A Global View of Cross-Border Migration*

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Abstract

This paper evaluates the welfare impact of observed levels of migration and remittances in both origins and destinations, using a quantitative multi-sector model of the global economy calibrated to aggregate and firm-level data on 60 developed and developing countries. Our framework accounts jointly for origin and destination characteristics, as well as the inherently multi-country nature of both migration and other forms of integration, such as international trade and remittance flows. In the presence of firm heterogeneity and imperfect competition larger countries enjoy a greater number of varieties and thus higher welfare, all else equal. Because of this effect, natives in countries that received a lot of migration – such as Canada or Australia – are better off. 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 quantitative results show that the welfare impact of observed levels of migration is substantial, at about 5 to 10% for the main receiving countries and about 10% for the main sending countries.

JEL Classifications: F12, F15, F22, F24

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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 United States, United Kingdom, and France, and some 20% of the population in small, 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 (Table 1).

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 the 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' contribution to 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 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 very 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 type of model is product variety. Inflows of immigrants increase market size, and thus the range of varieties available to everyone for consumption and as intermediate inputs. 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. Thus, we can be precise about the magnitude of impact of migration on market size, and thus on the welfare of the natives.

Third, we take explicit account of the role of goods trade in affecting the gains from migration. To that end, 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, the set of potential projects 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 decision of only the marginal firms, which lie near the productivity cutoff for setting up a firm. Since these are the least productive firms in the economy, their economic impact is very limited. In the long run, the set of potential projects will change in response to migration to dissipate net 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 long and the short run depends crucially on the relative productivity of the marginal firms compared to the inframarginal ones. In evaluating this distinction quantitatively, the calibration to the observed distribution of firm size is central.

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. First, in the absence of migration the natives in practically every receiving country would have been worse off, and this welfare loss increases in the observed share of non-native population. Natives in the countries with the largest stocks of immigrants (relative to population) such as Australia, New Zealand, or Canada, have 5-10% higher welfare in under the current levels of migration compared to the no-migration counterfactual. This welfare effect is generated by the general equilibrium response of domestic variety. A lower population in the absence of migration implies a smaller equilibrium mass of domestically produced varieties, and thus lower per-capita welfare. At the same time, the welfare impact on the staying natives of the emigration countries 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 more variety in their production and consumption. On the other hand, migrants send home remittances, which would stop if emigration were undone. 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% worse off in the no-migration scenario. 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 (as observed by Klein and Ventura, 2009). 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 and Turkey, would actually be 1−4% better off in the no-migration counterfactual.

In the short run, the welfare impact on the main in-migration countries is much smaller, at less than 1%. By contrast, the welfare impact of reversing migration on the main out-migration countries tends to be similar to the long-run impact: negative and large. This asymmetry between the long- and the short-run results is intuitive. For the main receiving countries, the long-run welfare impact is due primarily to the general equilibrium effect of increased variety, and because in the short run that channel is only of limited importance, there is a big difference in the welfare changes between the short and the long run. By contrast, for the main migration sending countries the welfare impact is driven mainly by the partial equilibrium channel of lost remittances, which works immediately in both the short and the long run.

We also compute the welfare changes of the migrants themselves. The magnitude of these changes is an order of magnitude larger than the welfare changes for stayers. For instance, according to our results the welfare of Mexican immigrants in the United States would fall by 83% in the long run. Analogously, the welfare of a Turkish immigrant in Germany would fall by 88%. As noted above, these individuals are going back to a country that typically has both much lower labor productivity and lower variety.

Let us now provide a brief review of the relevant literature. Existing treatments of the impact of migration adopt either the neoclassical (one-sector) or the Heckscher-Ohlin paradigms. While still not settled, there is a growing body of literature that suggests that neither theoretical framework is fully consistent with empirical findings of the economic effects of immigration. The closed-economy, one-sector model implies large effects on relative factor prices, which have proven elusive to empirical researchers. The analysis is complicated by the high requirements in terms of data and the need for strong identifying assumptions (Borjas (2003), Ottaviano and Peri (2011)). Empirical work on the effects of immigration based on the Heckscher-Ohlin framework has focused on the classical Rybczynski theorem. However, its predictions regarding the changes in sectoral composition have been rejected repeatedly in studies based on cross-city variation (Lewis, 2003; Gonzalez and Ortega, 2011; Dustmann and Glitz, 2009).[1]

Our approach to the economic analysis of migration builds on new trade theory and emphasizes the role of firm heterogeneity and endogenous varieties. Along these lines our work is closely related to Iranzo and Peri (2009), which develops a two-country model with a differentiated sector and endogenous variety, as well as skill differences between workers, and applies it to migration between Eastern and Western Europe. Our paper shares with Iranzo and Peri (2009) 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. Second, we adopt a quantitative approach and allow for a great deal of heterogeneity across countries, firms, and workers. Substantively, while both Iranzo and Peri (2009) and this paper find that welfare in the South is lower in the no-migration scenario, the mechanism is different: in Iranzo and Peri (2009) this is due to the reduction in imported variety; in our analysis it is mainly due to the loss of remittances.

Our paper also contributes to the literature on the welfare impact of migration. Benhabib and Jovanovic (2010) and Klein and Ventura (2007, 2009) examine the welfare consequences of migration in two-country one-good models closed to trade, focusing on skill complementarities and cross-country TFP differences, respectively. As a matter of fact, some recent large-scale immigration episodes affect very open economies, such as Israel, Ireland, Spain, and the UK. There are reasons to believe that the results obtained in closed-economy frameworks may not be good approximations for these very open countries. Davis and Weinstein (2002) examine the welfare impact of migration in the two-country Ricardian model of Dornbusch et al. (1977). In that paper, the neoclassical nature of the economy implies that the natives of the rich country lose, and workers remaining in the poor country win from migration.

The rest of the paper is organized as follows. Section 2 presents the theoretical framework. Section 3 describes the data. Section 4 simulates the model economy and presents the

[1] At the national level, some studies do find some evidence in favor of adjustments through the industry mix (Ciccone and Papaioannou, 2009).

main calibration results. Section 5 presents counterfactual experiments and main welfare results. Section 6 concludes.

2 Theoretical Framework

2.1 Migration, Productivity, and Labor Force Composition

The world is comprised of $\mathcal{C}$ countries, indexed by $i, j = 1, \ldots, \mathcal{C}$. Each country is endowed with L_i efficiency units of labor. Following the insight by Trefler (1993, 1995), the effective labor endowment is a combination of the number of people that live in the country and their efficiency units. These efficiency units are determined by worker-specific productivity as well as, albeit in reduced form here, by each country's endowment of capital.

We build on this approach by taking explicit account of migration. Each country's labor force is composed of natives and immigrants, who can be skilled (in practice, high-school graduates or higher educational attainment) or unskilled, indexed by $e = \ell, h$ respectively. In particular, 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 is the source). Immigrants will generically differ from native workers, conditional on skills, in how many efficiency units of labor they possess: workers of skill level e born in country i and working in country j have A_{ji}^e efficiency units of labor. Then the total effective labor endowment in country j is just the summation over all the efficiency units of labor of workers at each skill level coming from all the countries:

$$L_j = \sum_{i=1}^{\mathcal{C}} \sum_{e=\{\ell,h\}} A_{ji}^e N_{ji}^e, \tag{1}$$

where, of course, the summation includes the native workers and their efficiency, $A_{jj}^e N_{jj}^e$, $e = \ell, h$. We assume that, at each destination, skilled workers are more productive than unskilled workers from the same country of origin: $A_{ji}^\ell = A_{ji}$ and $A_{ji}^h = \mu A_{ji}$, with $\mu > 1$.

It is well documented that when migrants cross the border, their wages change dramatically, often by an order of magnitude. To a large extent this is due to the large observed differences in factor prices across borders (Hendricks, 2002; Klein and Ventura, 2007). Another well established fact is that upon arrival immigrants tend to earn lower wages than comparable natives, and that this wage gap diminishes over time as immigrants acquire local skills (see Schultz (1998) and Borjas (1999) for reviews). Thus at any given snapshot, we will observe a wage gap between natives and immigrants in the typical country. Hendricks (2002) reports that the gap between the earnings of immigrants and U.S. natives with the same observable skills is less than 25 percent for most source countries (1990 US Census data).

To account for these empirical patterns, we allow for a productivity differential between immigrants and natives at the same skill level: $A^e_{ji} = \phi^e_i A^e_{jj}$.[2] As a result, the total efficiency units of labor in country j can be expressed as

$$L_j = A_{jj} \sum_{i=1}^{\mathcal{C}} \phi^\ell_i N^\ell_{ji} + \mu \phi^h_i N^h_{ji}. \tag{2}$$

2.2 The Environment

Consider a production structure in the spirit of Melitz (2003) and Eaton et al. (2011). In each country there are two broad sectors, the tradeable T and the non-tradeable N. In country i, the representative consumer maximizes

$$\max_{\{y^N_i(k), y^T_i(k)\}} \left(\int_{J^N_i} y^N_i(k)^{\frac{\varepsilon_N - 1}{\varepsilon_N}} dk \right)^{\frac{\alpha \varepsilon_N}{\varepsilon_N - 1}} \left(\int_{J^T_i} y^T_i(k)^{\frac{\varepsilon_T - 1}{\varepsilon_T}} dk \right)^{\frac{(1-\alpha)\varepsilon_T}{\varepsilon_T - 1}}$$

$$s.t.$$

$$\int_{J^N_i} p^N_i(k)\, y^N_i(k)\, dk + \int_{J^T_i} p^T_i(k)\, y^T_i(k)\, dk = Y_i,$$

where $y^s_i(k)$ is consumption of good k belonging to sector $s = N, T$ in country i, $p^s_i(k)$ is the price of this good, and Y_i is total income, which is the sum of labor income $w_i L_i$, net profits (if any) in the two sectors $\Pi^N_i + \Pi^T_i$, and net remittances received from abroad R_i. That is, $Y_i = w_i L_i + \Pi^N_i + \Pi^T_i + R_i$. Finally, J^s_i is the mass of varieties available in sector s in country i, coming from all countries. Since consumer preferences are Cobb-Douglas in CES aggregates of N and T, it is well known that consumption expenditure on sector N is equal to αY_i, and on the T sector, $(1 - \alpha) Y_i$.

