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Migration, Human Capital, and Growth in a Globalized Economy

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“Nothing in life is to be feared,
it is only to be understood.
Now is the time to understand more,
so that we may fear less."

Maria Curie-Skłodowska

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To my Parents and my Wife

Preface

Despite the fact that international migration is not the fastest growing dimension of globalization process, it remains the most intensively discussed aspect of global integration. Indeed, in the last 25 years the volumes of international trade and foreign direct investments (expressed in constant USD) have risen fourfold and sixfold respectively.[1] Simultaneously, the number of international migrants increased by "only" 50% during the last 25 years.[2]

However, the fact is that the citizens of the most developed countries are extremely concerned about opening the borders of their countries to immigration. The debate on the consequences of international migration in the developed countries goes further than the respective discussion about trade and FDIs. Both voters and decision makers try to identify and evaluate the consequences of immanent processes triggered by in- and out-migration. Economically speaking, an inflow of foreign workers influences the labor markets in sending and receiving countries. While opinions in sending countries by and large emphasize the loss of young, talented and skilled workers (especially when emigrants are strongly positively selected), people in host economies often fear adverse effects of immigration on the level of wages, the unemployment rate and the number of beneficiaries of the welfare state. Citizens of the most developed countries are reluctant to opening borders for new waves of (even highly educated) migrants, motivating their choices by protecting their current jobs and their salaries. Even though quantitatively less important, the fiscal impact is the most opinion-forming one out of all economic implications of migration. Taxpayers in the rich countries perceive foreigners as net recipients of transfers and benefits, disregarding the fact that the majority of immigrants contribute regularly to host country's welfare state.[3]

Natives often overlook the positive aspects of an inflow of workers when forming their opinions about immigration. On the one hand, immigrants are consumers, who increase the demand for domestically produced goods. Broadening the size of market brings substantial benefits through the entries of new entrepreneurs, which enlarges the number of domestically manufactured goods. On the other hand, migrants introduce products from their homelands through international trade linkages. This increases the variety of goods consumed, which creates new tastes and induces novel possibilities. Furthermore, a diversified immigration is a source of a transfer of norms, ideas and knowledge among regions characterized by different backgrounds. A positively selected immigration is the major source of human capital in countries like Australia, Canada and New Zealand.

[1] In 1990 the volume of international trade constituted 16.5% of GDP, in 2013 it was more than 31.2%. For the FDIs this growth even more impressive: 0.9% in 1990 and 2.9% in 2013.

[2] Migrants composed 2.9% and 3.2% of total world population in 1990 and 2013.

[3] The best summary of these, sometimes contradictory, opinions, is a notion of a "Schrödinger's immigrant", who "lazes around on benefits whilst simultaneously stealing your job".

Controversies linked to immigration of foreign workers stem from the fact that, apart from important economic effects, migration induces non-economic processes, related to social, cultural, ideological and political spheres. Unlike, for example, international trade or FDIs, an inflow of people representing other norms, habits and customs affects natives' perception of living standards in a multidimensional and complex way. This fact is perfectly visible in the opinion polls on the attitudes of natives in the developed regions towards immigrants. People express their fears about the unforeseen impacts of cultural differences, crime and social pressures triggered by immigrants, apart from the aforementioned consequences for labor markets and welfare states. Moreover, natives in the developed countries are reluctant to inviting low-skilled illegal migrants and refugees, who may have smaller incentives to assimilate.[4] These global trends create a need for a thorough investigation of the impact of international migration on the economic performance in the developed world.

The aim of this thesis is twofold. On the one hand, I focus on the implications of past movements of people for the prosperity of natives and residents living in the highly developed regions. This descriptive part of the thesis (Chapter 1) convinces, that the gains and losses from international migration have taken non-negligible magnitudes. Moreover, the adverse economic processes, which are thought to be decisive in social and political debates on the consequences of migration, are little important in the overall effect. On the other hand, considering the former results, I propose migration policies that aim at solving currently discussed problems, and present their consequences for demography and economic performance of selected states. In Chapter 2, I tackle the issue of further integration of the OECD economies (by removing legal barriers to migration and trade between the European Union and five partner countries). Subsequently, in Chapter 3, I quantify the long-term consequences of modifying EU's migration policy towards the high-skilled foreigners (that is: implementing a version of H1B visa program and comparing it to a tax concession for the high-skilled immigrants in the EU). Both policies are evaluated using a novel theoretical approach.

