal of Public Economics*, September 2005, *89* (9-10), 1841–1863.

_ , "Immigration, Citizenship, and the Size of Government," *The B.E. Journal of Economic Analysis & Policy*, 2010, *10* (1), 26.

_ and Giovanni Peri, "Migration, Trade, and Income," November 2013. Forthcoming, *Journal of International Economics*.

_ and Javier Polavieja, "Labor-market Exposure as a Determinant of Attitudes toward Immigration," *Labour Economics*, 2012, *19*, 298–311.

Ottaviano, Gianmarco I. P. and Giovanni Peri, "Rethinking The Effect Of Immigration On Wages," *Journal of the European Economic Association*, February 2012, *10* (1), 152–197.

Ottaviano, Gianmarco I.P. and Giovanni Peri, "The economic value of cultural diversity: evidence from US cities," *Journal of Economic Geography*, January 2006, *6* (1), 9–44.

Pritchett, Lant, *Let their people come: breaking the gridlock on global labor mobility*, Washington, D.C.: Center for Global Development, 2006.

Ratha, Dilip and William Shaw, "South-South Migration and Remittances," April 2007. World Bank Working Paper No. 102.

Rauch, James E. and Vitor Trindade, "Ethnic Chinese Networks in International Trade," *Review of Economics and Statistics*, 2002, *84* (1), 116–130.

_ and _ , "Information, International Substitutability, and Globalization," *American Economic Review*, 2003, *93* (3), 775–791.

Romer, Paul M., "Endogenous Technological Change," *Journal of Political Economy*, October 1990, *98* (5), S71–S102.

Saiz, Albert, "Room in the Kitchen for the Melting Pot: Immigration and Rental Prices," *The Review of Economics and Statistics*, August 2003, *85* (3), 502–521.

The World Bank, "Doing Business Indicators," 2007.

Trefler, Daniel, "International Factor Price Differences: Leontief was Right!," *Journal of Political Economy*, December 1993, *101*, 961–987.

_ , "The Case of the Missing Trade and Other Mysteries," *American Economic Review*, December 1995, *85*, 1029–1046.

Yang, Dean, "International Migration, Remittances and Household Investment: Evidence from Philippine Migrants' Exchange Rate Shocks," *Economic Journal*, April 2008, *118* (528), 591–630.

Yi, Kei-Mu and Jing Zhang, "Structural Change in an Open Economy," April 2010. Mimeo, Federal Reserve Bank of Philadelphia and University of Michigan.

Table 1. OECD Countries: Migrant Stocks, Skill Composition, and Remittances

Country	Share Immigrants	Share Emigrants	Pop. Chg. in Counterfactuals	Remittances /GDP	Share skilled Stayers	Share skilled Immigrants	Share skilled Emigrants
Australia	0.242	0.015	-0.226	-0.009	0.29	0.45	0.55
Austria	0.108	0.046	-0.062	0.001	0.23	0.12	0.33
Belgium	0.108	0.030	-0.078	0.014	0.28	0.19	0.34
Canada	0.185	0.032	-0.154	-0.016	0.49	0.58	0.60
Czech Rep.	0.023	0.026	0.003	0.005	0.10	0.11	0.34
Denmark	0.058	0.038	-0.019	0.001	0.21	0.17	0.41
Finland	0.034	0.053	0.019	0.002	0.26	0.23	0.27
France	0.076	0.017	-0.060	-0.001	0.24	0.16	0.33
Germany	0.064	0.033	-0.031	-0.004	0.25	0.21	0.39
Greece	0.014	0.066	0.052	-0.002	0.15	0.15	0.20
Hungary	0.034	0.030	-0.005	-0.003	0.12	0.13	0.39
Ireland	0.129	0.156	0.026	-0.007	0.17	0.40	0.33
Italy	0.025	0.042	0.018	-0.002	0.18	0.15	0.16
Japan	0.015	0.005	-0.010	-0.001	0.23	0.28	0.61
Korea, Rep.	0.011	0.038	0.028	-0.001	0.25	0.37	0.50
Netherlands	0.101	0.047	-0.055	-0.002	0.21	0.22	0.43
New Zealand	0.251	0.128	-0.122	0.003	0.21	0.41	0.48
Norway	0.086	0.030	-0.056	-0.002	0.21	0.28	0.38
Poland	0.001	0.046	0.045	0.012	0.11	0.13	0.37
Portugal	0.023	0.134	0.111	0.010	0.12	0.18	0.10
Slovak Rep.	0.005	0.041	0.036	0.006	0.11	0.27	0.18
Spain	0.116	0.016	-0.100	-0.003	0.15	0.18	0.18
Sweden	0.106	0.022	-0.083	-0.005	0.17	0.25	0.46
Switzerland	0.137	0.035	-0.103	-0.007	0.20	0.21	0.40
United Kingdom	0.084	0.060	-0.024	-0.003	0.18	0.34	0.46
United States	0.119	0.003	-0.116	-0.008	0.52	0.42	0.58

Notes: This table presents the developed country sample, for which inward migration data are available for 2006. The first column presents the percentage of foreign born in total population. The second column presents the share of emigrants from each country to the receiving countries in the sample, as a share of the remaining population. The third column presents the percentage change in the population if there were no migration. This is the percentage change in the population evaluated in the counterfactual. The remaining columns report remittances as a share of GDP (negative numbers signify net outflows of remittances), and the shares of skilled among the native stayers, immigrants, and emigrants. Data sources and variable definitions are described in detail in the text.

Table 2. Non-OECD Countries: Migrant Stocks, Skill Composition, and Remittances

Country	Share Emigrants	Remittances /GDP	Share skilled stayers	Share skilled emigrants
Algeria	0.025	0.023	0.062	0.147
Argentina	0.012	-0.004	0.201	0.408
Belarus	0.005	0.001	0.201	0.172
Brazil	0.005	0.005	0.084	0.328
Bulgaria	0.037	0.082	0.189	0.234
Chile	0.016	-0.002	0.158	0.403
China	0.003	0.012	0.026	0.281
Colombia	0.023	0.034	0.099	0.317
Croatia	0.103	0.020	0.094	0.199
Dominican Rep.	0.097	0.143	0.141	0.256
Ecuador	0.068	0.050	0.160	0.266
Egypt, Arab Rep.	0.004	0.042	0.104	0.271
El Salvador	0.190	0.178	0.107	0.198
India	0.003	0.030	0.047	0.318
Indonesia	0.002	0.007	0.050	0.182
Iran, Islamic Rep.	0.011	0.006	0.067	0.487
Israel	0.021	-0.023	0.241	0.235
Jamaica	0.317	0.200	0.040	0.420
Malaysia	0.010	-0.006	0.077	0.352
Mexico	0.107	0.031	0.111	0.148
Nigeria	0.003	0.031	0.028	0.313
Pakistan	0.005	0.044	0.025	0.231
Philippines	0.030	0.155	0.159	0.545
Romania	0.070	0.058	0.087	0.334
Russian Fed.	0.008	0.001	0.202	0.309
Saudi Arabia	0.004	-0.049	0.093	0.301
Serbia and Mont.	0.106	0.191	0.082	0.230
South Africa	0.011	0.001	0.098	0.510
Thailand	0.006	0.002	0.110	0.296
Trinidad and Tob.	0.179	0.006	0.099	0.494
Turkey	0.038	-0.001	0.081	0.092
Ukraine	0.019	-0.010	0.162	0.222
U.A.E.	0.003	–	0.031	0.206
Venezuela	0.011	-0.004	0.185	0.521
Rest of World	0.011	0.021	0.095	0.118

Notes: This table presents the developing country sample, for which only outward migration data to the developed countries are available for 2006. Thus, the population change in the counterfactual coincides with the share of emigrants. The second column presents the share of emigrants from each country to the receiving countries in the sample relative the remaining population. The third column presents the percentage change in the population if there were no migration. This is the percentage change in the population evaluated in the counterfactual. The last column reports net remittances as a share of GDP (negative numbers signify net outflows of remittances). Data sources and variable definitions are described in detail in the text.

Table 3. Calibrated Parameter Values

Parameter	Baseline	Source
σ	3	Ottaviano and Peri (2012)
ε^s	6	Anderson and van Wincoop (2004)
θ^s	5.3	Axtell (2001): $\frac{\theta}{\varepsilon-1} = 1.06$
α	0.65	Yi and Zhang (2010)
$\{\beta_N, \beta_T\}$	$\{0.65, 0.35\}$	1997 U.S. Benchmark Input-Output Table
$\{\eta_N, \eta_T\}$	$\{0.77, 0.35\}$	
τ_{ij}	2.30	Helpman et al. (2008)
f^s_{ii}	14.24	The World Bank (2007); normalizing $f_{US,US}$
f_{ij}	7.20	so that nearly all firms the U.S. produce
f_E	34.0	To match 7,000,000 firms in the U.S. (U.S. Economic Census)

The details of how these parameters are chosen are described in Appendix A.2.

Table 4. Bilateral Trade Shares: Data and Model Predictions

	Model	Data
Domestic sales as a share of domestic absorption (π_{ii})		
mean	0.7559	0.7286
median	0.7468	0.7697
corr(model,data)	0.5662	
Export sales as a share of domestic absorption (π_{ij})		
mean	0.0041	0.0042
median	0.0018	0.0042
corr(model,data)	0.7822	

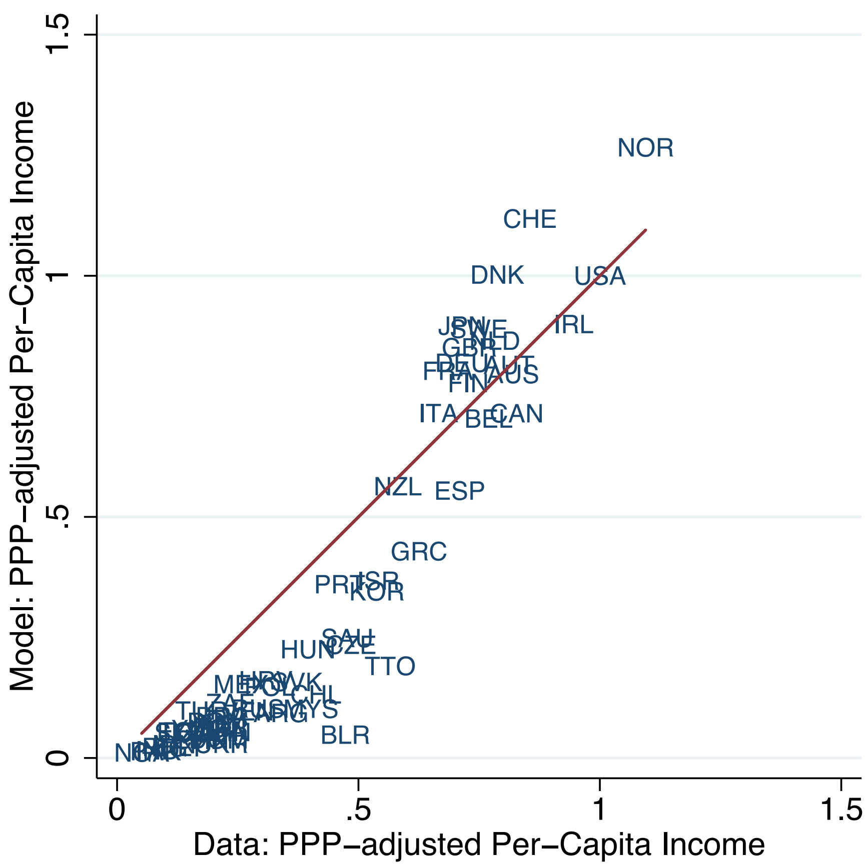
Notes: This table reports the means and medians of domestic output (top panel), and bilateral trade (bottom panel), both as a share of domestic absorption, in the model and in the data. Source: International Monetary Fund (2007) and model output.