The CES composites of both N and T are used both as final consumption and as intermediate inputs in production. Let X^s_i denote the total spending – final plus intermediate – on sector $s = N, T$ in country i. Given this total expenditure, it is well known that demand for an individual variety k in country i is equal to

$$x^s_i(k) = \frac{X^s_i}{(P^s_i)^{1-\varepsilon_s}} p^s_i(k)^{-\varepsilon_s}, \tag{3}$$

[2] In the quantitative implementation we consider several empirically relevant parameterizations of the productivity differential ϕ^e_i.

where P_i^s is the ideal price index of sector s in this economy,

$$P_i^s = \left[\int_{J_i^s} p_i^s(k)^{1-\varepsilon_s} dk \right]^{\frac{1}{1-\varepsilon_s}}. \quad (4)$$

Production in both sectors uses both labor and CES composites of N and T as intermediate inputs. In particular, a firm with unit input requirement a must use a input bundles to produce one unit of output. An input bundle in country j and sector s has a cost

$$c_j^s = w_j^{\beta_s} \left[\left(P_j^N\right)^{\eta_s} \left(P_j^T\right)^{1-\eta_s} \right]^{1-\beta_s}, \quad (5)$$

where w_j is the wage (i.e., the price of one unit of L) in country j. That is, production in sector $s = N, T$ requires labor, inputs of N, and inputs of T. The share of value added in total sales, β_s, and the share of non-tradeable inputs in total input usage, η_s, both vary by sector.

Each country j is populated by a mass n_j^s of entrepreneurs in sector s. Each entrepreneur $k \in [1, n_j^s]$ in each $s = N, T$ and $j = 1 \ldots, \mathcal{C}$ has an ability to produce a unique variety in sector s valued by consumers and other firms. Thus, each potential firm has some market power: it faces the downward-sloping demand for its variety given by (3). Entrepreneurs also differ in the unit input requirement $a(k)$ of producing their goods.

There are both fixed and variable costs of production and trade. Given $a(k)$, each entrepreneur in country j decides whether or not to pay the fixed cost of production f_{jj}^s, and which, if any, export markets to serve. In the N sector, we assume that trade costs are infinite, and thus a firm in country j may only serve its own market. 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 $\tau_{ij} > 1$.[3] We normalize the iceberg cost of domestic sales to one: $\tau_{jj} = 1$. Having paid the fixed costs of entering these markets, each firm produces with a unit input requirement $a(k)$, markets clear, and consumption takes place.

Firm k from country j selling to country i thus faces a demand curve given by (3), and has a marginal cost $\tau_{ij} c_j^s a(k)$ of serving this market in sector s. As is well known, the profit maximizing price is a constant markup over marginal cost, $p_i^s(k) = \frac{\varepsilon_s}{\varepsilon_s - 1} \tau_{ij} c_j^s a(k)$, the quantity supplied is equal to $\frac{X_i^s}{\left(P_i^s\right)^{1-\varepsilon_s}} \left(\frac{\varepsilon_s}{\varepsilon_s - 1} \tau_{ij} c_j^s a(k) \right)^{-\varepsilon_s}$, and the total ex-post variable profits are:

$$\pi_{ij}^{V,s}(a(k)) = \frac{X_i^s}{\varepsilon_s \left(P_i^s\right)^{1-\varepsilon_s}} \left(\frac{\varepsilon_s}{\varepsilon_s - 1} \tau_{ij} c_j^s a(k) \right)^{1-\varepsilon_s}, \quad (6)$$

[3] That is, the firm in country j must ship $\tau_{ij} > 1$ units to country i in order for one unit of the good to arrive there.

where once again we assume throughout that the only firms that can sell in sector N in country i are those based in that country. Note that these are variable profits of a firm in country j from selling its good to country i only, and are valid for destination-source pair i, j, including domestic sales: $i = j$.

Not all firms will decide to serve all markets. In particular, there is a cutoff unit input requirement a_{ij}^s, above which firms in country j do not serve market i. This cutoff a_{ij}^s is given by the following condition:

$$a_{ij}^s = \frac{\varepsilon_s - 1}{\varepsilon_s} \frac{P_i^s}{\tau_{ij} c_j^s} \left(\frac{X_i^s}{\varepsilon_s c_j^s f_{ij}^s} \right)^{\frac{1}{\varepsilon_s - 1}}. \tag{7}$$

We adopt the standard assumption that firm productivity in sector s, $1/a$, follows a Pareto(b_s, θ_s) distribution: $\Pr(1/a < y) = 1 - \left(\frac{b_s}{y}\right)^{\theta_s}$, where b_s is the minimum value labor productivity can take, and θ_s regulates dispersion. Standard steps of combining the definition of the price level (4) with the cutoffs (7) leads to the following expressions for prices:

$$P_i^N = \frac{1}{b_N} \left[\frac{\theta_N}{\theta_N - (\varepsilon_N - 1)} \right]^{-\frac{1}{\theta_N}} \frac{\varepsilon_N}{\varepsilon_N - 1} \left(\frac{X_i^N}{\varepsilon_N} \right)^{-\frac{\theta_N - (\varepsilon_N - 1)}{\theta_N (\varepsilon_N - 1)}} \left(n_i^N \left(\frac{1}{c_i^N} \right)^{\theta_N} \left(\frac{1}{c_i^N f_{ii}^N} \right)^{\frac{\theta_N - (\varepsilon_N - 1)}{\varepsilon_N - 1}} \right)^{-\frac{1}{\theta_N}} \tag{8}$$

and

$$P_i^T = \frac{1}{b_T} \left[\frac{\theta_T}{\theta_T - (\varepsilon_T - 1)} \right]^{-\frac{1}{\theta_T}} \frac{\varepsilon_T}{\varepsilon_T - 1} \left(\frac{X_i^T}{\varepsilon_T} \right)^{-\frac{\theta_T - (\varepsilon_T - 1)}{\theta_T (\varepsilon_T - 1)}} \left(\sum_{j=1}^{\mathcal{C}} n_j^T \left(\frac{1}{\tau_{ij} c_j^T} \right)^{\theta_T} \left(\frac{1}{c_j^T f_{ij}^T} \right)^{\frac{\theta_T - (\varepsilon_T - 1)}{\varepsilon_T - 1}} \right)^{-\frac{1}{\theta_T}}. \tag{9}$$

Trade is not balanced due to remittances. Let country i receive a net transfer of resources R_i, which can be positive (for countries receiving remittances), or negative (for countries sending them). 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. Let Y_i^N and Y_i^T denote the value of output by firms located in country i in sectors N and T, respectively. 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 N cannot be traded, it has to be the case that $X_i^N = Y_i^N$, and thus the aggregate resource constraint becomes:

$$X_i^T = Y_i^T + R_i. \tag{10}$$

Using the expression for total sales of a firm with unit input requirement $a(k)$ and adding up all the sales of all firms serving that market, 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 (7), and P_j^T in (9), the total exports from i to j become:

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

Adding up these across all destinations j and using (10), we obtain the market clearing condition for country i's total T-sector output:

$$Y_i^T = X_i^T - R_i = \sum_{j=1}^{\mathcal{C}} \frac{n_i^T \left(\frac{1}{\tau_{ji}c_i^T}\right)^{\theta_T} \left(\frac{1}{c_i^T f_{ji}^T}\right)^{\frac{\theta_T-(\varepsilon_T-1)}{\varepsilon_T-1}}}{\sum_{l=1}^{\mathcal{C}} n_l^T \left(\frac{1}{\tau_{jl}c_l^T}\right)^{\theta_T} \left(\frac{1}{c_l^T f_{jl}^T}\right)^{\frac{\theta_T-(\varepsilon_T-1)}{\varepsilon_T-1}}} X_j^T. \tag{11}$$

In assessing the welfare impact of migration, we consider two types of equilibria. The two equilibria differ in their assumptions on the mass of potential entrepreneurs n_i^s in each country and sector. The short-run equilibrium assumes that the set of available projects n_j^s is fixed in each country and sector, as in Chaney (2008) and Eaton et al. (2011). Thus, in the short-run equilibrium the stock of productive project ideas cannot adjust instantaneously to changes in the labor force. In the long-run equilibrium, the stock of projects n_j^s adjusts to satisfy the free entry condition, as in Krugman (1980) and Melitz (2003). Thus, in the long run this variable will respond to changing economic conditions, in our case migration.

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 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.

We now describe the equations defining the two equilibria.

2.3 Short-Run Equilibrium

In the short-run equilibrium, n_i^s is fixed exogenously. This 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 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:

$$X_i^N = \alpha Y_i + (1-\beta_N)\,\eta_N \left(1 - \frac{\varepsilon_s - 1}{\varepsilon_s \theta_s}\right) Y_i^N + (1-\beta_T)\,\eta_T \left(1 - \frac{\varepsilon_s - 1}{\varepsilon_s \theta_s}\right) Y_i^T \quad (12)$$

$$X_i^T = (1-\alpha) Y_i + (1-\beta_N)\,(1-\eta_N) \left(1 - \frac{\varepsilon_s - 1}{\varepsilon_s \theta_s}\right) Y_i^N + (1-\beta_T)\,(1-\eta_T) \left(1 - \frac{\varepsilon_s - 1}{\varepsilon_s \theta_s}\right) Y_i^T. \quad (13)$$

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. The 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 (8), (9), (11), (12), and (13) for each $i = 1, \ldots, \mathcal{C}$. Equations (12) and (13) imply that X_i^T is linear in $w_i L_i$ and R_i, which allows us to express (11) 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.