The first Chapter, co-authored with A. Aubry and F. Docquier, discusses the welfare impact of migration in the OECD countries. We take a positive approach towards quantifying the economic consequences of recent migration flows (net migration between 2000 and 2010), and total stock of migrants in 2010. Moreover, we draw conclusions about the importance of different channels through which migration affects the wellbeing of stayers. In order to compute all these effects, we construct a multi-country, general equilibrium model with endogenous prices and trade flows. The model differentiates between low and high-skilled workers, who can be either

[4] The controversies connected with migration may be depicted by current debates in several major recipient countries. The United States of America, whose share of immigrants surged from 9.1% to 14.3% in the last 25 years, try to fight illegal migration from Mexico, aim at controlling the quality of immigrants by issuing special types of temporary visas for the well-educated workers (the H1B program), and give strong incentives for a fast assimilation of diversified newcomers (Green Card program). The governments of Australia, Canada and New Zealand introduced selective migration programs, as a response to their substantial attractiveness among global emigrants and the needs of domestic labor markets. Imposing a point system designed to intercept the best candidates, they actually control the skill dimension of inflowing waves of migrants. Swiss citizens voted on imposing migration quotas on February 9, 2014. This act aims at restricting immigration from the European Union. The political forces in the United Kingdom, followed by overwhelming opinions of voters, declare reducing the access of immigrants originating from new EU members to the British welfare state. Finally, the EU as a whole has to deal with a huge number of incoming illegal migrants (and, recently, refugees) from Africa and Asia. The events that take place every day in many European cities, where thousands of illegal migrants arrive, camp and wait for the opportunity to cross intra-EU borders, show that this problem is far from being solved. Europe needs to compete in the global game for talents. By now, the North American and Oceania states visibly overtake the EU in attracting high-skilled workers. As a response to this disadvantageous trend, in 2009 the European authorities introduced the Blue Card program which was designed similarly to the H1B visas in the US. Unfortunately, until recently, this initiative has not gained expected popularity among emigrants, in contrast to the US counterpart.

natives or foreigners. The main findings convince that flows of 2000-2010 migrants are beneficial for the natives living in the majority of OECD members (especially: Australia, Switzerland, Canada, Spain and New Zealand), whereas the less attractive countries lose substantially (in this group we find Estonia, Poland, Slovakia and Mexico). On the contrary, total stocks of immigrants cause a substantial polarization between the winners (Australia or Luxembourg) and the losers (Poland or Mexico), which reaches 35 percentage points in terms of our welfare measure. In both cases of flows and stocks, the extra-OECD migration brings positive welfare consequences for almost all OECD members. In contrast, the intra-OECD movements of workers have negative welfare implications for the majority of OECD states, which clearly depicts past and current trends in international migration. The second important contribution of this paper is the quantification of the relative importance of the channels which constitute the overall welfare effect of migration. In our approach, we single out the labor market effect, the fiscal effect and the market size effect of migration (in the robustness check we verify the impact of migration on the level of TFP). By computing the magnitude of each constituent, we conclude that the within-country redistributive effects (wage and fiscal effects) are of smaller importance. The forces that drive our results are related to the elements that distribute the gains and losses among the countries (TFP and market size effects). In this way we give evidence that the economic processes, which are quoted by the politicians and citizens as the major threats of migration, have in fact a less pronounced impact on natives' welfare. Indeed, the wage and fiscal effect are quantitatively small, but have a substantial significance in forming social opinions. Furthermore, the economic phenomena which are less likely to be perceived by people, media and authorities (the implications of efficiency gains and an increase in the number of varieties consumed) are of key importance in the distribution of gains and losses from international migration.

In the second Chapter, I extend the theoretical framework from the first Chapter, and evaluate migration policies in a multi-country general equilibrium model with endogenous migration and trade. In particular, I quantify the economic impact of removing visa barriers between the European Union and five major partners (Australia, Canada, Japan, Turkey and the US). The results are compared with a hypothetical trade liberalization between the same five pairs of countries. I find that free trade causes mutually beneficial, but small welfare effects for the natives in the analyzed states. Contrary to that, zeroing legal migration costs brings exclusive gains for the EU, only in the case of cooperation with Turkey and Japan. A migration agreement with Australia, Canada and the US may have substantially negative consequences for the European citizens, due to potentially large out-migration. Then, a more academic simulation is conducted, assuming a full liberalization of migration and trade among all the OECD countries. The results give evidence that the magnitude of the effect of migration is larger than the one of trade. However, only a few countries gain from removing visa barriers (notably New Zealand, Australia, Canada, Switzerland and the US), whereas a reduction of (non-)tariff restrictions is beneficial for all members of the OECD. Finally, the proposed model gives theoretical evidence about the relations between migration and trade after imposing exogenous shocks to both types of barriers. Reinforcing them with simulation results, I show that liberalizing migration increases bilateral trade flows, while liberalizing trade reduces between-country flows of people. Therefore, the model relation between these two economic processes depends not only on the general assumptions, but also on the type of exogenous shock that is imposed in the system.