Table 5. Percentage Change in Average Welfare in the Counterfactual Relative to Benchmark

Country	Long Run	Short Run	Country	Long Run	Short Run
	OECD Countries			*Non-OECD Countries*	
Australia	-11.63	-0.68	Algeria	-1.55	-2.14
Austria	-3.06	-0.41	Argentina	0.07	-0.19
Belgium	-4.63	-1.36	Belarus	-1.25	-1.03
Canada	-7.07	0.25	Brazil	-0.27	-0.43
Czech Republic	-1.02	-0.85	Bulgaria	-5.68	-6.60
Denmark	-1.29	-0.31	Chile	0.34	-0.11
Finland	-0.13	-0.55	China	-0.75	-0.88
France	-3.12	-0.39	Colombia	-2.01	-2.75
Germany	-1.55	-0.09	Croatia	-0.35	-3.29
Greece	1.17	-0.59	Dominican Republic	-9.02	-11.55
Hungary	-0.46	-0.12	Ecuador	-2.26	-4.42
Ireland	-0.07	-0.54	Egypt, Arab Rep.	-3.47	-3.40
Italy	0.43	-0.15	El Salvador	-8.72	-14.08
Japan	-0.48	-0.01	India	-2.51	-2.53
Korea, Rep.	1.12	-0.01	Indonesia	-0.65	-0.63
Netherlands	-2.60	-0.12	Iran, Islamic Rep.	-0.15	-0.53
New Zealand	-6.89	-1.21	Israel	0.12	-0.04
Norway	-2.53	-0.05	Jamaica	-5.61	-14.89
Poland	0.16	-1.32	Malaysia	-0.39	-0.43
Portugal	1.37	-2.04	Mexico	1.32	-2.59
Slovak Republic	-0.10	-1.10	Nigeria	-2.74	-2.59
Spain	-4.91	-0.42	Pakistan	-3.45	-3.45
Sweden	-3.45	0.15	Philippines	-10.08	-11.27
Switzerland	-4.42	0.06	Romania	-2.73	-4.89
United Kingdom	-1.46	-0.23	Russian Federation	-0.18	-0.38
United States	-5.37	0.14	Saudi Arabia	-0.26	0.66
			Serbia and Montenegro	-11.54	-14.46
			South Africa	-0.05	-0.31
			Thailand	-0.51	-0.56
			Trinidad and Tobago	5.70	-0.77
			Turkey	1.07	-0.30
			Ukraine	-0.34	-0.58
			United Arab Emirates	-0.06	-0.07
			Venezuela, RB	0.10	-0.14
Mean	-2.38	-0.46	Mean	-2.00	-3.28
Std. Dev.	3.07	0.56	Std. Dev.	3.55	4.54

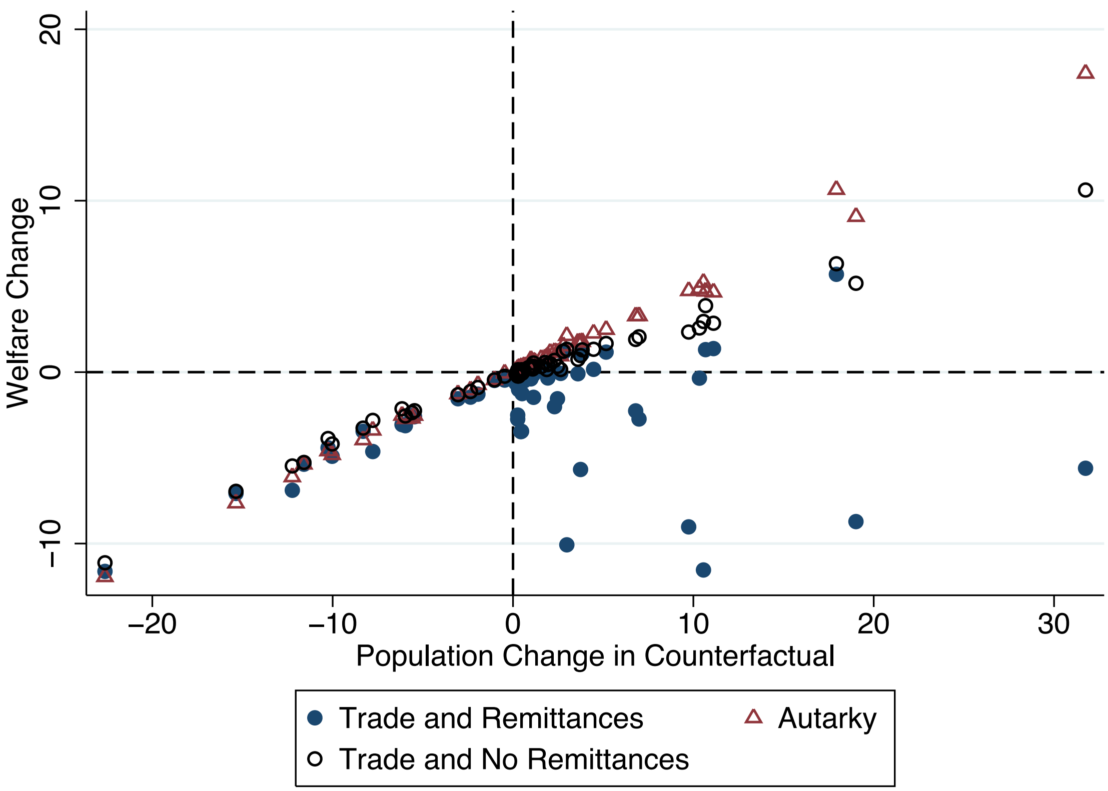
Notes: This table presents the percent change in welfare between baseline and counterfactual equilibria, assuming $\phi_i^\ell = \phi_i^h = 1$ for all countries. The measure of welfare employed here is the average real income of native stayers. The first column reports the welfare change in the long run, the second column in the short run.

Figure 1. Real Incomes: Model vs. Data



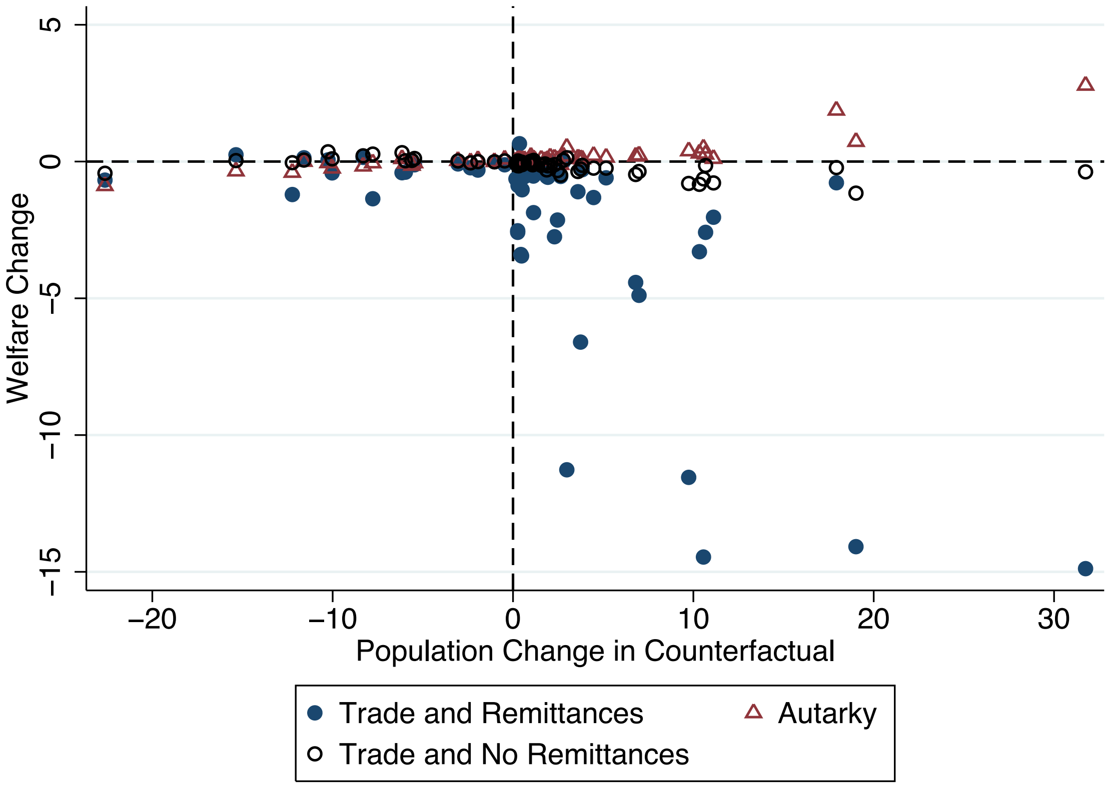
Notes: This figure reports the scatterplot of the real PPP-adjusted per capita income from the Penn World Tables (x-axis) against the real PPP-adjusted per capita income implied by the model. Both are expressed relative to the U.S..