2.4 Long-Run Equilibrium

In the long-run equilibrium, n_i^s will adjust to satisfy the free entry condition. As in Krugman (1980) and Melitz (2003), each country has a potentially infinite number of entrepreneurs 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 potential entrepreneurs n_j^s is then pinned down by the familiar free entry condition in each sector and each country. Entrepreneurs in sector s will enter until the expected profit equals the cost of finding out one's type:

$$\mathrm{E}\left[\sum_{i=1}^{\mathcal{C}} \mathbf{1}\left[a(k) \leq a_{ij}\right]\left(\pi_{ij}^{V,s}(a(k)) - c_j^s f_{ij}^s\right)\right] = c_j^s f_e, \tag{14}$$

for each country j and sector s, where $\mathbf{1}[\cdot]$ is the indicator function 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:

$$X_i^N = \alpha Y_i + (1 - \beta_N)\,\eta_N Y_i^N + (1 - \beta_T)\,\eta_T Y_i^T \tag{15}$$

$$X_i^T = (1 - \alpha) Y_i + (1 - \beta_N)(1 - \eta_N)\, Y_i^N + (1 - \beta_T)(1 - \eta_T)\, Y_i^T. \tag{16}$$

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 measures of potential 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. The 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 (8), (9), (11), (14), (15), and (16) for each $i = 1, \ldots, \mathcal{C}$. As in the short-run case, (15) and (16) allow us to express X_i^T as a linear function of $w_i L_i$ and R_i, implying that (11) can be solved numerically for wages given R_i and price levels.

3 Data and Summary Statistics

To construct the labor force disaggregated by skill level, origin, and destination country we rely on two sources: the aggregate migration stocks for year 2006 from the OECD International Migration Database and the data for year 2000 on the labor force for each country in the world, disaggregated by education level, origin and destination countries produced by Docquier et al. (2010). Let us provide a bit more detail on each of these sources.

The OECD International Migration Database contains information on the stocks of immigrants by both destination and origin country (thus, it contains separate information on the number of natives of Mexico, and the number of natives of El Salvador, residing in the United States). We use data for 2006, the most recent year these data are available with comprehensive coverage. An important feature of these data is that it only contains information on 27 destination countries, namely members of the OECD. Thus, while we have data on hundreds of origin countries, we only have information on rich country destinations. As a result, strictly speaking, our counterfactual exercise analyzes the consequences of undoing South-to-North migration. Any South-to-South migration flows will be left unchanged.

The data by education level is based on Docquier et al. (2010), which updates the well-known data produced by Docquier and Marfouk (2004). These data provide information on the stocks of stayers, emigrants, and immigrants, by education level, for year 2000 for 190 countries.[4] These data are used to compute the share of skilled individuals among stayers and migrants in year 2000 (ages 25 and above). These shares are then applied to the 2006 aggregate migration stocks for each origin-destination country pair. In these data skilled individuals are those that completed high school, including for college education and beyond.[5]

The calibration of the productivity differences between skilled immigrants and skilled natives follows Hendricks (2002) and is based on data from the US Census for year 2000 (one percent public-use micro-sample). The sample excludes individuals living in group quarters and selects only individuals 18-65 with positive salary income in year 2000. We provide further details in the calibration section. Finally, remittances data are sourced from Ratha and Shaw (2007). The sources and details for the other data we use are described as we present the calibration.

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. There is a 61st rest of the world country. These 60 countries together cover 98% of world GDP. 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. Thus, our model is not intended to fit these countries, though we do place them into the rest-of-the-world category.

Table 1 lists the 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 shares of skilled for stayers, immigrants and emigrants.

[4] The data also contain 1990, but we do not use this information here.

[5] This definition is compatible with the human capital indicators reported by Barro and Lee?. Across all origin-destination pairs, the share of skilled is 0.25, with a standard deviation of 0.24.

The left panel displays the countries for which data on immigrant stocks are available (the OECD) while the panel on the right contains the remaining countries in our sample (the South).[6]

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 like Australia and New Zealand, where 25% of the population is foreign born. At the other, El Salvador, Trinidad and Tobago, and Jamaica display emigration shares in the 20-30% range.[7] Second, some of the OECD countries have large gross stocks of both immigrants and emigrants. Because of that, if migration had never taken place their population would be broadly the same (the third column). Ireland is the clearest example: its share of immigrants is 13%, but the share of emigrants is 16%. If migration had never taken place, its population would only be 3% higher.

The table also reports the net remittances in each country as a share of GDP. Negative values mean that a country is a net sender or remittances. Clearly, most OECD countries send more remittances than they receive, and 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. It is also interesting to compare the share of skilled among stayers, immigrants and emigrants. For practically all OECD countries the share of skilled (high school graduation or beyond) among emigrants is substantially larger than among stayers (e.g. 0.58 versus 0.52 for the US). However, there is large heterogeneity in the share of skilled among immigrants relative to the native stayers in the host country. For instance, while US-born stayers exhibit a share of skilled equal to 0.52, the analogous share among its immigrants was 0.42. Thus US immigrants were relatively unskilled, compared to native stayers, by this measure. In contrast UK immigrants were relatively skilled (0.42 share) relative to native stayers (0.18).

[6] Since we lack data on immigration for the South (right panel), the counterfactual population change for these countries is equal to their emigration share. That is to say, in the counterfactual these countries only experience a return of their emigrants, but not the exit of the immigrants residing in these countries.

[7] Once again, for these countries we are reporting data on emigration to OECD countries only. Thus their total emigration shares are likely to be a bit higher.

4 Calibration and Model Fit

We numerically implement the general multi-country model laid out in Section 2. We use information on country sizes, fixed and variable trade costs, and bilateral migration flows and remittances to solve the model. Then we simulate the effects of un-doing the migration flows observed in the data. That is, we repatriate all individuals back to their countries of origin.

4.1 Parameter values

We implement the economy under the following parameter values (see Table 2 for a summary). 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, 2010, 2011; 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 still could 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. 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_{ii}^s and f_{ij}^s. To do this, we follow di Giovanni and Levchenko (2010) and use the information on entry costs from the Doing Business Indicators database (The World Bank, 2007a). 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_{ii}^s is a quantity of inputs rather than value. We must normalize the f_{ii}^s for one country. Thus, we proceed by setting $f_{US,US}^s$ to a level just high enough to ensure an interior solution for production cutoffs.[8] Then, for every other country f_{ii}^s 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 $f_{ii}^s = 10 \times f_{US,US}^s$. Since we do not have data on fixed costs of operating a business that vary by sector, we set f_{ii}^s to be equal in the N and T sectors.

[8]That is, we set $f_{US,US}^s$ to a level just high enough that $a_{ji}^s < 1/b_s$ 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.

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} are measured in the same units. We take the bilateral fixed cost f^T_{ij} 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^T_{ij} are on average about 40% of the domestic entry costs f^T_{ii}. This is sensible, as it presumably is more difficult to set up production than to set up a capacity to export.[9]

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 $f^s_{US,US}$, and 2.4 times higher than the average f^s_{ii} 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).

4.2 Solution algorithm

Using these parameter values, summarized in Table 2, we can solve the full model for a given vector of L_i. To find the values of L_i, we follow the approach of Alvarez and Lucas (2007). First, as described in Section 2.1 L_i is not population *per se*, but a combination of the number of workers and the efficiency units – or labor productivity – that workers possess in country i. To obtain the values of L_i that are internally consistent in the model,

[9] 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: $f^T_{ij} = f^T_{ii} + f^T_{jj}$. 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.

we start with an initial guess for L_i for all $i = 1, \ldots, \mathcal{C}$, and use it to solve the full model. Given the solution for wages, we update our guess for L_i for each country in order to match the GDP ratio between each country i and the U.S.. Using the resulting values of L_i, we solve the model again to obtain the new set of wages, and iterate to convergence (for more on this approach, see Alvarez and Lucas, 2007). Thus, our procedure generates vectors w_i and L_i in such a way as to match exactly the relative total GDPs of the countries in the sample. In practice, the results are not far from simply equating the relative total labor to the relative GDPs. In this procedure, we must normalize the population of one of the countries. We thus set L_{US} to its actual value of 300 million as of 2006, and compute L_i of every other country relative to this U.S. value. An important consequence of this approach is that countries with higher labor productivity A_{ii} will tend to have a greater number of potential productivity draws n_i^s, all else equal, since our procedure will give them a higher L_i. This is akin to the assumption adopted by Alvarez and Lucas (2007) and Chaney (2008), that the number of productivity draws is a constant multiple of equipped labor L_i. The difference in our approach is that we take labor-cum-productivity to be a measure of market size, we solve for n_i^N and n_i^T endogenously within the model.

4.3 Labor productivity parameters

Having obtained the estimates of the total efficiency-adjusted labor endowment L_i and the data on bilateral immigrant stocks (by skill), $(N_{ji}^{\ell}, N_{ji}^{h})$, for each destination and origin country, we obtain country-specific productivity A_j for every country j by using (2):

$$A_{jj} = \frac{L_j}{\sum_{i=1}^{\mathcal{C}} \phi_i^{\ell} N_{ji}^{\ell} + \mu \phi_i^{h} N_{ji}^{h}}. \tag{17}$$

Clearly, given data on the number of workers in each destination country, disaggregated by country of origin and skill level, the previous calculation requires assigning values to μ, ϕ_i^{ℓ} and ϕ_i^{h}. Regarding the skilled-unskilled relative productivity (μ), we assume that one skilled worker corresponds to 1.5 unskilled workers.[10]

Next, we turn to the identification for parameters $\phi_i^{\ell}, \phi_i^{h}$. We shall consider three scenarios. In the first scenario we assume that $\phi_i^{\ell} = \phi_i^{h} = 1$, common across all countries. In this case, all workers are homogeneous and the average equilibrium wages of natives and

[10] In a Mincerian fashion, we read productivity differences off of wage differences. Assuming a five percent return to each year of schooling beyond elementary education delivers the 1.5 factor. Lacking earnings data for all countries in our sample, we find this to be a reasonable parameterization of μ. Alternatively, we could follow Grogger and Hanson (2011) and use data on average income and the Gini coefficient for each country. By making a (log normal) distributional assumption they proxy the skilled-unskilled wage ratio using a ratio of percentiles of the wage distribution.

immigrants with the same skill level will be equal in all countries although they will differ across countries. This will be our baseline scenario as we find it helpful in explaining the main mechanisms driving our results.[11]

In the second scenario we depart slightly from the homogeneous labor assumption by assuming that skills are imperfectly transferable across borders: $\phi_i^\ell = \phi_i^h = 0.75$, again assuming the same value for all countries. [12] Thus, conditional on the skill level, immigrants' wages will be 25 percent lower than natives' wages in all countries. Upon returning to their home country, migrants regain a value of one for the corresponding ϕ_i^ℓ or ϕ_i^h. In the counterfactual we set $\phi_i^\ell = \phi_i^h = 1$, that is, when migrants return to their home country their skills have not depreciated in terms of their productivity in their home countries. The third scenario considers origin-specific native-immigrant relative productivities that we calibrated following Hendricks (2002). The details will be discussed in section Section 5.4.