The third Chapter proposes an innovative modeling technique to identify the global demographic impact of different migration policies in the EU. The model jointly considers peoples' endogenous decisions about the country of destination, type of visa to apply for, and the duration of stay. In consequence, incorporating the geographical, time and skill dimensions of agents' migration decisions, the proposed framework provides a micro-foundation for multilateral resistance to migration (a complex structure of dependencies between migration choice options). The research question posed in this paper relates to a single, politically important problem faced by the European Union that is the capacity of the EU of attracting high-skilled immigrants. The article proposes two potential solutions. The first one is a visa policy liberalization in the EU, which considers an implementation of H1B visa, following the US. An alternative to this approach is a fiscal incentive for potential college-educated immigrants, which comprises in a tax reduction scheme on their earned income. While the two policies induce similar "talent-stealing" effect (current migrants substitute other destinations for Europe), they produce various additional implications. The H1B policy causes current immigrants to the EU to change their visas (which alters the structure of migrants' duration of stay). Conversely, the fiscal incentive works through inviting new immigrants to the EU, especially those who previously had not decided to emigrate. The discrepancy between the two may be of great importance for the policy makers and the authorities in the EU. The former policy is expected to have significant fiscal cost in the long-run (due to pension expenditures for the medium and long-term foreign workers), whereas the latter might constitute an immediate burden on national budgets (through a decrease in tax collection from the current immigrants).

This thesis investigates the nature of contemporary economic processes linked to international migration. My goal is to draw conclusions about their consequences, and to evaluate relevant policies aiming at increasing the gains from migration. Considering the fact that the implications of global movements of people reach far beyond economics, these results should be interpreted as dealing with only one (out of many) dimension of the problem. However, the three developed approaches aim at deliberating more than just economic variables, incentives and motives. In what has been proposed, people are treated as rational individuals, who care about other objective determinants (such as social costs of moving) and subjective factors (for example individual preferences towards different destinations, or unexpected costs of emigrating). Combining these features with the multidimensionality of migration decisions may bring new insights in the literature on modeling migration flows.

IRES, Louvain-la-Neuve, Belgium, March 2016

Chapter 1

The welfare impact of global migration in OECD countries

Abstract[1]

This paper quantifies the effect of global migration on the welfare of non-migrant OECD citizens. We develop an integrated, multi-country model that accounts for the interactions between the labor market, fiscal, and market size effects of migration, as well as for trade relations between countries. The model is calibrated to match the economic and demographic characteristics of the 34 OECD countries and the rest of the world, as well as trade flows between them in the year 2010. We show that recent migration flows have been beneficial for 69 percent of the non-migrant OECD population, and for 83 percent of non-migrant citizens of the 22 richest OECD countries. Winners are mainly residing in traditional immigration countries; their gains are substantial and are essentially due to the entry of immigrants from non OECD countries. Although labor market and fiscal effects are non-negligible in some countries, the greatest source of gain comes from the market size effect, i.e. the change in the variety of goods available to consumers.

Keywords: migration, market size, labor market, fiscal impact, general equilibrium, welfare.

JEL Classification: C68, F22, J24.

1.1 Introduction

International migration has become a sensitive topic in OECD countries. Over the last 50 years, migration movements have drastically affected the socio-demographic characteristics of the 34 OECD member states.[2] They have influenced the skill structure of the labor force (impacting wage disparities between groups of workers), the age structure of the population (governing the numbers of net contributors to and net beneficiaries from the welfare state and other public interventions), and the geographical distribution of consumers (with consequences on the aggregate demand for domestic goods and services, number of entrepreneurs, and product varieties

[1] The paper, coauthored with Amandine Aubry and Frédéric Docquier, is accepted for publication in Journal of International Economics.

[2] Some stylized facts are described in Appendix 1.A.

available to consumers). The welfare impact of global migration results from the complex interactions between these effects. These interactions are unlikely to be fully internalized by public opinion. They are also imperfectly captured in the academic literature since, with a few exceptions, economists have investigated the transmission channels of migration shocks in isolation.

The objective of this paper is to quantify the impact of the current state of global migration (i.e. inflows of foreigners and outflows of natives) on the welfare of non-migrants living in each OECD country (representing about 96 percent of the native OECD population), and to shed light on the main transmission channels. We use a multi-country framework combining the major economic mechanisms highlighted in the recent literature and accounting for interdependencies between them and between countries. This allows us to assess the relative importance of each channel. The model is parametrized to fit the economic and socio-demographic characteristics of the 34 OECD countries and the rest of the world, as well as the trade flows between them in the year 2010. We then use counterfactual repatriation simulations to identify the between-country and within-country effects of global migration, distinguishing between intra-OECD migration and extra-OECD migration, and between the recent migration flows and the total stocks of migrants.