Figure 2. Change in Average Welfare in the Long Run: Autarky, Trade, and Remittances



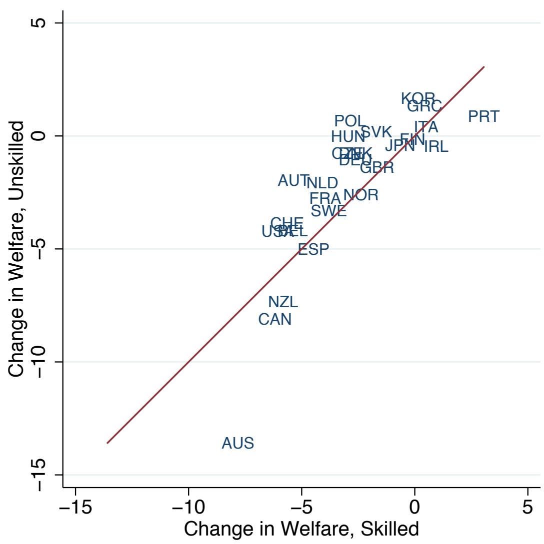
Notes: This figure reports the percentage change in welfare in the long-run counterfactual relative to the baseline (assuming $\phi_i^\ell = \phi_i^h = 1$ for all countries i) in three different scenarios. Solid dots depict the welfare change with both trade and remittances. Hollow dots, depict the welfare change with international trade but keeping remittances constant at zero in the baseline and counterfactual equilibria. Hollow triangles depict the welfare changes under prohibitive trade costs and no remittances. The measure of welfare is the average real income of native stayers. On the y-axis is the percent change in the population in the counterfactual relative to the baseline.

Figure 3. Change in Average Welfare in the Short Run: Autarky, Trade, and Remittances

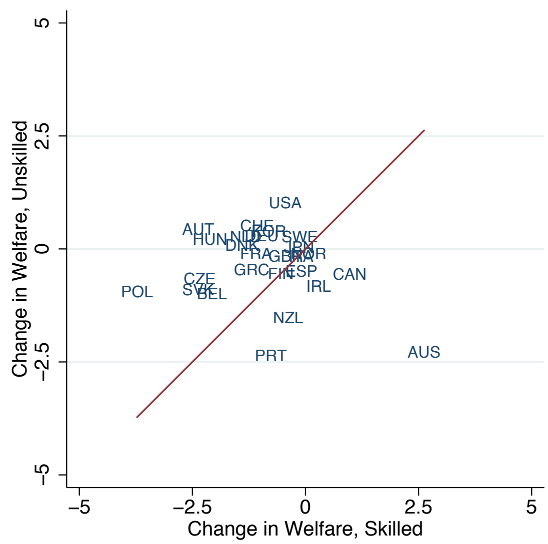


Notes: This figure reports the percentage change in welfare in the short-run counterfactual relative to the baseline (assuming $\phi_i^\ell = \phi_i^h = 1$ for all countries i) in three different scenarios. Solid dots depict the welfare change with both trade and remittances. Hollow dots, depict the welfare change with international trade but keeping remittances constant at zero in the baseline and counterfactual equilibria. Hollow triangles depict the welfare changes under prohibitive trade costs and no remittances. The measure of welfare is the average real income of the native stayers. On the y-axis is the percent change in the population in the counterfactual relative to the baseline.

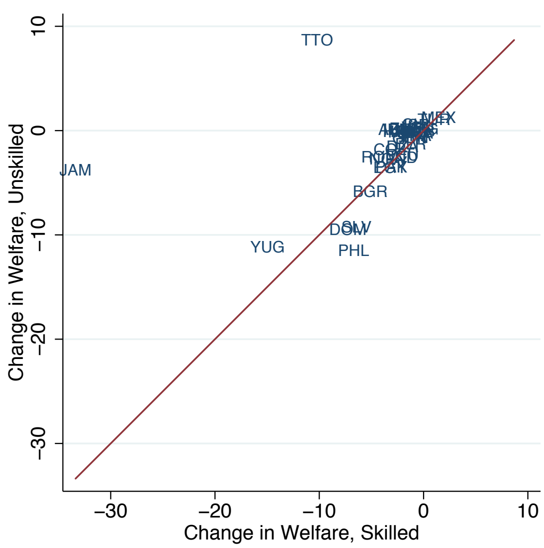
Figure 4. Distributional Effects: Welfare Changes of Skilled and Unskilled Natives



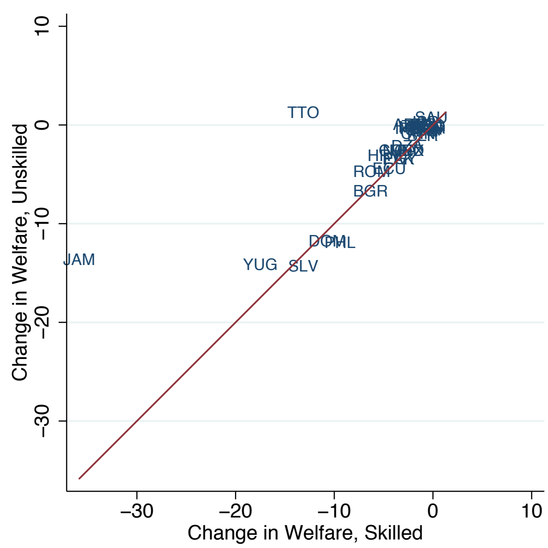
(a) OECD Countries, Long Run



(b) OECD Countries, Short Run



(c) Non-OECD Countries, Long Run



(d) Non-OECD Countries, Short Run

Notes: Units on both axes are in percentage points. These figures present scatterplots of the percent change in welfare of the unskilled native stayers against the change in welfare of the skilled native stayers, for the OECD (top half) and the non-OECD (bottom half) countries respectively, in both the long run (left side) and the short run (right side). The line through the data is the 45-degree line in each plot.

ONLINE APPENDIX

A Global View of Cross-Border Migration

Julian di Giovanni Andrei A. Levchenko Francesc Ortega

March 13, 2014

Appendix A Complete Model and Calibration

A.1 Complete Model Equations

Let Y_i^s denote the value of output by sector s firms located in country i, and let X_i^s denote the expenditure on sector s in country i by consumers and firms. The country's resource constraint states that total spending must equal the value of domestic production plus net transfers: $X_i^N + X_i^T = Y_i^N + Y_i^T + R_i$. Because sector N output cannot be traded, it has to be the case that $X_i^N = Y_i^N$, and thus the aggregate resource constraint becomes:

$$X_i^T = Y_i^T + R_i. \tag{A.1}$$

Using the expression for he total sales of a firm with unit input requirement $a(k)$ and summing over the sales of all country i firms serving j, the total sales from country i to country j can be written as:

$$X_{ji}^T = \frac{X_j^T}{\left(P_j^T\right)^{1-\varepsilon_T}} \left(\frac{\varepsilon_T}{\varepsilon_T - 1}\tau_{ji}c_i^T\right)^{1-\varepsilon_T} n_i^T \frac{b_T^{\theta_T}\theta_T}{\theta_T - (\varepsilon_T - 1)} \left(a_{ji}^T\right)^{\theta_T-(\varepsilon_T-1)}.$$

Using expressions for a_{ji}^T in (9), and P_j^T in (11), the total exports from i to j become:

$$X_{ji}^T = \frac{n_i^T \left(\tau_{ji}c_i^T\right)^{-\theta_T} \left(c_i^T f_{ji}^T\right)^{-\frac{\theta_T-(\varepsilon_T-1)}{\varepsilon_T-1}}}{\sum_{l=1}^{\mathcal{C}} n_l^T \left(\tau_{jl}c_l^T\right)^{-\theta_T} \left(c_l^T f_{jl}^T\right)^{-\frac{\theta_T-(\varepsilon_T-1)}{\varepsilon_T-1}}} X_j^T.$$

Adding these up across all destinations j and using (A.1), we obtain the market clearing condition for country i's total T-sector output:

$$Y_i^T = X_i^T - R_i = \sum_{j=1}^{\mathcal{C}} \frac{n_i^T \left(\tau_{ji}c_i^T\right)^{-\theta_T} \left(c_i^T f_{ji}^T\right)^{-\frac{\theta_T-(\varepsilon_T-1)}{\varepsilon_T-1}}}{\sum_{l=1}^{\mathcal{C}} n_l^T \left(\tau_{jl}c_l^T\right)^{-\theta_T} \left(c_l^T f_{jl}^T\right)^{-\frac{\theta_T-(\varepsilon_T-1)}{\varepsilon_T-1}}} X_j^T. \tag{A.2}$$

A.1.1 Short-Run Equilibrium

Not imposing free entry means that entrepreneurs with access to productive projects earn net profits in this economy. Straightforward steps (see, for instance, Proposition 1 in di Giovanni and Levchenko, 2010) establish that total profits in each sector and country are a constant multiple of the total sales by firms in that sector: $\Pi_i^s = \frac{\varepsilon_s - 1}{\varepsilon_s\theta_s} Y_i^s$. This implies that the total spending on intermediate inputs in each sector is $(1-\beta_s)\left(1 - \frac{\varepsilon_s-1}{\varepsilon_s\theta_s}\right) Y_i^s$. Final spending is the sum of all net income, which includes labor income, profits, and remittances: $Y_i = w_i L_i + \Pi_i^N + \Pi_i^T + R_i$. Market clearing in each sector implies that total spending equals final consumption spending plus purchases of intermediate inputs:

$$X_i^N = \alpha Y_i + (1-\beta_N)\,\eta_N \left(1 - \frac{\varepsilon_s - 1}{\varepsilon_s \theta_s}\right) Y_i^N + (1-\beta_T)\,\eta_T \left(1 - \frac{\varepsilon_s - 1}{\varepsilon_s \theta_s}\right) Y_i^T \tag{A.3}$$

$$X_i^T = (1-\alpha) Y_i + (1-\beta_N)\,(1-\eta_N) \left(1 - \frac{\varepsilon_s - 1}{\varepsilon_s \theta_s}\right) Y_i^N + (1-\beta_T)\,(1-\eta_T) \left(1 - \frac{\varepsilon_s - 1}{\varepsilon_s \theta_s}\right) Y_i^T. \tag{A.4}$$

The **short-run equilibrium** is obtained as a solution to $(\mathcal{C}-1) + 2 \times \mathcal{C}$ equations in w_i, P_i^N, and P_i^T, that satisfies equations (11) for $s = N, T$, (A.2), (A.3), and (A.4) for each $i = 1, \ldots, \mathcal{C}$. Equations (A.3) and (A.4) imply that X_i^T is linear in $w_i L_i$ and R_i, which allows us to express (A.2) as a system of equations in relative wages given the vector of R_i and sectoral price levels. These equations do not admit an analytical solution for a realistic number of countries and reasonable parameter values, but are straightforward to solve numerically.