Our counterfactual experiments will evaluate welfare under the assumption that all immigrants residing in OECD countries return to their countries of origin. In this scenario the counterfactual effective labor forces of each country j will be:

$$\widetilde{L_j} = A_{jj} \sum_{i=1}^{\mathcal{C}} \left(\phi_i^\ell N_{ij}^\ell + \mu \phi_i^h N_{ij}^h \right). \tag{18}$$

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 to.[13] Our main task ahead is the computation of welfare for both natives and migrants in the counterfactual world with labor endowments (18), distinguishing between the short- and the long-run effects of such an experiment.

4.4 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 country level. The baseline is solved as the long-run equilibrium given

[11] Moreover, we show later, that the results are almost unchanged by using country-specific parameters matched to data.

[12] Hendricks (2002) reports that the gap between the earnings of immigrants and U.S. natives with the same observable skills is less than 25 percent for most source countries (1990 US Census data). Klein and Ventura (2009) assume that international migration entails a 15% permanent loss in skills. Their choice is consistent with the estimates in Borjas (1996) and delivers realistic migration rates.

[13] 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), Dustmann (2008), and Dustmann et al. (2011).

the total populations (including migrants), total GDPs, and remittances in all countries as they are in the data in 2006.

Figure 1 reports the scatterplot of bilateral trade ratios, $\pi_{ij} = X_{ij}/w_i L_i$.[14] 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. 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. On the horizontal axis is the natural logarithm of π_{ij} that comes from the model, while on the vertical axis is the corresponding value of that bilateral trade flow in the data.[15] Hollow dots represent exports from one country to another, π_{ij}, $i \neq j$. Solid dots, at the top of the scatterplot, represent sales of domestic firms as a share of domestic absorption, π_{ii}. For convenience, we add a 45-degree line. It is clear that the trade volumes implied by the model match the actual data well. Most observations are quite close to the 45-degree line. It is especially important that we get the variation in the overall trade openness $(1 - \pi_{ii})$ right, since that will drive the contribution of trade to the welfare impact of migration in each country. Figure 1 plots the actual values of $(1 - \pi_{ii})$ against those implied by the model, along with a 45-degree line. We can see that though the relationship is not perfect, it is quite close.

Table 3 compares the means and medians of π_{ii} and π_{ij}'s for the model and the data, and reports the correlations between the two. The correlation between domestic shares π_{ii} calculated from the model and those in the data for this sample of countries is around 0.57. The correlation between export shares, π_{ij}, 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 labor productivities A_j for each country, and we would like to compare these estimates to the data. Unfortunately, as a model object, A_j reflects the physical productivity of a unit of labor, which we cannot measure in the data. In addition, in the model one native worker will receive a wage equal to $w_j A_j$, and, because of global market clearing, wages of a single efficiency unit of labor will differ across countries as

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

[15]Note that the scatterplot is in log-log scale, so that the axes report the trade shares in levels.

well. To match the model precisely with the data, we calculate in the model the real, PPP-adjusted per capita income (for a native stayer worker), which is given by $w_j A_j(1+\mu_j\omega_j)/P_j$, with $P_j = (P_j^N)^\alpha (P_j^T)^{1-\alpha}$ the consumption price level, and $\omega_j \equiv N_j^h/(N_j^h + N_j^\ell)$ is the share of skilled in the total population of country j. This object is then directly comparable to income data from the Penn World Tables. Figure 2 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 a 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

We are now ready to perform our main counterfactual exercise. Namely, we use the model to evaluate the welfare effects of sending all foreign-born individuals currently living in OECD countries back to their countries of birth.[17]

As discussed in Section 2, in the short run the mass of potential firms (n_i^T and n_i^N) is fixed. Thus we compare the baseline equilibrium to the equilibrium when all OECD migrants return to their home countries, *given the benchmark values of* n_i^s. In the long-run counterfactual we let n_i^s adjust to the new size of the labor force.

The welfare comparison between the baseline equilibrium and the return migration counterfactual is not obvious. Qualitatively, the increasing returns arising from the presence of fixed costs suggest that net population gains will be welfare enhancing. However, we need to keep in mind that the typical migrant will be moving back to a lower TFP country. Thus the world as a whole will be shrinking in terms of efficiency units of labor. Additionally, countries that will receive net inflows of return migrants will simultaneously lose the remittances that those individuals were previously sending home. From a quantitative standpoint, the welfare effects will depend on the parameters governing the firm-size distribution. As argued

[16] The plots and the correlations are reported dropping United Arab Emirates, for which the model underpredicts real per capita income by about a factor of 2. 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 U.A.E., the simple correlation between the model and the data is 0.91, and Spearman correlation is 0.94.

[17] Recall that we lack data on immigration by country of origin for non-OECD countries. Thus in our counterfactual we keep South-South migration unchanged.

by di Giovanni and Levchenko (2010) in the context of trade liberalization, this matters crucially for the *short-run* welfare analysis.

5.1 Welfare Analysis

Our main measure of welfare is the average utility of native stayers, taking into account the distribution of skill levels among them. In the counterfactual, no-migration scenario all observed migrants to the OECD countries are instead assumed to reside in their country of birth.[18]

In the baseline scenario a generic country i's population can be divided in three groups: individuals born in country i that stayed in the country (stayers), individuals born in country i that migrated to another country (emigrants) and individuals born in other countries that migrated to country i (immigrants). Individual welfare corresponds to the indirect utility function. Since the direct utility function is CES and homothetic, indirect utility is simply an individual's income divided by the consumption price level. In the presence of remittances, we have to consider natives and migrants separately. We assume that outgoing remittances are sent by the migrants only, that is, natives living in their home country are not transferring any of their income abroad. We also assume that incoming remittances are received by natives only, that is, remittances from abroad coming into the country go to natives, and not to immigrants living in that country.[19] Note also that we are implicitly assuming that immigrants' human capital remains unaffected by the migration experience. That is, upon return to their home country migrants bring no new skills and display the same skill level as the natives from their home country that never left the country. While a bit simplistic we think this is a reasonable starting point.[20]

In the baseline equilibrium the utility levels enjoyed by the native stayers (born and residing in j) are given by

$$W_{jj} = \frac{w_j A_j (1 + \omega_{jj}\mu_j) + (\Pi_j^N + \Pi_j^T)/\sum_{k=1}^{\mathcal{C}} N_{jk} + R_j^{in}/N_{jj}}{P_j}, \quad (19)$$

and

$$W_{ji} = \frac{w_j A_j ((1 - \omega_{ji})\phi_i^\ell + \omega_{ji}\phi_i^h \mu_j) + (\Pi_j^N + \Pi_j^T)/\sum_{k=1}^{\mathcal{C}} N_{jk} - R_{ji}^{out}/N_{ji}}{P_j}, \quad (20)$$

[18] Below we will also report estimates of the welfare changes for the migrants themselves.

[19] 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 we think it is reasonable and it is not likely to bias our results in any economically important manner.

[20] See Rauch and Trindade (2002) and Rauch and Trindade (2003) for estimates of the effects of migration on enhancing trade flows via the information conveyed through ethnic networks.

where $\omega_{ji} \equiv N^h_{ji}/(N^\ell_{ji} + N^h_{ji})$ is the share of skilled among those born in i and residing in j, $N_{ji} = N^\ell_{ji} + N^h_{ji}$ 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 $P_j = (P^N_j)^\alpha (P^T_j)^{1-\alpha}$ is the consumption price level for all residents of country j. In this notation, R^{in}_j is the total gross amount of remittances received by the native stayers in country j from the rest of the world, R^{out}_{ji} are the total gross remittances that individuals born in country i and working in country j send to their country of origin.[21] We make the assumption that all residents of a country have an equal number of shares to domestic profits, regardless of their skill level of nativity status or skill. As discussed earlier, there are positive profits in the short run. In the long run, due to free entry, profits are zero.

In the counterfactual scenario each country's population is composed by the individuals that were born in that country, including both those that never left and returnees.[22] Our measures of individual welfare in the counterfactual equilibrium where all migrants return to their countries of origin are analogous to the previous expressions, with the proviso that all remittances disappear from the equations. Now all residents of country j are natives of that country: some had never left and others did but now have returned. Hence, counterfactual individual utility of a ntive stayer in country j is given by

$$\widetilde{W_{jj}} = \frac{\widetilde{w_j} A_j (1 + \omega_{jj}\mu_j) + (\widetilde{\Pi^N_j} + \widetilde{\Pi^T_j}) / \sum_{k=1}^{\mathcal{C}} N_{kj}}{\widetilde{P_j}},$$

where the tilde denotes the counterfactual equilibrium value.

5.2 The Long Run

Table 4 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 counterfactual relative to the benchmark scenario. Positive (negative) values will be interpreted as welfare gains (losses) from undoing international migration. We break up the sample into OECD countries and non-OECD countries. Roughly, we can think of the first group (left panel) as the

[21] 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.

[22] Recall the caveat that we lack data on the distribution of immigrants by origin country for non-OECD countries. Hence, the counterfactual population in these countries includes native stayers, immigrants and returnees from OECD countries. Thus the change in population experienced by these countries is equal to their baseline share of emigrants. Our remittance data include South-South remittances, but those account for only 21% of remittances received by a typical non-OECD country (16% when receiving countries from the former Soviet bloc are excluded). Thus South-South remittances are unlikely to have have a significant impact on our results.

migrant-receiving countries (the North) and the second group (right panel) as the migrant-sending countries. But keep in mind that there is substantial North-North migration as well. Let us first focus on the long-run results.