Assessing the welfare impact of international migration is important. Indeed, recent surveys reveal that worries about migration are on the rise. A majority of respondents in OECD countries see immigration and emigration as sources of problems.[3] While the perceived channels through which emigration operates are rarely reported, those pertaining to immigration are better documented. In particular, public opinions reflect two major economic concerns, i.e. adverse labor market and fiscal effects of immigration. European Social Survey data for the year 2014 show that only 26.0 percent of European respondents believe that immigrants contribute positively to public finances, and only 35.9 percent think that immigrants create new jobs for natives.[4] In the Transatlantic Trends on Immigration 2010, 56 percent of Americans think that immigrants take jobs away from the native-born, while 44 percent of Europeans think that immigrants bring down the wages of citizens.[5] These public views are likely to be based on a simplistic vision of the functioning of the economy (e.g. fixed labor demand, perfect substitutability between natives' and migrants' characteristics, immigrants receiving generous welfare benefits, etc.) and a biased estimation of the magnitude of migration flows.[6]

The academic literature does not support such perceptions. However, the channels of transmission of migration shocks have usually been studied in isolation, relying on one-country, partial equilibrium frameworks. First, the labor market literature investigates how citizens' wages and employment react to international migration. These effects will be referred to as the *labor market effects* of migration, henceforth. Recent studies of these labor market effects usually rely on models of aggregate supply and demand for labor, which leave out entrepreneurship and tax responses (see Battisti et al., 2014, Borjas, 2015, Docquier et al., 2014, Ottaviano and Peri, 2012). They show that the wage and employment responses to immigration and emigration

[3] In 2014, the Transatlantic Trends on Immigration (see http://trends.gmfus.org/) showed that 58 percent of European citizens considered immigration as a problem and not as an opportunity. In the US, this percentage amounted to 31 percent. Worries were particularly important in the case of immigrants from developing countries; in Europe, 56 percent of respondents expressed concerns about extra-EU immigrants, while only 43 percent worried about intra-EU migration. Similarly, 57 percent of Europeans and 28 percent of Americans viewed emigration as a problem.

[4] On a scale from 0 to 10, these respondents valued a positive contribution of immigration ranging from 6 and 10. See http://www.europeansocialsurvey.org/.

[5] See http://trends.gmfus.org/.

[6] For example, Canadians, Americans and Europeans estimate that 37, 35 and 24 percent of their population are immigrants, while the actual shares are 20, 14 and 11 percent, respectively. The differences between the perceived and actual shares cannot be explained by illegal migration or by second-generation immigrants.

are governed by the differences in the socio-demographic characteristics of the native and migrant populations, as well as by the elasticities of substitution between groups of workers as defined by age, education and origin. Second, migrants also contribute to national budgets and collect social transfers. These effects will be referred to as the *fiscal effects of migration*, henceforth. Studies of the fiscal impact of migration use accounting models with exogenous wages and prices, or general equilibrium models with simple labor market interactions (see Chojnicki, 2013, Chojnicki et al., 2011, Dustmann and Frattini, 2014, Dustmann et al., 2010, Storesletten, 2000).[7] Third, international migration affects the aggregate demand for goods and services in the receiving and sending countries. In a monopolistic competition context, the aggregate demand determines firms' entry and exit decisions and in turn, the numbers of entrepreneurs and goods available to consumers. These effects will be referred to as *market size effects* of migration, henceforth. They have been understudied in the literature. Borrowing concepts from the recent trade literature, Iranzo and Peri (2009) or Di Giovanni et al. (2015) investigated the welfare impact of market size in a love-of-variety environment à la Krugman (1980) without taxation and with a simple labor market structure. Finally, immigrants and emigrants usually differ from non-migrants in terms of education. Hence, migration directly impacts the average level of schooling in the origin and destination countries, with possible consequences on the level of the total factor productivity. Such *TFP effects* are more controversial. They have been analyzed in a limited number of empirical studies and mainly pertains to the mobility of high-skilled workers.[8]

A growing consensus on how to formalize and quantify some of these effects has emerged due to the development of new theoretical foundations and the availability of migration data. However, these effects are interdependent and deserve to be studied jointly. Little is known about their relative magnitudes and their interactions. For example, changes in total factor productivity affect wages, the demand for goods and trade flows. Simultaneously, changes in wage inequality and prices directly influence the fiscal impact of migration, through labor income and consumption tax revenues. In addition, geographical disparities in the production of goods govern the interactions between countries through the incentives to trade. Assessing the welfare impact of migration on non-movers requires accounting for these interactions between countries and between the transmission channels.