A.1.2 Long-Run Equilibrium

Entrepreneurs in sector s will enter until the expected profit equals the cost of discovering one's productivity:

$$\mathrm{E}\left[\sum_{i=1}^{\mathcal{C}} \mathbf{1}_{ij}\,[k] \left(\pi_{ij}^{V,s}(a(k)) - c_j^s f_{ij}^s\right)\right] = c_j^s f_E \tag{A.5}$$

for each country j and sector s, where $\mathbf{1}_{ij}\,[k]$ is the indicator function for whether firm k in j finds it profitable to enter market i, $\pi_{ij}^{V,s}(a(k))$ are ex post variable profits from selling there, and once again in sector N, profits can only be positive for $i = j$.

With free entry, the total profits in the economy are zero. Thus the total final spending equals labor income plus remittances, $Y_i = w_i L_i + R_i$, and total spending on intermediate inputs equals a fraction $(1-\beta_s)$ of total sales by all firms in each sector s. Market clearing in each sector implies that total spending equals final consumption spending plus purchases of intermediate inputs:

$$X_i^N = \alpha Y_i + (1-\beta_N)\,\eta_N Y_i^N + (1-\beta_T)\,\eta_T Y_i^T \tag{A.6}$$

$$X_i^T = (1-\alpha) Y_i + (1-\beta_N)\,(1-\eta_N)\, Y_i^N + (1-\beta_T)\,(1-\eta_T)\, Y_i^T. \tag{A.7}$$

The **long-run equilibrium** is obtained as a solution to $(\mathcal{C}-1) + 2 \times \mathcal{C} + 2 \times \mathcal{C}$ equations in w_i, P_i^N, P_i^T, n_i^N and n_i^T that satisfies equations (11) for $s = N, T$, (A.2), (A.5), (A.6), and (A.7) for each $i = 1, \ldots, \mathcal{C}$. As in the short-run case, (A.6) and (A.7) allow us to express X_i^T as a linear function of $w_i L_i$ and R_i, implying that (A.2) can be solved numerically for wages given R_i and price levels.

A.2 Parameter Values

We implement the economy under the following parameter values (see Table 3 for a summary). The elasticity of substitution between more and less educated workers is $\sigma = 3$. This elasticity has been estimated in the context of a CES aggregator in a number of studies since the initial attempts by Katz and Murphy (1992), mostly based on U.S. data.[25] The estimates provided by Ottaviano and Peri (2012) are particularly useful for our purposes since they consider alternative definitions of the skilled. When the skilled group consists of individuals with a completed college degree, these authors find an elasticity of substitution around 1.5−2, confirming the results in Ciccone and Peri (2005). In our data skilled workers are individuals with at least some college education. For this group (vis-à-vis individuals with no college education at all) Ottaviano and Peri (2012) report an elasticity of substitution of 3. We take this as our baseline value. An earlier version of our paper (di Giovanni et al., 2012) conducted the analysis under the assumption that skilled and unskilled labor are perfect substitutes ($\sigma = \infty$). The results regarding the aggregate welfare were virtually identical. Of course, perfect substitutability of skilled and unskilled workers rules out any distributional effects of migration.

The elasticity of substitution is $\varepsilon_s = 6$, for both $s = N, T$. Anderson and van Wincoop (2004) report available estimates of this elasticity to be in the range of 3 to 10, and we pick a value close to the middle of the range. The key parameter is θ_s, as it governs the firm size distribution. As described in much greater detail elsewhere (see, e.g., di Giovanni and Levchenko, 2012, 2010; di Giovanni et al., 2011), in this model firm sales follow a power law with the exponent equal to $\frac{\theta_s}{\varepsilon_s - 1}$. In the data, firm sales follow a power law with the exponent close to 1. Axtell (2001) reports the value of 1.06, which we use to find θ_s given our preferred value of ε_s: $\theta_s = 1.06 \times (\varepsilon_s - 1) = 5.3$. We set both the elasticity of substitution and the Pareto exponent to be the same in the N and the T sectors. di Giovanni et al. (2011) show that the reduced form exponent in the empirical distribution of firm size, which corresponds to $\theta_s/(\varepsilon_s - 1)$ in sector s is similar between the traded and non-traded sectors. It could still be the case that while $\theta_T/(\varepsilon_T - 1) \approx \theta_N/(\varepsilon_N - 1)$, the actual values of θ_s and ε_s differ. Since we do not have reliable information about how these two individual parameters differ across sectors, we adopt the most agnostic and neutral assumption that both θ_s and ε_s are the same in the two sectors.

We set the value of α – the share of non-tradeables in consumption – to be 0.65. This is the mean value of services value added in total value added in the database compiled by the Groningen Growth and Development Center and extended to additional countries by Yi and Zhang (2010). It is the value also adopted by Alvarez and Lucas (2007). The values of β_N and β_T – share of labor/value added in total output – are calibrated using the 1997 U.S. Benchmark Input-Output Table. We take the Detailed Make and Use tables, featuring more than 400 distinct sectors, and aggregate them into a 2-sector Direct Requirements Table. This table gives the amount of N, T, and factor inputs required to produce a unit of final output. Thus, β_s is equal to the share of total output that is not used pay for intermediate inputs, i.e., the payments to factors of production.

[25] Card (2009) offers a review that includes an insightful discussion.

According to the U.S. Input-Output Matrix, $\beta_N = 0.65$ and $\beta_T = 0.35$. Thus, the traded sector is considerably more input-intensive than the non-traded sector. The shares of non-traded and traded inputs in both sectors are also calibrated based on the U.S. I-O Table. According to the data, $\eta_N = 0.77$, while $\eta_T = 0.35$. Thus, more than 75% of the inputs used in the N sector come from the N sector itself, while 65% of T-sector inputs come from the T sector. Nonetheless, these values still leave substantial room for cross-sectoral input-output linkages.

Next, we must calibrate the values of τ_{ij} for each pair of countries. To do that, we use the gravity estimates from the empirical model of Helpman et al. (2008). Combining geographical characteristics such as bilateral distance, common border, common language, whether the two countries are in a currency union and others, with the coefficient estimates reported by Helpman et al. (2008) yields, up to a multiplicative constant, the values of τ_{ij} for each country pair. We vary the multiplicative constant so as to match the mean and median imports/GDP ratios observed in the data in our sample of countries. The advantage of the Helpman et al. (2008) estimates is that they are obtained in an empirical model that accounts explicitly for both fixed and variable costs of exporting, and thus correspond most closely to the theoretical structure in our paper. Note that in this formulation, $\tau_{ij} = \tau_{ji}$ for all i and j.

Next, we must take a stand on the values of f^s_{ii} and f^s_{ij}. To do this, we follow di Giovanni and Levchenko (2012) and use the information on entry costs from the Doing Business Indicators database (The World Bank, 2007). This database collects information on the administrative costs of setting up a firm – the time it takes, the number of procedures, and the monetary cost – in a large sample of countries in the world. In this application, the particular variable we use is the amount of time required to set up a business. We favor this indicator compared to others that measure entry costs either in dollars or in units of per capita income, because in our model f^s_{ii} is a quantity of inputs rather than value. We must normalize the f^s_{ii} for one country. Thus, we proceed by setting $f^s_{US,US}$ to a level just high enough to ensure an interior solution for production cutoffs.[26] Then, for every other country f^s_{ii} is set relative to the U.S.. To be precise, if according to the Doing Business Indicators database, in country i it takes 10 times longer to register a business than in the U.S., then $f^s_{ii} = 10 \times f^s_{US,US}$. Since we do not have data on fixed costs of operating a business that vary by sector, we set f^s_{ii} to be equal in the N and T sectors.

To measure the fixed costs of international trade, we use the Trading Across Borders module of the Doing Business Indicators. This module provides the costs of exporting a 20-foot dry-cargo container out of each country, as well as the costs of importing the same kind of container into each country. Parallel to our approach to setting the domestic cost f^s_{ii}, the indicators we choose are the amount of *time* required to carry out these transactions. This ensures that f^T_{ii} and f^T_{ij}

[26]That is, we set $f^s_{US,US}$ to a level just high enough that $a^s_{ji} < 1/b_s$ for all $i, j = 1, ..., \mathcal{C}$ in all the baseline and counterfactual exercises, with $1/b_s$ being the upper limit of the distribution of a.

are measured in the same units. We take the bilateral fixed cost f_{ij}^T to be the sum of the cost of exporting from country j and the cost of importing into country i. The foreign trade costs f_{ij}^T are on average about 40% of the domestic entry costs f_{ii}^T. This is sensible, as it presumably is more difficult to set up production than to set up a capacity to export.[27]

Finally, we set the value of the "exploration cost" f_E such that the long-run equilibrium number of operating firms in the U.S. is equal to 7 million. According to the 2002 U.S. Economic Census, there were 6,773,632 establishments with a payroll in the United States. There are an additional 17,646,062 business entities that are not employers, but they account for less than 3.5% of total shipments. Thus, while the U.S. may have many more legal entities than what we assume here, 7 million is a sufficiently high target number. Since we do not have information on the total number of firms in other countries, we choose to set f_E to be the same in all countries. In the absence of data, this is the most agnostic approach we could take. In addition, since f_E represents the cost of finding out one's abilities, we do not expect it to be affected by policies and thus differ across countries. The resulting value of f_E is 15 times higher than $f_{US,US}^s$, and 2.4 times higher than the average f_{ii}^s in the rest of the sample. The finding that the ex-ante fixed cost of finding out one's type is much higher than the ex-post fixed cost of production is a common one in the quantitative models of this type (see, e.g., Ghironi and Melitz, 2005).

A.3 Numerical Algorithm

The solution to the model involves a large system of equations in w_i's, P_i^s's, and, in the long run only, n_i^s's. This system of equations is solved by adapting the tatonnement procedure of Alvarez and Lucas (2007). For a guess of the wage and price vectors, we use (A.2) and (11) to compute the next guess for the wage and price vectors, and iterate to convergence.