The first important observation to emerge from the Table is that the vast majority of countries in the North would experience welfare losses. The average country in the North would experience a utility loss of 2.43%, with substantial dispersion in outcomes (the standard deviation is 2.99%). At one extreme, the natives of the countries with the largest baseline shares of foreign-born in the population, such as Australia, New Zealand, and Canada would suffer the largest losses. Respectively, the changes in welfare for these countries would be −11.04%, −6.72%, and −6.96%. However, it is worth noting that a handful of countries in the North would experience welfare gains: Greece, Korea and Portugal would all be about 1% better off in the no-migration counterfactual. As Table 1 shows, these are the OECD countries with noticeable net out-migration. Thus these countries actually gain population in the counterfactual scenario: 5.2%, 2.8%, and 11.1%, respectively.

Secondly, we note that virtually all countries in the South would also experience a welfare loss, although dispersion in country incomes is very high. The average loss is 2.24% with an associated standard deviation of 3.62%. For several countries the welfare loss is very high. For instance, the natives in El Salvador, the Dominican Republic, Jamaica, and the Philippines would suffer a welfare loss around 10%. Interestingly, a handful of countries in the South experience welfare gains: mainly, Trinidad and Tobago (3.83%), Mexico (1.22%), and Turkey (1.05%). A quick glance at Table 1 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 ha emigration rate over 10%, remittances account for 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.

The intuition for why there is a welfare loss for most countries in the North and in the South is that the allocation of labor is more efficient in the baseline equilibrium since migrants tend to go to move from low to high TFP countries. As a result there is an increase in the world's total efficiency units of labor. This is reminiscent of the forces highlighted in Klein and Ventura (2007) in their analysis of the welfare costs of barriers to international labor mobility.[23] The main recipients of immigrants (the North) expand

[23] Their model features two regions and a single good. Both international trade and remittances is absent from their analysis.

the number of varieties they produce. The countries of origin benefit, both because they are able to import the new varieties and because of remittances. Their emigrants are now typically experiencing large increases in earnings and a fraction of those is being shared with the native stayers through remittances.[24]

Let us now try to isolate the roles played by changes in population size, international trade, and remittances. We shall present these results using scatter plots. The horizontal axis in all the following figures is the percentage change in the total population between the baseline and the counterfactual scenarios (column 3 of Table 1), with positive values corresponding to increases in population. Figure 3 summarizes the main results. Solid dots depict the welfare change in the long-run counterfactual (the first column of Table 4). As discussed above, most countries in the North suffer population loss as migrants return to their home countries while most countries in the South gain population. Among the countries in the North we note the positive association between the degree of population growth and the percentage change in long-run welfare. As a result, 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.% welfare loss for its native stayers. The picture is much less clear for the countries in the South. 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, respectively, 19% and 17.9%. But while the former would suffer a welfare loss of 9.1%, the latter would experience a welfare gain of 3.83%. As we show below, the diverging effects of return migration on these two countries are explained by the role of remittances.

Figure 3 plots the results from two additional counterfactual scenarios. In the first case, 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, while this is not the case in Trinidad and Tobago. Note also that for the countries in the

[24] Iranzo and Peri (2009) first formalized the argument that one channel through which migration source countries benefit from migration is through increased access to new varieties through imports. Their analysis is based on a two-region framework and, more importantly, does not take remittances into account. In part for this reason our results differ substantially from theirs, as we discuss below.

North the welfare changes remain practically unchanged. This is because the remittances originated in these countries are very small relative to the country's GDP.

Next, we examine the scenario where both remittances and international trade are assumed away. The corresponding welfare changes are depicted using hollow triangles. We note that the relationship between population and welfare changes becomes practically linear (with slope 0.4). This is because when a country in the South experiences net population growth it will respond by producing a wider set of varieties. In autarky, consumers in that country clearly benefit from the larger 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 international imports, giving rise to a decreasing marginal welfare gain.

5.3 The Short Run

Let us now analyze the effects of undoing migration in the short run, that is, we reallocate all individuals to their countries of origin but we keep unchanged the baseline mass of potential entrepreneurs in each country n_i^N and n_i^T. Changes in a country's labor force will thus affect the number of operating firms *only* through changes in the operating and exporting cutoffs.[25]

The changes in the welfare of native stayers for each country can be found in the second column of Table 4. As shown in the bottom rows of the Table, welfare for natives in the North is practically unchanged in the short run (an average loss of 0.49%, compared to the previous −2.43%). Turning now to the South (right panel), we find that 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 (3.44%, compared to 2.24% in the long run). The intuition for the differences between the short and long run effects is as follows. The typical country in the North experiences a net reduction in its labor force. As a result, some of the firms operating in the North shut down. In the short run, the set of potential projects available in the economy is fixed. Hence, the reduction in the number of firms/varieties is attained by a reduction in the cutoff determining domestic entry. 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 North. At the other end, the South receives a net inflow of workers. This increase in the labor force will induce an increase in the cutoff for domestic entry in the South. As a result, new firms will be established. However, these firms will be the least productive firms; those that before the inflow of new workers did not

[25] The measure of firms in sector s that operate in the domestic market is given by $n_i^s G(a_{ii}^s)$.

find it worthwhile to operate.

Let us now flesh out the channels at work (Figure 4) reports the short-run results graphically and provides the decomposition of the roles of remittances and international trade. As was the case in the long run, once country heterogeneity in remittances is removed, the relationship between population and welfare changes becomes roughly monotonic. As illustrated by the hollow dots, under trade but no remittances, larger population *gains* in the counterfactual lead to larger welfare *losses* among countries in the South.[26] Among countries in the North the relationship appears practically flat. In other words, in the short run the increase in domestic varieties experienced by countries in the South is not enough to compensate for the loss in imported varieties. The main reason for this is that return migrants are leaving high-productivity countries in the North to go back to their low-productivity countries of origin, which entails a large loss in worldwide efficiency units of labor. Let us now turn to the role of international trade. When we consider the counterfactual scenario without remittances and international trade, the relationship between population and welfare changes becomes again fairly linear and now features a *positive* slope. This reflects the fact that the increased labor force in the South will deliver a net increase in varieties available for consumption, obviously with no change in imported varieties.

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, existing 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 potential firms – a larger n_i^s. When an increase in population leads more entrepreneurs to draw their productivity, some of those new draws will turn out to be very productive, stimulating 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.

[26] Recall that this relationship had a positive in the long run.

5.4 Imperfect skill transferability and Selection into Emigration

In our baseline scenario the overall long-run welfare gains from migration stemmed from the global increase in units of efficiency of labor from the point of view of the world. This is because most migrants move from low to high TFP countries, as emphasized by Klein and Ventura (2007, 2009).

However, it is well documented that migrants suffer a reduction in human capital associated to imperfect transferability of skills across countries, at least in the short run.[27] If this is the case then our previous findings (*benchmark scenario*) may overstate the effects of migration on the labor force (in efficiency units) of the host country. On the other hand, there are instances where some immigrants appear to be permanently more productive (and earn higher wages) than natives with similar schooling levels. This may be due to non-random (positive) selection into migration. In some cases migrants will tend to be above-average in terms of unobservable skills (such as talent or ability) relative to observationally equivalent individuals (in terms of education, experience, gender, and so on) in the origin and destination countries.[28] In this case the results presented earlier would understate the effects of migration. Of course, negative selection is also a possible outcome and it may well vary substantially by origin country.[29]

In order to gain further insight on these issues, and as a robustness check on the findings presented above, we consider two alternative scenarios. In the first one we assume that migration is associated to a productivity loss. Specifically, immigrants are assumed to have a 25% productivity disadvantage relative to natives with the same skill level. In the notation of Section 2.1, $\phi_i^\ell = \phi_i^h = 0.75$, for all i countries).[30] In the counterfactual scenario we assume that when these individuals return to their home country they are equally productive as their compatriots that never left. We refer to this scenario as characterized by *imperfect skill transferability*.

The second alternative scenario that we consider allows for selection into migration. Specifically, we allow migrants to differ, in terms of efficiency units of labor, from individuals with the same observable skill level at the origin and destination. We refer to this setup as the scenario with *origin-specific selection*. Let us now explain how we discipline these parameters using earnings data. Ideally, one would like to allow for productivity differences

[27] This would lead to immigrant-native relative wages (controlling for education) below unity.

[28] Alternatively, immigrant-native relative wages (controlling for educational attainment) may reflect differences in the quality of education or other factors.

[29] Borjas (1987) lays down conditions for one or the other to take place.

[30] An alternative interpretation is that labor-market discrimination keeps immigrants employed in jobs for which they are overqualified.

that vary by both origin *and* destination. However, this would require earnings data for all destination countries, disaggregated by country of origin, which is not available. Instead we follow Hendricks (2002) and use US Census data (for year 2000) to compute native-immigrant hourly wage ratios, controlling for skill level, for all immigration countries of origin. Then we set

$$\phi_i^\ell = \frac{W_{US,i}^\ell}{W_{US,US}^\ell} \quad (21)$$

$$\phi_i^h = \frac{W_{US,i}^h}{W_{US,US}^h}, \quad (22)$$

for origin country i. Implicitly, we are assuming that the relative native-immigrant productivity of, say, Mexican immigrants in the US is the same as that of Mexican immigrants in Canada or Spain. While somewhat restrictive, we find this assumption to be reasonable and easy to implement. Figure 5 presents the resulting relative productivities, conditional on skill level, for all origin countries. The vertical axis reports ϕ_i^ℓ and the vertical axis reports ϕ_i^h. We also include a 45 degree line. The mean values for the unskilled and skilled relative productivities are 1.14 and 1.06, respectively. For most countries the values range 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 ratios. For instance, Finnish migrants appear to be roughly 50% more productive (based on their hourly wages in the US) than natives with similar education.[31] In contrast, Mexican migrants appear to be roughly 25% less productive than natives with similar education.

To compute the counterfactual equilibrium we assign the same values for ϕ_i^ℓ and ϕ_i^h to the return migrants in their country of origin. In words, if one particular country of origin had suffered positive selection, that is to say, its *best and brightest* had migrated above, now these exceptionally productive individuals are returning home and will earn higher wages than stayers with the same observable skills.