The analysis proposed in this paper combines three major transmission channels of migration shocks into an integrated, multi-country model. It ignores the societal implications of immigration (not or indirectly related to economic variables), on which there is no clear consensus in the literature (see Alesina et al., 2013, Borjas, 2015, Collier, 2013). Our setup is an extension of the model proposed by Krugman (1980), augmented with eight classes of individuals (working-age and old, college and non-college educated, immigrants and natives), redistributive taxes and transfers, and complex labor market interactions between natives and migrants. It accounts for the market-size effects initially underlined by Iranzo and Peri (2009) or Di Giovanni et al. (2015). The latter use a love-of-variety, monopolistic competition model with heterogeneous firms *à la* Melitz (2003) to study the implications of global migration for developed and developing countries. Although Di Giovanni and Levchenko (2013) provide important contributions to the literature on firm heterogeneity, we assume that firms are homogeneous in each country

[7] In a recent comparative study, the OECD (2013) shows that the fiscal effect of immigration varies across countries; its sign and magnitude are strongly affected by the uncertain effect of migration on public consumption.

[8] For example, Peri et al. (2013) found that immigration flows of scientists, technology professionals, engineers and mathematicians have a significantly positive effect on the wages of college-educated non-migrants in the U.S., and almost no effect on the less educated.

and disregard both the production of intermediate goods and the remittances sent by migrants to their country of origin.[9]

Our contribution to the existing literature is threefold. First, we combine the labor market, fiscal and market size effects described above in an integrated framework, accounting for the interaction between them. A special attention is devoted to the fiscal effect of migration, which has been disregarded in Iranzo and Peri (2009) and Di Giovanni et al. (2015). The fiscal effect will prove to be important in some countries. We will also account for schooling externalities in our robustness analysis. Second, we calibrate the model to perfectly fit the economic and demographic characteristics of the 34 OECD countries and those of the rest of the world, as well as the trade flows between them in the year 2010. In particular, distinguishing between eight classes of individuals, our model captures the effect of migration on the age structure of the population. Third, we consider richer numerical experiments. We analyze the effect of total migration versus recent migration (i.e. migrants who arrived between 2000 and 2010) and distinguish between intra-OECD and extra-OECD migration. This allows us to quantify the effect of each channel, to identify the dominant ones, and to compare the between- and within-country redistributive effects of migration.

The effect of global migration on welfare is computed using two counterfactual experiments: a repatriation of recent migrants to their home countries, and a repatriation of the total stock of migrants (as if the legal barriers for migration, for example the visa costs, had been infinitely large over the last ten years or over the last century, respectively). We quantify the overall economic impact for the high-skilled and the low-skilled non-movers, and identify the relative contribution of the three main channels described above: the labor market, market-size, and fiscal effects.[10] We also account for schooling externalities in the robustness section.

Using estimated elasticities from the empirical literature, we show that recent migration flows induced many winners and a few losers among OECD citizens.[11] As stated above, we distinguish between 8 groups of individuals per country. The set of winners represents 69.1 percent of OECD non-migrant population aged 25 and over. This share increases to 83.0 percent if one considers the 22 countries whose GDP per capita was above USD 30,000 in the year 2010. Contrary to popular perceptions, winners mainly reside in net immigration countries; their gains can be important and are essentially due to the entry of immigrants from non-OECD countries, which has a drastic effect on market size. Losers mostly reside in net emigration countries; welfare losses are smaller (except in relatively poorer countries such as Mexico, Turkey, Estonia or Poland) and are essentially due to the (intra-OECD) emigration of their nationals. However, for these traditional emigration countries, we overestimate the magnitude of the losses because we disregard remittance inflows (accounting for 2.1, 0.8 and 0.2 percent of GDP in the year 2010 in Mexico, Poland and Turkey, respectively). Although labor market and fiscal effects are important sources of variability across countries, the market-size effect is a significant source of welfare gains. On average, the market-size effect increases the welfare of all workers by 1.0

[9] Assuming heterogeneous firms and intermediate inputs has both advantages and disadvantages. On the one hand, this might provide a more realistic representation of macro and micro features highlighted by the recent trade literature. On the other hand, it requires to define firm preferences towards intermediate goods and demand a precise calibration of the parameters of the distribution of firm productivity and size. The former is difficult to model in a one-sector framework and usually imposes a strong assumption of identical preferences for consumers and firms. The literature is still in its early stages concerning the latter and, due to data limitation, has essentially focused on the United States.

[10] In general, our analysis focuses on the welfare impact on the non-movers, because this is the group that has the voting power and decides on migration and fiscal policies.

[11] In a previous version of this paper, we calibrated the model on the year 2000, and simulated the effects of a repatriation of the 1990-2000 migration wave. Similar results were obtained, available upon request.

percent in the OECD, whereas the average fiscal effect equals 0.4 percent, and the average labor market effect equals 0.1 percent for college graduates and 0.2 percent for the less educated.[12]

Very similar results are obtained if trade is ruled out, if we change the fiscal rule, or if we let the elasticities of substitution between varieties vary within the range of values provided in the empirical literature. Larger effects can be obtained if we allow for schooling externalities on total factor productivity, or if we change the elasticity of substitution between native and immigrant workers in production. In addition, we also evaluate the effect of global migration stocks as if all past waves of migration had been nil. Although the average magnitude of the effect becomes greater and we identify more losers, the market-size effect remains important. It increases the welfare of all workers by 2.6 percent in the OECD. This is greater than the average fiscal effect (1.2 percent) and the average labor market effect (0.2 percent for the less educated and -0.4 percent for college graduates). In line with Di Giovanni et al. (2015), we find that the market size is instrumental to explaining the welfare consequences of migration.