For solving the long-run equilibrium, there is an outer loop that uses a transformed version of the free entry condition (A.5) to find the vectors of n_i^s conditional on the vectors of w_i's and P_i^s's. Given an initial guess for the vector of n_i^s, we solve for the wages and prices as in the paragraph above. Then we compute the next guess for the vector of n_i^s using (A.5) given the vectors of wages and prices, and then use the next guess for n_i^s to find the next vectors of wages and prices. We iterate to convergence, at which point the solution yields vectors of w_i's, P_i^s's, and n_i^s satisfying all the equilibrium conditions.

Finally, to calibrate the model we must find a vector of L_i's such that the model matches perfectly the relative GDPs of all the countries. We do this following the approach of Alvarez and Lucas (2007). Given an initial guess for the vector of L_i's, we solve for the long-run equilibrium as

[27] The results are very similar if we instead set the bilateral fixed cost to be the sum of domestic costs of starting a business in the source and destination countries: $f_{ij}^T = f_{ii}^T + f_{jj}^T$. This approach may be preferred if fixed costs of exporting involved more than just shipping, and required, for instance, the exporting firm to create a subsidiary for the distribution in the destination country.

in the paragraph above, and use the model-implied wages w_i and observed actual country GDPs to back out the next guess for L_i. Using this new value of L_i, we solve for the new long-run equilibrium, and iterate to convergence. Thus, the complete model solution features a set of parameters L_i and equilibrium outcomes w_i's, P_i^s's, and n_i^s such that all the equilibrium conditions are satisfied and the model matches relative GDPs in the data.

Appendix B Extensions and Robustness

B.1 Imperfect Skill Transferability and Selection

We implement two alternative approaches to calibrating native-immigrant productivity differentials, introduced in Section 4.1. The first one assumes that immigrants have a 25% productivity disadvantage relative to natives with the same skill level: in all destinations j and for all origins $i \neq j$, $\phi_{ji}^{\ell} = \phi_{ji}^{h} = 0.75$. Hendricks (2002) reviews the empirical literature measuring native-immigrant wage gaps conditional on age and years of schooling for a variety of countries, and concludes that a reasonable upper bound on the immigrants' productivity disadvantage relative to the natives is 25%.[28] In the counterfactual scenario we assume that when these individuals return to their home countries, they are as productive as their compatriots that never left. We refer to this approach as *imperfect skill transferability*.

The second alternative approach allows for a much broader set of reasons – most notably selection into migration – why migrants would differ systematically from natives with the same observable skill level. We refer to this setup as *origin-specific selection*, and discipline the choice of the $\{\phi_{ji}^e\}$ parameters using earnings data. Ideally, one would like to allow for productivity differences that vary by both origin and destination. However, this would require earnings data for migrants disaggregated by country of origin for all destination countries, which are not available. Instead we follow Hendricks (2002) and use the U.S. Census data for the year 2000 to compute native-immigrant hourly wage ratios, controlling for skill level, for each immigration country of origin. The sample includes only individuals 18−65 years of age with positive salary income in year 2000. For all destination countries j we set

$$\phi_{ji}^e = \phi_i^e = \frac{W_{US,i}^e}{W_{US,US}^e}$$

for all origin countries $i \neq j$ and skill level $e = \ell, h$.[29] This approach assumes that, controlling for

[28] This is also consistent with the recent reviews of the literature by Dustmann and Frattini (2011) and De la Rica et al. (2013). Both of these papers provide numerous estimates from a wide range of studies of the wage gaps between natives and immigrants of different origins, and how these gaps differ across European countries and over time as a function of the immigrants length of residence in the host country. Another calibration study, Klein and Ventura (2009), assumes that international migration entails a 15% permanent loss in skills. Their choice is consistent with the estimates in Borjas (1996) and in their model delivers realistic migration rates.

[29] We are slightly abusing notation by using ϕ_i^e now to denote the native-immigrant productivity gap that varies only by country of origin.

educational attainment, the relative immigrant-native productivity of, say, Mexican immigrants in the U.S. is the same as that of Mexican immigrants in Canada or Spain. Though restrictive, this assumption appears reasonable and transparent. Figure A1 presents the resulting native-immigrant productivity gaps for all origin countries as a scatterplot of ϕ_i^h on the y-axis against ϕ_i^ℓ on the x-axis, along with the 45-degree line. The mean values for the unskilled and skilled relative productivities are 1.14 and 1.06, respectively. For most origin countries the values are in the $0.75-1.25$ range, consistent with the findings in Hendricks (2002), suggesting that controlling for schooling removes a great deal of heterogeneity. However, several countries exhibit large native-immigrant gaps. For instance, Finnish migrants appear to be roughly 50% more productive (based on their hourly wages in the U.S.) than natives with a similar education.[30] In contrast, Mexican migrants appear to be roughly 25% less productive than natives with a similar education.

In the counterfactual exercise migrants keep the same values of ϕ_i^ℓ and ϕ_i^h when returning to their country of origin, and thus the counterfactual labor force is calculated as

$$L_j = A_{jj}\left[\left(\sum_{i=1}^{\mathcal{C}}\phi_j^\ell N_{ij}^\ell\right)^{\frac{\sigma-1}{\sigma}} + \zeta_j\left(\mu_j\sum_{i=1}^{\mathcal{C}}\phi_j^h N_{ij}^h\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

(compare to (13)). If a country of origin had suffered positive selection into emigration – its best and brightest had emigrated – now these exceptionally productive individuals are returning home and will earn higher wages than stayers with the same observable skills.

The results are reported in Table A1. Throughout, we focus on the long-run effects. The Table reports the mean and the standard deviation of the welfare change in the no-migration counterfactual relative to the baseline with the observed migration patterns, as well as the correlation between the welfare change in each alternative model and the welfare results in the main text. For convenience, the top row of the table reproduces from Table 5 the summary statistics for the long-run welfare changes in the OECD and non-OECD. Under imperfect skill transferability, the welfare changes for the receiving country natives from un-doing migration are somewhat more subdued at -1.44% (compared to -2.38% in the baseline). This is intuitive: for these countries the loss of immigrants now implies a 25% smaller reduction in total efficiency units of labor compared to the benchmark. By contrast, the origin countries receive the same efficiency units of labor as they did under the benchmark approach. The cross-country pattern of welfare changes is quite similar to the baseline analysis, with the correlation between this scenario and the baseline results of 0.99 among the OECD countries. It is important to keep in mind that our welfare measure is based on the average utility of native stayers. Hence, for the emigration countries the differences in welfare changes across approaches are driven solely by the global general equilibrium effects.

[30] Recall that our definition of skilled is binary. Skilled workers include individuals with some college and above. Hence, substantial within-group heterogeneity remains.

The results of implementing the model under the origin-specific selection calibration are reported in the row "Selection Migrants" of Table A1. Here, average impact of migration is even more similar to the baseline, with a -2.18% welfare change in the OECD. Once again, the correlation between these results and the baseline is exceedingly high at 0.985 for the OECD, and essentially 1 for the non-OECD.

To summarize, the two approaches implemented in this section deliver very similar results to those obtained in the main text. We conclude that our benchmark results appear to be robust to alternative parameterizations of the productivity of migrants relative to native individuals in the host countries.

B.2 Imperfect Substitutability between Natives and Immigrants

This section implements a version of the model in which immigrants and natives of the same skill level are imperfect substitutes in production. Instead of (6), the labor endowment of country j is given by:

$$L_j = A_{jj} \left\{ \left[\left(N_{jj}^{\ell}\right)^{\frac{\lambda-1}{\lambda}} + \left(\sum_{i=1, i \neq j}^{\mathcal{C}} \phi_{ji}^{\ell} N_{ji}^{\ell} \right)^{\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}\frac{\sigma-1}{\sigma}} + \zeta_j \mu_j^{\frac{\sigma-1}{\sigma}} \left[\left(N_{jj}^{h}\right)^{\frac{\lambda-1}{\lambda}} + \left(\sum_{i=1, i \neq j}^{\mathcal{C}} \phi_{ji}^{h} N_{ji}^{h} \right)^{\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{\sigma-1}}. \tag{B.1}$$

That is, total labor endowment in country j is a CES aggregate of skilled and unskilled labor (as in the baseline), and in turn labor of skill $e = \ell, h$ is a CES aggregate of the native and immigrant workers of skill level e. Thus λ is the elasticity of substitution between the (un)skilled natives and the (un)skilled immigrants.

Define the labor aggregates by skill:

$$L_j^{\ell} \equiv \left[\left(N_{jj}^{\ell}\right)^{\frac{\lambda-1}{\lambda}} + \left(\sum_{i=1, i \neq j}^{\mathcal{C}} \phi_i^{\ell} N_{ji}^{\ell} \right)^{\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}} \tag{B.2}$$

$$L_j^{h} \equiv \left[\left(N_{jj}^{h}\right)^{\frac{\lambda-1}{\lambda}} + \left(\sum_{i=1, i \neq j}^{\mathcal{C}} \phi_i^{h} N_{ji}^{h} \right)^{\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}}. \tag{B.3}$$

Then (B.1) can be rewritten as:

$$L_j = A_{jj} \left\{ \left(L_j^{\ell}\right)^{\frac{\sigma-1}{\sigma}} + \zeta_j \mu_j^{\frac{\sigma-1}{\sigma}} \left(L_j^{h}\right)^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{\sigma-1}}. \tag{B.4}$$

As in the main text, let w_j be the price of a unit of L_j in equation (B.4). Let w_j^e denote the price of one unit of L_j^e, the CES-aggregate of skill level e, which is not observable directly in the data.[31]

[31]When we assume that natives and immigrants are perfect substitutes then we do observe skill prices since they coincide with the wages of workers of that skill level.

Let w^e_{ji} denote the wage of an *individual* of skill level e born in i working in j. Straightforward manipulation of the first-order conditions yields the following relationships:

$$\frac{w^h_j}{w^\ell_j} = \zeta_j \mu_j^{\frac{\sigma-1}{\sigma}} \left(\frac{L^h_j}{L^\ell_j}\right)^{-\frac{1}{\sigma}}, \tag{B.5}$$

and

$$\frac{w^e_{ji}}{w^e_{jj}} = \left(\phi^e_{ji}\right)^{\frac{\lambda-1}{\lambda}} \left(\frac{\sum_{k=1,k\neq j}^{\mathcal{C}} \left(\frac{w^e_{jk}}{w^e_{ji}}\right) N^e_{jk}}{N^e_{jj}}\right)^{-\frac{1}{\lambda}}. \tag{B.6}$$

Now the supply of immigrant workers relative to natives at a given skill level is inversely related to the native-immigrant wage gap within that skill level. The model in the main text with perfect substitutability between immigrants and natives of the same skill level corresponds to $\lambda \to \infty$. In that case the skill-specific native-immigrant wage ratio is not a function of the relative supply of immigrant workers.