Figure 6 reports the long-run welfare changes for the three scenarios: benchmark, imperfect skill transferability, and origin-specific migrant selection.[32] The benchmark values are depicted by solid dots, and coincide exactly with the values in Figure 3. Let us now turn to the case with imperfect skill transferability, depicted by hollow dots. Compared to the benchmark results, two observations stand out. First, the welfare *gains* associated to return migration are now uniformly higher across all countries. However, the increase

[31] Recall that our definition of skilled is a bit rough: educational attainment equal to a high-school degree or above. Hence, substantial within-group heterogeneity remains.

[32] Throughout the three scenarios we allow for international trade and remittances.

is only noticeable for countries in the North (for which return migration implies a net reduction in their labor force). This is intuitive since for these countries the loss of their immigrants now implies a 25% smaller reduction in total efficiency units of labor than in the benchmark (with $\phi_i^\ell = \phi_i^h = 1$. For Australia the long-run welfare loss accounting for imperfect skill transferability is 8.6%, as opposed to 11% in the benchmark. In contrast the origin countries receive the same efficiency units of labor as they did in the benchmark scenario.[33]

Let us now turn to the scenario with *origin-specific migrant selection*, depicted in the Figure by hollow triangles. Again, there is virtually no change in the welfare calculation for the countries in the South. However, the typical country in the North suffers a larger loss than in the benchmark. This is driven by the fact that ϕ_i^ℓ and ϕ_i^h are on average larger than one. As a result, the reduction in the total efficiency units of labor in the North countries is larger now than in the benchmark.[34]

As it turns out, the two scenarios considered in this section deliver very similar results to those obtained in the benchmark model. For countries in the South the welfare changes are virtually identical to the previous ones. For the North they provide a sort of confidence bands. Since these are relatively narrow we conclude that our benchmark results appear to be robust to alternative parameterizations of the relative productivity between migrants and comparable individuals in the host and origin countries.

5.5 The Welfare of Migrants

The discussion above describes the welfare impact of migration on the native stayers, and thus highlighted primarily the general equilibrium effects of migration through population changes and the role of remittances. The model can also be used to understand 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 comparisons is quite large. Thus, an individual from country j produces with A_j in her home country, and with $\phi_j A_{ii}$ in foreign country i. Since the differences between A_j and $\phi_j A_{ii}$ are often several-fold, the welfare impact of migration on migrants' earnings is large, as has been commonly observed in micro data (see Hanson,

[33] It is important to keep in mind that our welfare measure is based on the average utility of native stayers. Hence, the differences in welfare change across scenarios are solely driven by the global general equilibrium effects.

[34] As a caveat it is important to recall that the calibration of these parameters was based solely on US data. If one believes that the selectivity of migrants (conditional on education) from a given country of origin varies across destinations then these results can be questioned.

2009; Clemens et al., 2008).

Table 5 reports, for selected country pairs, the percentage change in a migrant's welfare (real income) in the long-run counterfactual (in which she is living in the home country) compared to the baseline, (in which she is living in the host country).[35] Thus, 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 ($\phi_i^\ell = \phi_i^h = 1$). Columns 1 and 2 report, respectively, the long-run and short-run changes in the migrant's welfare associated to returning to the home country. Let us first discuss the long-run results (column 1). Clearly, the welfare losses for the migrants themselves associated to returning all migrants to their home countries would be large. In the long run, a Canadian immigrant to the U.S. would lose 33.5% of her initial real income upon returning to Canada, while a Spanish immigrant to the U.S. would suffer a 24.7% loss. A Salvadorean (Mexican) in the United States that were returned to El Salvador (Mexico) would suffer a 94.2% (83.4%) loss in real income and the earnings of an Indian in Australia returned to her home country would fall by 97.9%. Likewise a Turkish worker in Germany that were returned to Turkey would see her earnings reduced by 87.8%. The average migrant would lose 69.4% of her earnings. Turning now to the short-run estimates (column 2), we observe that the coefficients are uniformly lower but still very sizeable. For the average migrant the short-run loss in real earnings is −48.8%. This is sensible: one of the benefits of migration in the long run is stimulating net entry and raising welfare through increased variety. That channel is largely turned off in the short run.

Thus the loss from return migration for the migrants themselves is very large. This is largely 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, including both groups. The resulting figures for the short run and long run, respectively, are −2.2% and −2.6%.[36] These figures are very close to what we obtained earlier for native stayers, reflecting the fact that migrants are a small share of the world population.

[35] Note that these welfare changes are somewhat different from the evaluations of the similar question in the empirical literature. Those 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.

[36] Technically, we take the simple average of the percentage welfare change across all the individuals in the world, migrants and the non-migrants.

5.6 The Long-Run Scale Effect

The key mechanism through which natives in destination countries gain from migration in the long run is through increased variety. Because equilibrium variety responds endogenously to market size, and because larger markets exhibit greater equilibrium variety, individuals living in larger markets enjoy greater welfare, all else equal. This phenomenon is often referred to as a "scale effect." Scale effects are common and well-studied in both economic growth (e.g., Romer, 1990) and international trade (e.g., Krugman, 1980) models. 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.

Jones (2002) and Jones and Romer (2010) posit the following relationship between real per capita income and population size:

$$\frac{w_j}{P_j} = constant \times N_j^{\gamma}.$$

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. We can estimate this same relationship inside our model, and compare the γ implied by our model to the Jones and Romer (2010) values. We also note that our calibration strategy did 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 our model, if we use the actual population (number of persons N_j living in the country), the resulting $\gamma = 0.17$, 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 elasticity of real per capita income with respect of L_j is 0.38, still quite close to the bottom of the range of empirical estimates.

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 0.79. Though slightly higher, it is comparable in magnitude. We also use our model to estimate the elasticity of the number of exporting firms with respect to total GDP, as opposed to the number of product varieties used by Hummels and Klenow (2005). If multiple firms exported the same product variety – a reasonable assumption – our model elasticity would be somewhat higher.

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 (2009) 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.

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.

6 Conclusion

The cross-border movements of people are large relative to the overall population of many countries. This paper is the first global-scale assessment of the welfare impact of migration in a large cross-section of both sending and receiving countries. Migration affects welfare through two main channels. First, a typical migrant moves from a low-labor productivity country to a high-labor productivity one. This has a direct impact on the migrants themselves, as well as on the remaining natives of emigration countries through remittances. An important feature of our calibration is that we match GDP and cross-border remittances for all countries.

The second channel is that an inflow of migrants increases the size of the labor force, thereby increasing the mass of varieties available for consumption and as intermediate inputs. All else equal, this raises the welfare of the natives of receiving countries, and lowers the welfare of the remaining natives in the sending countries. Quantitatively, our model evaluates the relevance of this effect by matching the labor endowments (in efficiency units) in each country and using data on observed migration flows to compute the resulting changes in labor force. In addition, since international trade has an impact on the set of varieties available in each economy, we model all the multilateral trade relationships between the countries, and match the observed overall and bilateral trade volumes. Throughout, the paper distinguishes between the short run, during which equilibrium variety adjusts by adding or removing inferior (low-productivity) varieties, and the long run, in which equilibrium variety can change throughout the whole firm size distribution. The quantitative implications for the short and long run results rely importantly on the calibration of the distribution used to draw firm-level productivity. We discipline this parameters by matching the observed firm size distribution, which contains information on the relative productivity of the marginal firms compared to the inframarginal ones.

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 rats (Australia, New Zealand, Canada), migration raised welfare through increased equilibrium variety. For the countries with the highest emigration rates (El Salvador, Jamaica), the staying natives were better off because of remittances. These forces are also at work for all other countries, but the relative strength of each varies substantially among them. 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, leading us to conclude that migration has been seriously detrimental for the natives of these countries.

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Table 1: Country Sample and Migrant Stocks

Country	Share Immigrants	Share Emigrants	Pop. Chg. in Counterfactuals *Destination and Source*	Remittances /GDP	Sh. skilled Stayers	Sh. skilled Immigrants	Sh. 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

Country	Share Immigrants	Share Emigrants	Pop. Chg. in Counterfactuals *Source Only*	Remittances /GDP
Algeria	–	0.025	0.025	0.023
Argentina	–	0.012	0.012	-0.004
Belarus	–	0.005	0.005	0.001
Brazil	–	0.005	0.005	0.005
Bulgaria	–	0.037	0.037	0.082
Chile	–	0.016	0.016	-0.002
China	–	0.003	0.003	0.012
Colombia	–	0.023	0.023	0.034
Croatia	–	0.103	0.103	0.020
Dominican Rep.	–	0.097	0.097	0.143
Ecuador	–	0.068	0.068	0.050
Egypt, Arab Rep.	–	0.004	0.004	0.042
El Salvador	–	0.190	0.190	0.178
India	–	0.003	0.003	0.030
Indonesia	–	0.002	0.002	0.007
Iran, Islamic Rep.	–	0.011	0.011	0.006
Israel	–	0.021	0.021	-0.023
Jamaica	–	0.317	0.317	0.200
Malaysia	–	0.010	0.010	-0.006
Mexico	–	0.107	0.107	0.031
Nigeria	–	0.003	0.003	0.031
Pakistan	–	0.005	0.005	0.044
Philippines	–	0.030	0.030	0.155
Romania	–	0.070	0.070	0.058
Russian Fed.	–	0.008	0.008	0.001
Saudi Arabia	–	0.004	0.004	-0.049
Serbia and Mont.	–	0.106	0.106	0.191
South Africa	–	0.011	0.011	0.001
Thailand	–	0.006	0.006	0.002
Trin. and Tob.	–	0.179	0.179	0.006
Turkey	–	0.038	0.038	-0.001
Ukraine	–	0.019	0.019	-0.010
U.A.E.	–	0.003	0.003	–
Venezuela	–	0.011	0.011	-0.004
Rest of World	–	0.011	0.011	0.021

Notes: This table presents the countries in the sample, broken down into those for which inward migration data are available for 2006 (the OECD), and those for which only outward migration to the OECD data are available. 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 last column presents the percentage change in the population if all the emigrants never left, and all the immigrants never arrived. This is the percentage change in the population evaluated in the counterfactual. Source: The World Bank (2007b); OECD (2011).