The remainder of the paper is organized as follows. In Section 1.2, we present the theoretical model. The quantitative analysis is provided in Section 1.3. It describes the calibration strategy, our benchmark findings, and the results of a large set of robustness checks. Section 1.4 concludes.

1.2 Theoretical model

We develop a static, multi-country model endogenizing the economic effect of global migration (i.e. inflows of foreigners and outflows of natives) on the welfare of non-migrants in OECD countries. Three channels of influence are taken into consideration in the benchmark model: the labor market effect, the fiscal effect, and changes in the mass of horizontally differentiated products available to consumers. We model the competitive labor market effect as in Docquier et al. (2014), the fiscal effect as in Storesletten (2000) or Chojnicki et al. (2011), and the market-size effect using the "love-of-variety" model of Krugman (1980). The latter endogenizes the mass of varieties produced in a country as a function of the market size. By changing the mass and the type of consumers in origin and destination countries, migration affects the aggregate demand for goods, the mass of entrepreneurs, and the available product diversity. The "love-of-variety" model has been used extensively to quantify the large effect of the trade-induced growth in product variety on welfare (see Broda and Weinstein, 2006). Although the model has no physical capital, we model the effect of migration on firm creation and entrepreneurship investments (each entrepreneur incurs a fixed cost of entry).[13] Countries are interdependent: the economic effects are propagated across countries through endogenous trade flows.

Our model is static and includes C countries indexed by $c \in \{1, 2, ..., C\}$. Each country is populated by 8 groups of individuals. We denote the individual's skill/origin type by $m \in \{H, L, h, l\}$ and the individual's cohort by $a \in \{w, r\}$, and we assume that all agents have identical preferences. Total population in country c is made of $L^T_{w,c}$ working-age individuals and $L^T_{r,c}$ retirees. Each group is divided into four types of individuals: $L^L_{w,c}$ and $L^L_{r,c}$ low-skilled natives, $L^H_{w,c}$ and $L^H_{r,c}$ high-skilled natives, $L^l_{w,c}$ and $L^l_{r,c}$ low-skilled immigrants, and $L^h_{w,c}$

[12] In an earlier version of this paper, we quantified the impact of global migration between 1990 and 2000 and obtained very similar conclusions. Overall, most OECD citizens benefited from South-North migration, intra-OECD migration was a zero-sum game, and the market size effect was instrumental to explaining these effects.

[13] Capital adjustments are rapid in open economies. Ortega and Peri (2009) find that an exogenous inflow of immigrants increases one-for-one employment and capital stocks in the receiving country in the short term (i.e. within one year), leaving the capital/labor ratio unchanged.

and $L^h_{r,c}$ high-skilled immigrants. We use superscript S when aggregating high-skilled natives and foreigners (H, h), and subscript U when aggregating the less educated (L, l). Individuals are assumed to be homogeneous within each group; we thus disregard heterogeneity based on unobservable characteristics, and assume that all immigrant workers in a given skill cell are perfect substitutes on the labor market.

The demographic structure is considered as exogenous, since we aim to quantify the "causal" impact of migration flows on income (as in Di Giovanni et al., 2015, Docquier et al., 2014). Within a skill and age cell, individuals differ only in terms of income and place of residence, governing their access to local and foreign varieties. In this section, we describe the preferences and technologies used to endogenize consumers' and firms' decisions. We then characterize the monopolistically competitive equilibrium of the global economy.

1.2.1 Preferences and consumers' decisions

The preferences of a representative consumer of type $m \in \{H, L, h, l\}$ and cohort $a \in \{w, r\}$ living in country c are identical across types of consumers. They are described by a CES utility function over a continuum of varieties indexed by k:

$$U^m_{a,c} = \left(\sum_{j \in C} \int_0^{B_j} q^m_{a,cj}(k)^{\frac{\epsilon-1}{\epsilon}} dk \right)^{\frac{\epsilon}{\epsilon-1}}, \tag{1.1}$$

where $q^m_{a,cj}(k)$ stands for the quantity of variety k produced in country j and consumed in country c by an agent of type m and cohort a, and B_j is the mass of varieties produced in country j. Varieties are imperfect substitutes, characterized by a constant elasticity of substitution equal to $\epsilon > 1$.[14]