Implementing this model requires setting a value for one new parameter, λ, and re-calibrating the set of country-specific parameters $\{\phi^e_{ji}, \zeta_j, \mu_j, A_{jj}\}$. The rest of the parameters of the model are the same as in the main text. We set $\lambda = 10$, which is near the lower end of the values found in the literature, implying maximum plausible difference (i.e., lack of substitution) between immigrants and natives of the same skill. Manacorda et al. (2012) report estimates around 10 for the U.K., while Ottaviano and Peri (2012) find values of around 20 for the U.S.. By using a relatively low substitution elasticity between natives and immigrants, this implementation will yield higher gains from immigration in the receiving countries.

The first step computes the productivity terms $\{\phi^e_{ji}\}$ using equation (B.6). As in Appendix B.1, due to lack of data we assume that these terms are origin-specific, and do not vary by destination: $\phi^e_{ji} = \phi^e_i$. For this step we use U.S. data on the immigrant and native populations and wages. Second, we use equations (B.2) and (B.3) to build skill aggregates $\{L^\ell_j, L^h_j\}$. Third, we compute w^h_j/w^ℓ_j from the market clearing conditions stating that total payments to labor must equal the sum of payments to different workers, both in aggregate and for each skill level: $w_j L_j = w^\ell_j L^\ell_j + w^h_j L^h_j$ and $w^e_j L^e_j = w^e_{jj} N^e_{jj} + \sum_{i=1,i\neq j}^{\mathcal{C}} w^e_{ji} N^e_{ji}$. Manipulation of these market clearing conditions delivers

$$\frac{w^h_j}{w^\ell_j} = \frac{w^h_{jj}}{w^\ell_{jj}} \frac{\frac{1}{L^h_j}\left(N^h_{jj} + \sum_{i=1,i\neq j}^{\mathcal{C}} \frac{w^h_{ji}}{w^h_{jj}} N^h_{ji}\right)}{\frac{1}{L^\ell_j}\left(N^\ell_{jj} + \sum_{i=1,i\neq j}^{\mathcal{C}} \frac{w^\ell_{ji}}{w^\ell_{jj}} N^\ell_{ji}\right)}.$$

Together with estimates of the country-specific skill premium w^h_{jj}/w^ℓ_{jj} described in Section 2, this condition is used to obtain the price of the skilled composite relative to the unskilled composite w^h_j/w^ℓ_j in each j. Fourth, we use equation (B.5) to solve for $\zeta_j \mu_j^{\frac{\sigma-1}{\sigma}}$ for each country.[32] Finally, as

[32] As in the main text, we need not take a stand on the values of ζ_j and μ_j separately.

in the baseline we find A_{jj} by solving for the equilibrium and a set of L_j's such that the relative nominal GDPs of all countries match the data. We then use these L_j's and (B.4) to compute the country productivity terms A_{jj}.

Having implemented this model, we evaluate the same counterfactual scenario as in the main text. Table A1 reports the results, in the row labelled "Imperfect Substitution." Note that the most precise comparison for these welfare changes is not the baseline but the "Selection Migrants" scenario, since it also uses origin-specific ϕ_i^e terms computed based on U.S. immigrant-native wage differences. As expected, immigration confers a somewhat greater benefit if migrants and natives are imperfect substitutes. Now the average welfare change for the OECD in the no-migration counterfactual is -4.10%, compared to -2.38% in the main text. In terms of cross-country variation, the welfare changes predicted by this model are extremely similar to the baseline, with a 0.99 correlation between the two for both the OECD and the non-OECD.

B.3 The Long-Run Scale Effect

This appendix explores the scale effect: the positive relationship between country size and per capita income. Jones (2002) and Jones and Romer (2010) posit the following relationship between real per capita income and population size:

$$\frac{(Income/Pop)_j}{P_j} = constant \times N_j^{\gamma}. \tag{B.7}$$

They argue that empirically the elasticity γ of real per capita income with respect to population size is between 0.25 and 1. That is, larger countries have greater PPP-adjusted per capita income, all else equal. We can estimate this same relationship inside our model, and compare the γ implied by our model to the Jones and Romer (2010) values. It is important to note that our calibration strategy does not target any moment directly related to the scale effect. The magnitude of the scale effect in the model is driven by parameters chosen for other reasons, most importantly ε_s, θ_s, β_s, as well as international trade costs τ_{ij}.

In order to examine the magnitude of the scale effect in our model and benchmark it to the empirical estimates, we fit the simple bivariate log-linear relationship (B.7) across countries inside our model. When we use the actual population in the right-hand side (number of persons N_j living in the country), the resulting OLS estimate is $\gamma = 0.17$, which is below the range suggested by Jones and Romer (2010). If we instead use the labor force in efficiency units L_j as the right-hand side variable, the estimated elasticity is 0.38. Thus the magnitude of the scale effect in our model appears plausible in the context of the existing estimates in the literature.

Our scale effect operates through greater equilibrium variety available in larger countries. Unfortunately, it is not possible to measure directly all the varieties available even in a single country, much less in a large set of countries. However, we can use existing estimates from the international trade literature to benchmark the model. Hummels and Klenow (2005) demonstrate that larger countries export a greater number of products. Although that paper does not use firm-level data, it employs highly disaggregated product categories. These authors estimate that the elasticity of the extensive margin of exports to total country GDP is 0.61. Estimating this relationship inside our model yields an elasticity of 0.8. Though slightly higher, it is comparable in magnitude. In addition, in the model we can only compute the elasticity of the number of exporting firms with respect to total GDP, whereas Hummels and Klenow (2005)'s relationship is with respect to the number of product varieties. If multiple firms exported the same product variety – a reasonable assumption – our model elasticity would be somewhat lower.[33]

We conclude from this benchmarking exercise and review of the literature that (i) scale effects appear to be present in the data, and (ii) the scale effect exhibited by our model has a magnitude that is in line with existing empirical estimates.

Nevertheless, we also assess how our results would change if we instead targeted smaller scale effects. Jones (2002) presents a range of estimates and argues that a plausible lower bound for the scale effect is in the range of $\gamma = 0.05 - 0.08$. We choose parameter values such that the model reproduces a scale effect of this magnitude. In particular, we eliminate input linkages ($\beta_s \approx 0$), and set the elasticity of substitution to $\varepsilon = 15$. As a result, the implied scale effect in our model is $\gamma = 0.04$ with respect to N_j and 0.07 with respect to L_j.

Table A1 presents the results of the counterfactual analysis under this calibration. As expected, the welfare change for OECD countries from returning all immigrants to their countries of birth is now smaller (-0.75% compared to a change of -2.38% in the baseline analysis). The loss to non-OECD countries is now larger (-3.23% compared to -2.01%). This is intuitive: lower scale effects reduce the welfare benefits from immigration-driven increases in market size. By the same token, all else equal, the scale-induced welfare benefit to emigration countries from returning migrants is more muted under a lower scale effect, leading to larger losses in the non-OECD in the no-migration counterfactual.

It may be that the scale effects are present, but they are counteracted by the presence of fixed factors that induce congestion costs.[34] We introduce congestion into our framework following Doc-

[33]Finally, we review some sub-national evidence on availability of varieties. Handbury and Weinstein (2011) use grocery store scanner data to show that larger U.S. cities have greater variety, with an elasticity of variety with respect to city size of about 0.2−0.3. Since U.S. cities are much more integrated than the countries in our sample, this elasticity does not have a direct counterpart in our model. The Handbury and Weinstein (2011) findings nonetheless imply that scale effects exist even across locations within the same country. To our knowledge, Mazzolari and Neumark (2012) is the only paper to report empirical estimates of the association between product variety and levels of immigration. Using data for California they find that immigration into a local economy leads to a wider range of varieties in the restaurant industry.

[34]Note that our analysis treats countries, rather than cities, as the unit of analysis. While congestion effects may be more apparent in cities, they are likely to be less relevant at the country level. Note also that our counterfactual exercise involves un-doing migration, not increasing it further. Clearly, if we were to implement a scenario that moves most of the world's population into a single country, congestion effects would become more important.

quier et al. (2012), modelling it in reduced form as a negative relationship between total population and labor productivity:

$$A_{jj} = \widetilde{A}_{jj} N_j^{\phi},$$

where $\widetilde{A}_{jj}$ is a constant. Following Docquier et al. (2012), we set $\phi = -0.03$, justified by appealing to the (low) share of land in the aggregate production function.

Table A1 presents the results. Not surprisingly, the welfare losses to the OECD countries from losing their immigrants are slightly smaller, as lower population now implies higher productivity. By the same token, the welfare losses to the non-OECD from un-doing migration are larger, since in these countries higher population leads to lower productivity. All in all, the results are quite similar to those reported in the main text, both in terms of magnitudes and the patterns of welfare changes across countries.[35]

B.4 TFP a Function of the Skilled Share

It is possible that changes in the skill composition of the labor force affect total factor productivity (Jones, 2002; Benhabib and Spiegel, 2005).[36] We model a direct link between TFP and the skilled share following the functional form suggested by Docquier et al. (2012):

$$A_{jj} = \widehat{A}_{jj} \left(\frac{N_j^h}{N_j^h + N_j^{\ell}} \right)^{\psi}, \tag{B.8}$$

where N_j^e is the total number of workers of skill level e residing in j (in the baseline or counterfactual), and $\widehat{A}_{jj}$ is a constant. We choose a value of $\psi = 0.32$ following the estimates in Docquier et al. (2012).[37]

The results are presented in Table A1, in the row labelled "TFP a Function of Skilled Share." For the OECD, the welfare reduction from losing its immigrants is now smaller, -1.57% instead of the baseline -2.38%. This is consistent with the fact that the immigrant population in the average OECD country is less skilled than the natives. Now the losses when immigrants leave the country are partially offset by a boost in TFP arising from the higher share of skilled in the remaining (native) population. The correlation between the welfare changes in this model and the benchmark model is 0.92 for OECD countries, so the overall cross-country pattern of welfare changes among receiving countries is quite similar.