Table 2: Parameter Values for Symmetric and Non-Symmetric Country Simulations

Parameter	Baseline	Source
ε [a]	6	Anderson and van Wincoop (2004)
θ [b]	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} [c,d]	2.30	Helpman et al. (2008)
f_{ii} [c]	14.24	The World Bank (2007a); normalizing $f_{US,US}$
f_{ij} [c]	7.20	so that nearly all firms the U.S. produce
f_e	34.0	To match 7,000,0000 firms in the U.S. (U.S. Economic Census)

Notes:
[a] Robustness checks include $\varepsilon = 4$ and $\varepsilon = 8$.
[b] Robustness checks include $\frac{\theta}{\varepsilon-1} = 1.5$ and $\varepsilon = 6$, so that $\theta = 6.5$.
[c] Average in our sample of 60 countries.
[d] $\tau_{ij} = \tau_{ji}$. Trade costs are adjusted by a constant ratio to match the median-level of openness across the 60-country sample.

Table 3: Bilateral Trade Shares: Data and Model Predictions for the 60-Country Sample

	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).

Table 4: Proportional Change in Native Welfare in the Counterfactual Relative to Benchmark

Country	Long Run	Short Run	Country	Long Run	Short Run
	Destination and Source Countries			*Source Only Countries*	
Country	Long Run	Short Run	Country	Long Run	Short Run
Australia	-0.1172	-0.0072	Algeria	-0.0154	-0.0214
Austria	-0.0303	-0.0039	Argentina	0.0007	-0.0019
Belgium	-0.0459	-0.0134	Belarus	-0.0124	-0.0103
Canada	-0.0715	0.0020	Brazil	-0.0026	-0.0042
Czech Republic	-0.0094	-0.0080	Bulgaria	-0.0566	-0.0659
Denmark	-0.0126	-0.0029	Chile	0.0035	-0.0010
Finland	-0.0012	-0.0055	China	-0.0079	-0.0090
France	-0.0308	-0.0036	Colombia	-0.0200	-0.0274
Germany	-0.0153	-0.0008	Croatia	-0.0033	-0.0328
Greece	0.0118	-0.0059	Dominican Republic	-0.0908	-0.1159
Hungary	-0.0042	-0.0010	Ecuador	-0.0225	-0.0442
Ireland	0.0004	-0.0047	Egypt, Arab Rep.	-0.0347	-0.0339
Italy	0.0043	-0.0015	El Salvador	-0.0889	-0.1419
Japan	-0.0048	-0.0001	India	-0.0256	-0.0256
Korea, Rep.	0.0108	-0.0004	Indonesia	-0.0066	-0.0064
Netherlands	-0.0251	-0.0007	Iran, Islamic Rep.	-0.0014	-0.0052
New Zealand	-0.0685	-0.0117	Israel	0.0008	-0.0006
Norway	-0.0251	-0.0004	Jamaica	-0.0704	-0.1587
Poland	0.0020	-0.0130	Malaysia	-0.0053	-0.0052
Portugal	0.0144	-0.0199	Mexico	0.0129	-0.0260
Slovak Republic	-0.0005	-0.0108	Nigeria	-0.0274	-0.0259
Spain	-0.0491	-0.0042	Pakistan	-0.0350	-0.0348
Sweden	-0.0343	0.0017	Philippines	-0.1040	-0.1147
Switzerland	-0.0447	0.0002	Romania	-0.0271	-0.0488
United Kingdom	-0.0148	-0.0024	Russian Federation	-0.0016	-0.0037
United States	-0.0535	0.0016	Saudi Arabia	-0.0030	0.0063
			Serbia and Montenegro	-0.1155	-0.1447
			South Africa	-0.0004	-0.0030
			Thailand	-0.0055	-0.0059
			Trinidad and Tobago	0.0483	-0.0137
			Turkey	0.0107	-0.0030
			Ukraine	-0.0031	-0.0056
			United Arab Emirates	-0.0011	-0.0010
			Venezuela, RB	0.0010	-0.0014
Mean	-0.0237	-0.0045	Mean	-0.0209	-0.0335
Std. Dev.	0.0309	0.0055	Std. Dev.	0.0358	0.0463

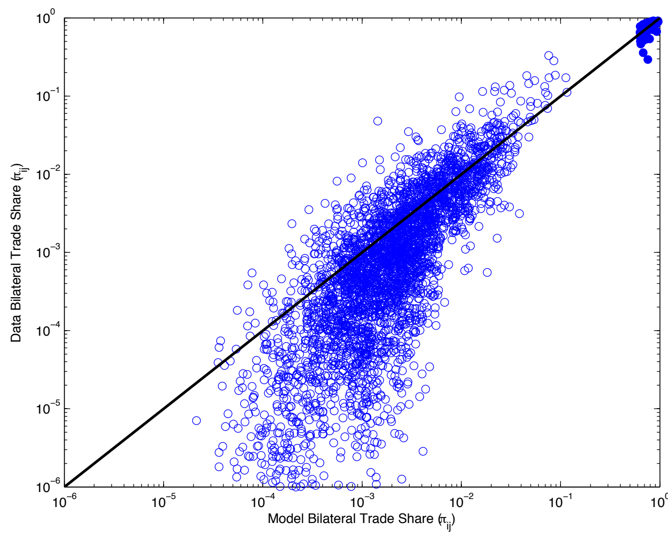
Notes: This table presents the proportional change in welfare between baseline and counterfactual equilibria, assuming $\phi_i^\ell = \phi_i^h = 1$ for all countries. The measure of welfare employed here is the real income of the average native stayer. The first column reports the welfare change in the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

Table 5: Change in Migrants' Welfare

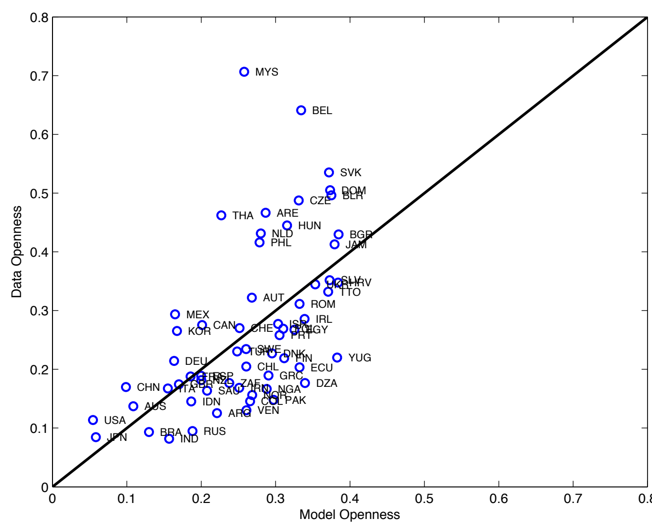
	Long Run	Short Run
Canada → United States	-0.335	-0.226
Spain → United States	-0.126	-0.075
Mexico → United States	-0.800	-0.563
El Salvador → United States	-0.930	-0.695
Poland → United Kingdom	-0.815	-0.638
Turkey → Germany	-0.868	-0.633
New Zealand → Australia	-0.269	-0.182
India → Australia	-0.976	-0.739
Migrant Mean	-0.613	-0.470
Change in Global Welfare	-0.025	-0.022

Notes: This table presents the 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 1: Benchmark Model vs. Data



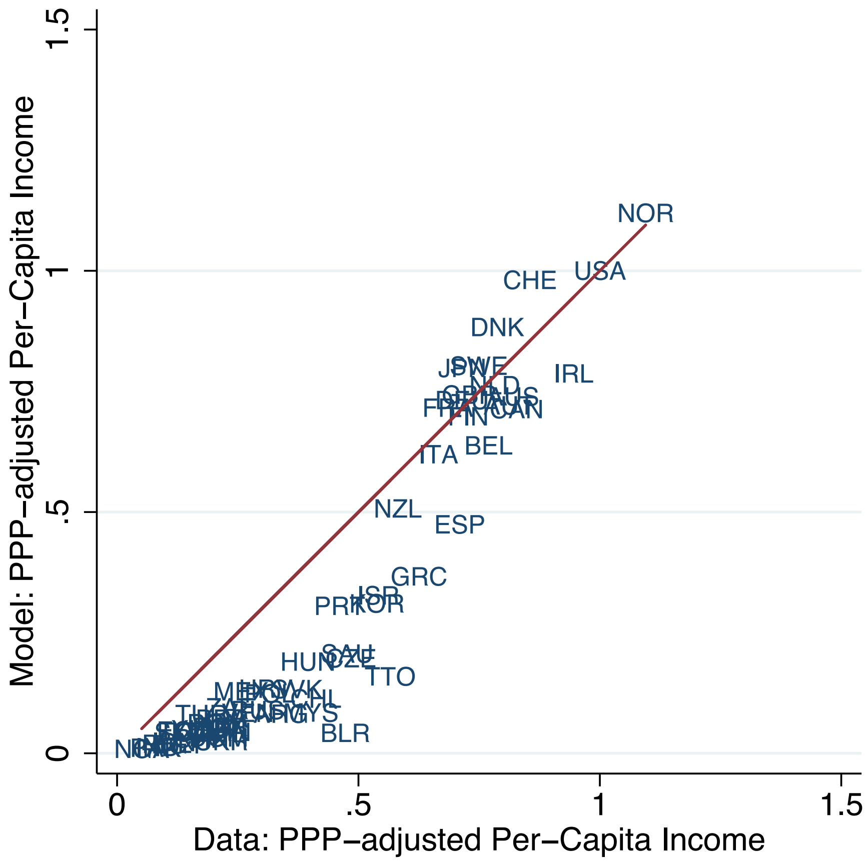
[Bilateral Trade Shares]



[Overall Openness]

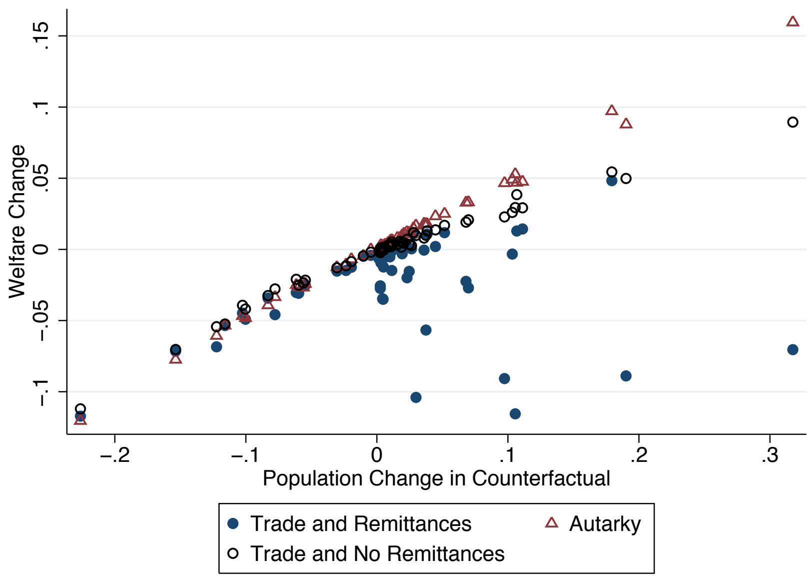
Notes: This figure presents the scatterplots of bilateral trade shares and overall imports/GDP, model (x-axis) against the data (y-axis). The straight line in each plot is the 45-degree line.