Labor supply is exogenous and we do not model savings decisions, assuming that each individual consumes her income entirely.[15] Workers' nominal income is the sum of group-specific net wages and public transfers; retirees only receive public transfers. Hence, the utility function (1.1) is maximized subject to a static budget constraint:

$$\sum_{j \in C} \int_0^{B_j} \widetilde{p}_{cj}(k) q^m_{a,cj}(k) dk = \widetilde{\omega}^m_{a,c}, \tag{1.2}$$

where $\widetilde{p}_{cj}$ defines the gross price of variety k produced in country j and consumed in c. In particular, every consumer pays a consumption tax in her country of residence, hence: $\widetilde{p}_{cj}(k) = (1 + \upsilon_c)p_{cj}(k)$, where υ_c is the consumption tax rate in country c and $p_{cj}(k)$ is the before-tax price of good k. Variable $\widetilde{\omega}^m_{a,c}$ represents the net nominal income of an individual of type m and cohort a

[14] We follow the traditional model of Krugman (1980) by supposing that foreign and domestic products enter symmetrically in the utility function and are subject to the same elasticity of substitution.

[15] The elasticity of labor supply to wages is usually found to be small (Evers et al., 2008). However, endogenizing labor supply matters if the participation rates of natives and immigrants are strongly different. A recent OECD report (OECD, 2015) indicates that immigrants from developing countries exhibit smaller participation rates than natives in Europe (in particular, low-skilled women from Muslim countries). Although these immigrants represent a small fraction of the working-age population, accounting for differences in participation rates can attenuate the magnitude of the labor market and market size effects. Dealing with heterogeneous participation rates is a non-trivial extension, which requires a more general utility function with leisure, and calibrating origin-specific preference parameters (i.e. relaxing the hypothesis of homogeneous preferences).

who lives in country c. The CES preferences induce that she spends all her income on consumption, and every available variety faces a positive demand (i.e. $\lim_{q^m_{a,cj}(k)\to 0} \partial U^m_{a,c}/\partial q^m_{a,cj}(k) = \infty$).

The demand function derived from the first-order condition of this maximization problem is written:

$$q^m_{a,cj}(k) = \frac{P_c^{\epsilon-1}}{\widetilde{p}_{cj}(k)^{\epsilon}}\widetilde{\omega}^m_{a,c}, \tag{1.3}$$

where P_c denotes the ideal price index in country c and is defined as:

$$P_c = \left[\sum_{j\in C}\int_0^{B_j} \widetilde{p}_{cj}(k)^{1-\epsilon}dk\right]^{\frac{1}{1-\epsilon}}. \tag{1.4}$$

The latter expression reflects the underlying love-of-variety property of the CES utility function. Given that $\epsilon > 1$, a greater mass of varieties tends to lower the value of the ideal price index and to increase the individual's welfare (keeping the consumer's expenditure unchanged). Intuitively, under CES preferences, the ideal price index can be seen as an indicator of (optimized) costs of living. Indeed, the individual's indirect utility function is given by:

$$U^m_{a,c} = \left(\sum_{j\in C}\int_0^{B_j}\left(\frac{P_c^{\epsilon-1}}{\widetilde{p}_{cj}(k)^{\epsilon}}\widetilde{\omega}^m_{a,c}\right)^{\frac{\epsilon-1}{\epsilon}} dk\right)^{\frac{\epsilon}{\epsilon-1}} = \frac{\widetilde{\omega}^m_{a,c}}{P_c}, \tag{1.5}$$

with $\frac{\partial P_c}{\partial B_j} < 0$ and so $\frac{\partial U^m_{a,c}}{\partial B_j} > 0$.

From eq. (1.3), we derive the demand function faced by each firm in country c, $q_c(k)$, and the total expenditure function in country c, X_c:

$$q_c(k) = \sum_{j\in C}\sum_{m,a} L^m_{a,j} q^m_{a,jc}(k) \qquad \text{and} \qquad X_c = \sum_{m,a} L^m_{a,c}\sum_{j\in C}\int_0^{B_j} \tilde{p}_{cj}(k) q^m_{a,cj}(k)dk. \tag{1.6}$$

1.2.2 Technology and firms' decisions

In each country c, there is a mass B_c of firms that operate on a monopolistically competitive market. Therefore, strategic interdependencies between firms are ruled out. Production requires labor, which is supplied inelastically by the four types of imperfectly substitutable workers. The labor market is perfectly competitive, so that each type of worker is remunerated according to her marginal productivity. Obviously, in countries with restrictive institutions, many factors hamper wage adjustments, which result in adjustments in the employment rate (see Angrist and Kugler, 2003, Aydemir and Kirdar, 2013, Glitz, 2012). This issue mainly pertains to low-skilled workers living in European countries, where wage rigidities are stronger. In our general equilibrium setting, there is no unemployment and we do not deal with the heterogeneity between employed and unemployed workers, conjecturing that the effect of migration on the aggregate wage bill (and on market size effects) does not depend too much on the type of labor market adjustment.[16]

[16] Endogenizing unemployment would also affect the fiscal impact of migration (through unemployment benefits). This effect is expected to be small. On average, unemployment benefits represent 1.24 percent of GDP in OECD countries. Most of the fiscal cost of immigration is driven by the effect of migration on old-age, health and public education expenditures.