[35] One of the types of immigration-related congestion costs invoked in the literature is through the housing market. Saiz (2003), Ottaviano and Peri (2006) and Gonzalez and Ortega (2013) find that immigration has led to increases in housing prices and rents in the U.S.. Naturally, the welfare of natives that do not own their dwellings is likely to be negatively affected. However, in many countries home ownership rates are high, and higher immigration-induced house prices will benefit owners. Thus the main effect of immigration operating through housing prices may be an increase in inequality.

[36] For evidence at the sub-national level see Ciccone and Peri (2006), Moretti (2004), and Iranzo and Peri (2009b).

[37] Existing micro-estimates of the strength of this human capital externality vary, and typically cannot be easily mapped into the elasticity ψ.

Interestingly, the welfare effects from undoing migration are very different for the non-OECD countries when TFP is an increasing function of the skilled share in the population. Now the average non-OECD country is better off in the absence of migration, with a mean welfare change of +2.59% compared to −2% in the baseline model. This result is driven by the much higher skilled share among emigrants compared to the source countries' overall population. As the share of the skilled in the population falls due to emigration, the TFP of the staying natives is reduced. This effect appears to dominate the gains from the observed remittances. Under this parameterization one can make sense of the concerns in some low-income countries about "brain-drain." The reliability of these results is limited by the lack of precise empirical estimates of the relationship between the skilled share and TFP that could be used as calibration targets. In addition, in the data this type of effect could be non-linear or conditional on other factors, something that we could of course not capture here. Nonetheless, the results here suggest that this is a promising direction for future research.

B.5 Other Robustness Checks and Policy Counterfactuals

The elasticity of substitution between the skilled and the unskilled is set to $\sigma = 3$ in the baseline analysis. To check whether the results are sensitive to this choice, Table A1 reports the results of re-implementing the model with $\sigma = 1.3$, which is at the bottom of the range proposed in the literature (Ottaviano and Peri, 2012). The results are quite similar to the baseline. The welfare changes due to migration have virtually the same magnitude, and virtually perfect correlation with those in the main analysis.

The counterfactual evaluated throughout the paper is rather drastic if interpreted as a policy experiment – a complete elimination of cross-border migration. Thus, we consider smaller changes that resemble more closely what can be achieved through policy. In particular, we evaluate the welfare impact of a 10% reduction in the stocks of all immigrants in each country. Since this experiment does not involve the complete elimination of migration, in the counterfactual there will still be remittances. In the absence of a good benchmark estimate of the propensity of different migrants to remit, we adopt the most agnostic approach and assume that the individual-level propensity to remit is the same for each skill category and origin-destination pair, and reduce the remittances accordingly in the counterfactual.[38] The results are presented in the row labelled "10% Repatriation" of Table A1. We can see that the welfare changes are essentially – and not

[38]The literature is inconclusive on the cross-country or cross-skill heterogeneity, if any, in the propensity to remit. Niimi et al. (2010) use cross-country data to empirically examine the determinants of remittances, paying special attention to the migrants' education level. Their findings suggest that countries whose emigrants are more educated tend to receive lower remittances than countries with less educated emigrants. These authors note that while skilled migrants tend to earn higher income and could thus afford to send larger remittances, it is also the case that their relatives in the home country tend to be better off than the relatives of less educated migrants. However, Bollard et al. (2011) use micro-data and find results that point in the opposite direction. All in all, it is not clear how remittances are be affected by migrants' education levels.

surprisingly – one-tenth of the main counterfactual welfare change. While the size of the welfare change is smaller, the correlation between the baseline welfare changes and this scenario for both the OECD and the non-OECD is virtually perfect.

We also perform two alternative experiments: in one we reduce the only unskilled immigrant population in each country by 10% and, in the other, we do the same but now applied only to the stock of skilled immigrants. The results are in the last 2 rows of Table A1. Naturally, these welfare changes are smaller than under a 10% reduction of all migrant stocks. Interestingly, both OECD and non-OECD countries, on average, would suffer a greater welfare loss from the partial repatriation of unskilled workers. This is most likely due to the fact that the unskilled migrants are larger in absolute numbers, and thus a 10% reduction in the unskilled immigrant stocks produces larger population changes in most countries.

B.6 The Welfare of Migrants

The main text analyzes the welfare impact of migration on the native stayers, and thus highlights primarily the general equilibrium effects of migration through population changes and the role of remittances. The model can also be used to evaluate the impact of migration on the welfare of the migrants themselves. The dominant mechanism here is the labor productivity differential between the source and destination countries, which in the case of developing-developed country comparisons is quite large. An individual of skill level e from country i produces with A_{ii}^e in her home country, and with $\phi_{ji}^e A_{jj}$ in foreign country j. Since the differences between A_{ii}^e and $\phi_{ji}^e A_{jj}$ are often several-fold, the welfare impact of migration on migrants' earnings is large, as has been commonly observed in micro data (see Hanson, 2009; Clemens et al., 2008).

The baseline equilibrium welfare of immigrants from i living in j is

$$W_{ji} = \frac{(1-\omega_{ji})\phi_i^\ell w_j^\ell + \omega_{ji}\phi_i^h w_j^h + (\Pi_j^N + \Pi_j^T)/\sum_{k=1}^{\mathcal{C}} N_{jk} - R_{ji}^{out}/N_{ji}}{(P_j^N)^\alpha (P_j^T)^{1-\alpha}},$$

where, as in the main text, w_j^e is the wage of a native-born individual of skill level e, $\omega_{ji} \equiv N_{ji}^h/(N_{ji}^\ell + N_{ji}^h)$ is the share of skilled among those born in i and residing in j, $N_{ji} = N_{ji}^\ell + N_{ji}^h$ is the total number of individuals born in i residing in j (thus $\sum_{k=1}^{\mathcal{C}} N_{jk}$ is the total population of country j, including both immigrants and natives of both skill levels), and R_{ji}^{out} are the total gross remittances that individuals born in country i and working in country j send to their country of origin. In the counterfactual scenario, the welfare of a returning migrant is given by (14), but with ω_{jj} replaced by ω_{ij}. That is, the skill composition of emigrants from country j can differ from the skill composition of those who never left, and those differences will be reflected in the average welfare of migrants returning from each country i.

An important caveat here is that the migration decision is not modelled in our framework. Thus, to the extent that there are high costs of migration, the true welfare impact of migration on the immigrant will be lower. The results in this section should be interpreted more narrowly as the change in the real income of migrants, acknowledging fully that these do not take into account any migration costs.

Table A2 reports, for selected country pairs, the percentage change in a migrant's welfare in the counterfactual (in which she is living in the home country) compared to the baseline (in which she is living in the host country).[39] A negative number means that the migrant would be worse off if she returned to the home country. Throughout we assume that skills are perfectly transferable and ignore migrant selection ($\phi_{ji}^{\ell} = \phi_{ji}^{h} = 1$). Columns 1 and 2 report the long-run and the short-run changes in the migrant's welfare associated with returning to the home country.

Clearly, the welfare losses to the migrants themselves associated with returning all migrants to their home countries are large. In the long run, a Canadian immigrant to the U.S. would lose 34.55% of her initial real income upon returning to Canada, while a Spanish immigrant to the U.S. would suffer a 14.37% loss. A Salvadorean (Mexican) in the United States that returned to El Salvador (Mexico) would suffer a 92.82% (80.00%) loss in real income, and the real income of an Indian in Australia who returned to her home country would fall by 96.40%. Likewise a Turkish worker in Germany that returns to Turkey would see her real earnings fall by 86.97%. The average migrant would lose 54.05% of her real earnings in the long run. The short-run effects are uniformly more muted but still very sizeable. For the average migrant the short-run loss in real earnings is 46.84%. This is sensible: one of the benefits of migration in the long run is in stimulating net entry and raising welfare through increased variety. That channel is largely turned off in the short run.

The large losses from return migration for the migrants themselves are very large due to the fact that most individuals migrated from low- to high-TFP countries. It is also interesting to aggregate native stayers and migrants and compute the change in welfare for the average individual in the world, pooling both groups. The resulting figures for the short run and the long run are -2.16% and -2.35%, respectively.[40] These figures are very close to what we obtained earlier for native stayers, reflecting the fact that migrants represent a small share of the world population.

Appendix References

Alvarez, Fernando and Robert E., Jr. Lucas, "General Equilibrium Analysis of the Eaton-Kortum Model of International Trade," *Journal of Monetary Economics*, September 2007, *54* (6), 1726–1768.

Anderson, James and Eric van Wincoop, "Trade Costs," *Journal of Economic Literature*, 2004, *42* (3), 691–751.

[39]Note that these welfare changes are somewhat different from the evaluations of the similar question in the empirical literature. Empirical studies compare the earnings of comparable individuals across locations for given factor prices. In our experiment, we compute the earnings before and after *all* the migrants in the world are returned to their home countries, allowing for general-equilibrium effects on all prices.

[40]To be precise, we take the simple average of the percentage welfare change across all the individuals in the world, migrants and the non-migrants.

Axtell, Robert L., "Zipf Distribution of U.S. Firm Sizes," *Science*, September 2001, *293* (5536), 1818–1820.

Benhabib, Jess and Mark M. Spiegel, "Human Capital and Technology Diffusion," in Philippe Aghion and Steven Durlauf, eds., *Handbook of Economic Growth*, Vol. 1 of *Handbook of Economic Growth*, Elsevier, 2005, chapter 13, pp. 935–966.

Bollard, Albert, David McKenzie, Melanie Morten, and Hillel Rapoport, "Remittances and the Brain Drain Revisited: The Microdata Show That More Educated Migrants Remit More," *World Bank Economic Review*, May 2011, *25* (1), 132–156.

Borjas, George, "The economic effects of Mexican immigrants in the United States," *Journal of Development Economics*, 1996, *51* (1), 69–98.

Card, David, "Immigration and Inequality," *American Economic Review*, May 2009, *99* (2), 1–21.

Ciccone, Antonio and Giovanni Peri, "Long-Run Substitutability Between More and Less Educated Workers: Evidence from U.S. States, 1950-1990," *The Review of Economics and Statistics*, November 2005, *87* (4), 652–663.

_ and _ , "Identifying Human-Capital Externalities: Theory with Applications," *Review of Economic Studies*, 2006, *73* (2), 381–412.

Clemens, M., C. Montenegro, and L. Pritchett, "The great discrimination: borders as a labor market barrier," 2008. Mimeo.

De la Rica, Sara, Albrecht Glitz, and Francesc Ortega, "Immigration in Europe: Trends, Policies and Empirical Evidence," 2013. ISA Discussion Paper.

di Giovanni, Julian and Andrei A. Levchenko, "Firm Entry, Trade, and Welfare in Zipf's World," August 2010. NBER Working Paper No. 16313.