Figure 2: Real Incomes: Model vs. Data



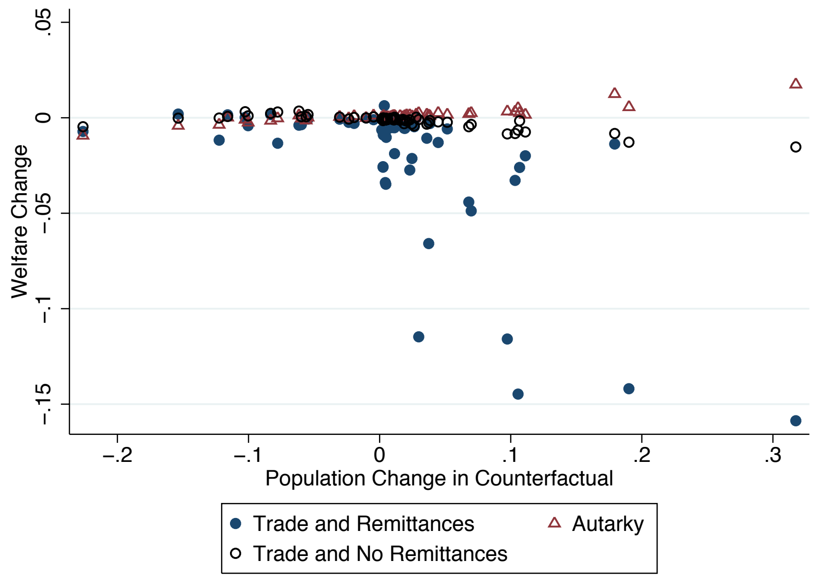
Notes: This figure reports the scatterplot of the real PPP-adjusted per capita income from the Penn World Tables (x-axis) against the real PPP-adjusted per capita income implied by the model. Both are expressed relative to the U.S..

Figure 3: Proportional Change in Native Welfare in the Long Run: Autarky, Trade, and Trade & Remittances



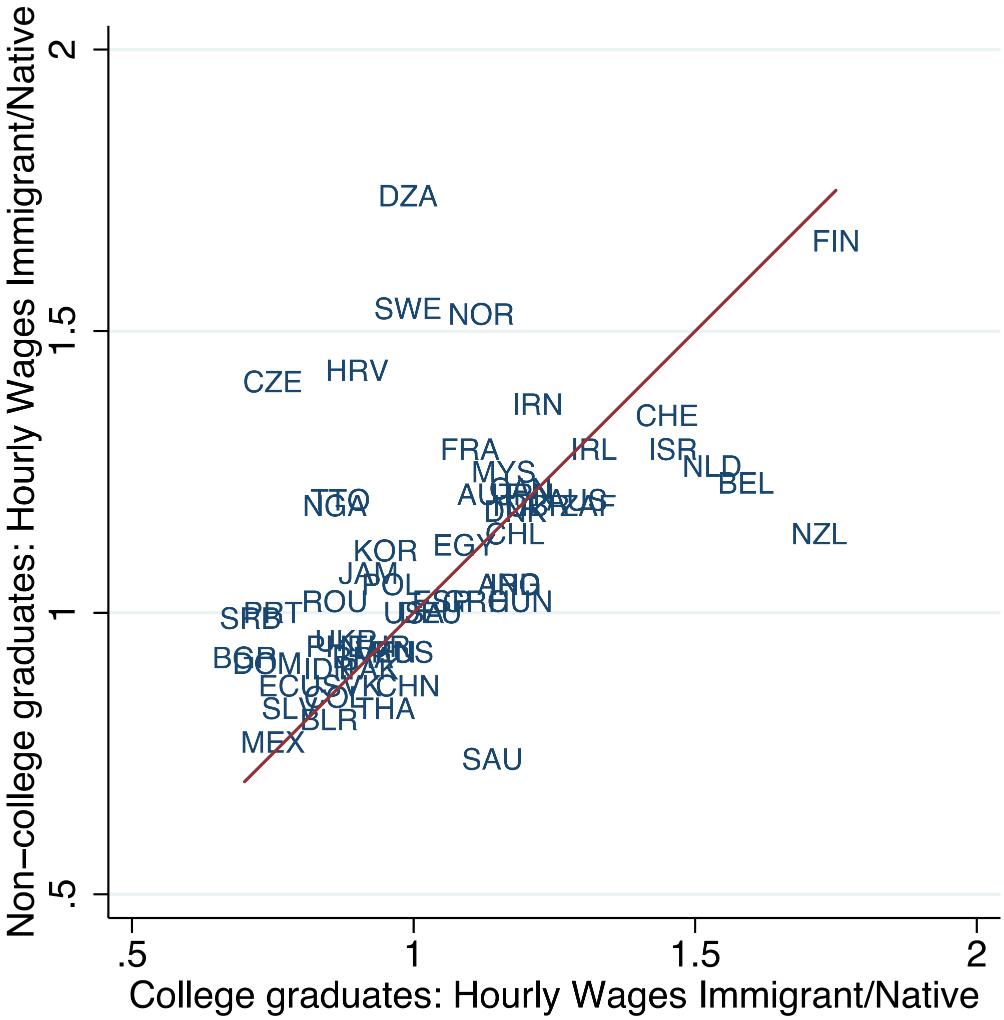
Notes: This figure reports the proportional change in welfare in the long-run counterfactual relative to the baseline (assuming $\phi_i^\ell = \phi_i^h = 1$ for all countries i) in three different scenarios. In the first we allow for trade and remittances (solid dots). In scenario 2 we allow for international trade but keep remittances constant at zero in the baseline and counterfactual equilibria (hollow dots). Scenario 3 depicts a world with prohibitive trade costs and no remittances. The measure of welfare reported is the real income of the average native stayer.

Figure 4: Proportional Change in Native Welfare in the Short Run: Autarky, Trade, and Trade & Remittances



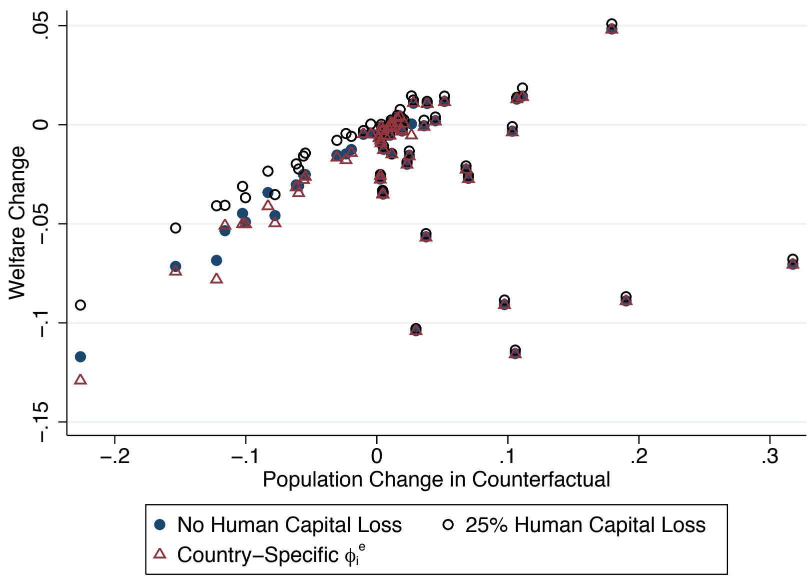
Notes: This figure reports the proportional change in welfare in the short-run counterfactual relative to the baseline (assuming $\phi_i^{\ell} = \phi_i^h = 1$ for all countries i) in three different scenarios. In the first we allow for trade and remittances (solid dots). In scenario 2 we allow for international trade but keep remittances constant at zero in the baseline and counterfactual equilibria (hollow dots). Scenario 3 depicts a world with prohibitive trade costs and no remittances. The measure of welfare reported is the real income of the average native stayer.

Figure 5: Migrant-native relative productivity by origin country



Notes: Includes a 45 degree line. Each point in the scatter plot reports the ratio between the hourly wage of an individual born in a particular origin country relative to a US-born individual with the same skill level (college graduate). The calculations are based on the 2000 US Census.

Figure 6: Proportional Change in Native Welfare in the Long Run: Imperfect transferability of skills and Migrant Selection



Notes: This figure reports the proportional change in welfare in the long-run counterfactual relative to the baseline equilibrium. We consider three scenarios: benchmark ($\phi_i^\ell = \phi_i^h = 1$, solid dots), imperfect skill transferability ($\phi_i^\ell = \phi_i^h = 0.75$, hollow dots), and origin-specific selection (ϕ_i^ℓ and ϕ_i^h) calibrated as described in Section 5.4. The measure of welfare reported here is the real income of the average native stayer.