_ and _ , "Country Size, International Trade, and Aggregate Fluctuations in Granular Economies," *Journal of Political Economy*, December 2012, *120* (6), 1083–1132.

_ , _ , and Francesc Ortega, "A Global View of Cross-Border Migration," May 2012. IZA Discussion Paper 6584.

_ , _ , and Romain Rancière, "Power Laws in Firm Size and Openness to Trade: Measurement and Implications," *Journal of International Economics*, September 2011, *85* (1), 42–52.

Docquier, Frédéric, Joël Machado, and Khalid Sekkat, "Efficiency gains from liberalizing labor mobility," 2012. mimeo, UCLouvain and Université Libre de Bruxelles.

Dustmann, Christian and Tommaso Frattini, "Immigration: The European Experience," 2011. CReAM Discussion Paper No 22/11.

Ghironi, Fabio and Marc J. Melitz, "International Trade and Macroeconomic Dynamics with Heterogeneous Firms," *Quarterly Journal of Economics*, August 2005, *120* (3), 865–915.

Handbury, Jessie and David E. Weinstein, "Is New Economic Geography Right? Evidence from Price Data," May 2011. NBER Working Paper No. 17067.

Hanson, Gordon H., "The Economic Consequences of the International Migration of Labor," *Annual Review of Economics*, 2009, *1*, 179–207.

Helpman, Elhanan, Marc Melitz, and Yona Rubinstein, "Estimating Trade Flows: Trading Partners and Trading Volumes," *Quarterly Journal of Economics*, May 2008, *123* (2), 441–487.

Hendricks, Lutz, "How Important is Human Capital for Development? Evidence from Immigrant Earnings," *American Economic Review*, March 2002, *92* (1), 198–219.

Hummels, David and Peter Klenow, "The Variety and Quality of a Nation's Exports," *American Economic Review*, June 2005, *95* (3), 704–723.

Iranzo, Susana and Giovanni Peri, "Schooling Externalities, Technology, and Productivity: Theory and Evidence from U.S. States," *The Review of Economics and Statistics*, May 2009, *91* (2), 420–431.

Jones, Charles I., "Sources of U.S. Economic Growth in a World of Ideas," *American Economic Review*, March 2002, *92* (1), 220–239.

_ and Paul M. Romer, "The New Kaldor Facts: Ideas, Institutions, Population, and Human Capital," *American Economic Journal: Macroeconomics*, January 2010, *2* (1), 224–245.

Katz, Lawrence F and Kevin M Murphy, "Changes in Relative Wages, 1963-1987: Supply and Demand Factors," *The Quarterly Journal of Economics*, February 1992, *107* (1), 35–78.

Klein, Paul and Gustavo Ventura, "Productivity Differences and the Dynamic Effects of Labor Movements," *Journal of Monetary Economics*, 2009, *56*, 1059–1073.

Manacorda, Marco, Alan Manning, and Jonathan Wadsworth, "The Impact Of Immigration On The Structure Of Wages: Theory And Evidence From Britain," *Journal of the European Economic Association*, February 2012, *10* (1), 120–151.

Mazzolari, Francesca and David Neumark, "Immigration and Product Diversity," *Journal of Population Economics*, July 2012, *25* (3), 1107–1137.

Moretti, Enrico, "Workers' Education, Spillovers, and Productivity: Evidence from Plant-Level Production Functions," *American Economic Review*, June 2004, *94* (3), 656–690.

Niimi, Yoko, Çağlar Özden, and Maurice Schiff, "Remittances and the Brain Drain: Skilled Migrants Do Remit Less," *Annales d'Economie et de Statistique*, 2010, *97-98*, 123–141.

Ottaviano, Gianmarco I. P. and Giovanni Peri, "Rethinking The Effect Of Immigration On Wages," *Journal of the European Economic Association*, February 2012, *10* (1), 152–197.

The World Bank, "Doing Business Indicators," 2007.

Yi, Kei-Mu and Jing Zhang, "Structural Change in an Open Economy," April 2010. Mimeo, Federal Reserve Bank of Philadelphia and University of Michigan.

Table A1. Welfare Changes: Extensions and Sensitivity

	OECD			Non-OECD		
	Mean	St. Dev.	Corr/w baseline	Mean	St. Dev.	Corr/w baseline
Baseline	-2.38	3.07	..	-2.00	3.55	..
Imperf. Transferability	-1.44	2.48	0.991	-1.86	3.54	1.000
Selection Migrants	-2.18	3.19	0.985	-2.04	3.67	0.997
Imperfect Substitution	-4.10	3.81	0.990	-2.47	3.77	0.989
Smaller Scale Effect	-0.75	0.57	0.578	-3.23	4.36	0.909
Congestion	-2.22	2.77	1.000	-2.15	3.61	0.998
TFP a Fcn. of Skilled Share	-1.43	4.43	0.918	2.51	11.05	0.204
$\sigma = 1.3$	-2.40	3.11	1.000	-1.96	3.57	1.000
10% Repatriation	-0.26	0.29	0.998	-0.28	0.42	0.987
10% Unskilled Repatriation	-0.18	0.16	0.901	-0.21	0.29	0.928
10% Skilled Repatriation	-0.11	0.16	0.927	-0.11	0.16	0.942

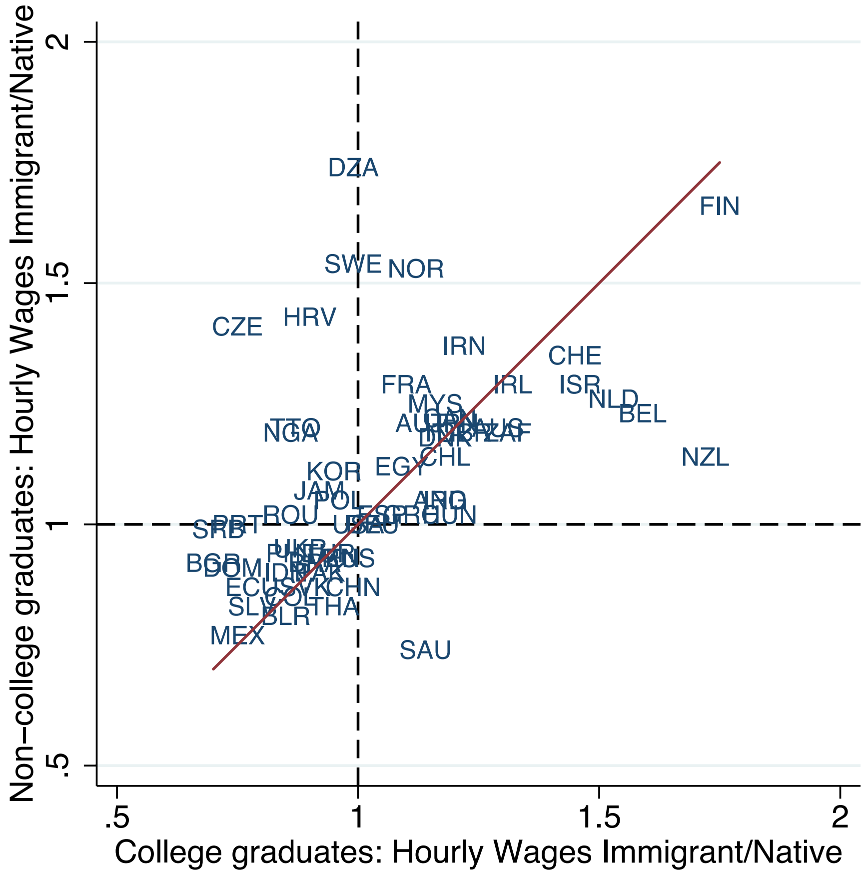
Notes: This table reports the mean welfare changes in the counterfactual relative to the baseline under alternative model specifications and counterfactual exercises. All results are for the long run. “Mean” is the average welfare change within the country group (OECD and non-OECD), “St. Dev.” is the standard deviation of welfare changes within the country group, and “Corr/w baseline” is the correlation between welfare changes in a particular scenario and the welfare change implied by the baseline model implemented and calibrated in the main text. The row labelled “Baseline” reports the welfare changes in the main analysis, reproduced from the bottom two rows of Table 5. “Imperf. Transferability” refers to the scenario where workers are penalized and can only use 75% of their efficiency units of labor when working in a country different from their country of origin (Section B.1). “Selection Migrants” is the scenario where we allow for origin-specific selection and the native-immigrant productivity gaps are measured on the basis of the wage gaps in the US between natives and each group of immigrants (Section B.1).“Imperfect Substitution” assumes that the elasticity of substitution between immigrants and natives of the same skill level is 10 and native-immigrant wage gaps are also calibrated on the basis of US data (Section B.2). “Smaller Scale Effect” refers to the scenario in which the scale effects implied by the model are at the bottom of the range found in Jones (2002) (Section B.3). “Congestion” refers to a scenario in which total population has a direct negative effect on TFP (Section B.3). “TFP a Fcn. of Skilled Share” refers to the scenario in which the level of TFP is assumed to be a function of the skilled share (Section B.4). “$\sigma = 1.3$” implements a model with that elasticity of substitution between skilled and the unskilled. “10% Repatriation” evaluates the welfare impact of reducing immigrant stocks by 10% worldwide. “10% (Un)skilled Repatriation” evaluates the welfare impact of reducing (un)skilled immigrant stocks by 10% worldwide.

Table A2. Percentage Change in Migrants' Welfare

	Long Run	Short Run
Canada → United States	-34.55	-23.48
Spain → United States	-14.37	-8.73
Mexico → United States	-80.00	-56.39
El Salvador → United States	-92.82	-69.50
Poland → United Kingdom	-82.89	-65.24
Turkey → Germany	-86.97	-63.68
New Zealand → Australia	-25.40	-16.78
India → Australia	-96.40	-71.65
Migrant Mean	-54.05	-46.84
Change in Global Welfare	-2.35	-2.16

Notes: This table presents the percent welfare (real income) change for the migrants themselves between baseline and counterfactual equilibria. Notation X → Y denotes an individual born in country X that migrated to country Y.

Figure A1. Migrant-native relative productivity by origin country



Notes: Each point in the scatterplot reports the ratio of the hourly wage of an individual born in a particular origin country relative to a U.S.-born individual with the same skill level. The calculations are based on the 2000 U.S. Census. The line through the data is the 45 degree line.