Contrary to Di Giovanni et al. (2015), we assume that firms are homogeneous in productivity within a country and that labor is the unique production factor.

Each firm maximizes its profit, which then leads to the decision to enter the market or not, and what price to set once in. For the sake of clarity, we separately describe the two related sides of the profit maximization problem, i.e. the minimization of the unit cost of production for a given level of output, and the determination of the optimal price and output. We first describe the former, which enables us to highlight the labor demand for each type of worker, as well as the aggregate labor demand. We continue with the latter which allows us to derive the pricing rule and the optimal output per firm.

1.2.2.1 Production function

The production function of firm k in country c is defined as a nested CES combination of labor. The upper-level production function determines the quantity of high-skilled and low-skilled workers needed to produce $y_c(k)$, and is specified as:

$$y_c(k) = A_c \bar{\ell}_c^T(k) = A_c \left(\theta_c^S \left(\bar{\ell}_c^S(k) \right)^{\frac{\sigma_S - 1}{\sigma_S}} + \left(1 - \theta_c^S\right) \left(\bar{\ell}_c^U(k) \right)^{\frac{\sigma_S - 1}{\sigma_S}} \right)^{\frac{\sigma_S}{\sigma_S - 1}}, \tag{1.7}$$

where A_c is the country-specific level of total factor productivity (TFP), $\bar{\ell}_c^T(k)$ is total employment in efficiency units by firm k, which divides into $\bar{\ell}_c^S(k)$ and $\bar{\ell}_c^U(k)$, total employment of high-skilled and low-skilled labor in efficiency units. Each factor is defined in terms of efficiency units to account for the inherent productivity of each type of worker and the benefits resulting from the interactions between workers. The elasticity of substitution, $\sigma_S \in (1, \infty)$, captures the imperfect substitutability between workers of different education levels. Parameter θ_c^S reflects the relative productivity of high-skilled labor.

Moreover, it is well documented that conditional on education, immigrants and natives are imperfect substitutes. Recent papers (such as Manacorda et al., 2012, Ottaviano and Peri, 2012) find imperfect degrees of substitution between these two types of workers. To account for this, we define the efficient labor supply for each level of education as a CES function of native and immigrant employment:

$$\bar{\ell}_c^U(k) = \left[\theta_c^M \left(\ell_c^L(k) \right)^{\frac{\sigma_M - 1}{\sigma_M}} + \left(1 - \theta_c^M\right) \left(\ell_c^l(k) \right)^{\frac{\sigma_M - 1}{\sigma_M}} \right]^{\frac{\sigma_M}{\sigma_M - 1}}, \tag{1.8a}$$

$$\bar{\ell}_c^S(k) = \left[\theta_c^M \left(\ell_c^H(k) \right)^{\frac{\sigma_M - 1}{\sigma_M}} + \left(1 - \theta_c^M\right) \left(\ell_c^h(k) \right)^{\frac{\sigma_M - 1}{\sigma_M}} \right]^{\frac{\sigma_M}{\sigma_M - 1}}, \tag{1.8b}$$

where the country-specific θ_c^M is a parameter of relative productivity of national workers, and $\sigma_M \in (1, \infty)$ is the elasticity of substitution between national and foreign workers. We constrain the native-immigrant elasticity to be the same across education levels. Indeed, to the best of our knowledge, there is no consensus on the elasticities of substitution within each group once we relax this constraint. For instance, Card (2009) finds that less-educated immigrants and natives are closer to perfect substitutes than skilled immigrants and natives. Ottaviano and Peri (2012) report opposite results.

1.2.2.2 Optimal labor demand

The before-tax nominal wage rate for a worker of type $m \in \{H, L, h, l\}$ is denoted by w_c^m. Since the labor market is competitive, firms take w_c^m as given. The ideal (composite) wages of efficient low-skilled and high-skilled workers, denoted by W_c^U and W_c^S, and the ideal composite aggregate wage, denoted by W_c, result from the cost minimization described below. Since high-skilled workers are, on average, more productive, we have $W_c^S > W_c^U$; and within each skill category, nationals are usually better paid than immigrants (reflecting, for instance, the imperfect transferability of skills across countries): $w_c^H > w_c^h$ and $w_c^L > w_c^l$.

The optimal labor demand allocated to the production process is determined by a two-stage cost minimization. First, for a given production level $y_c(k)$, each firm chooses the optimal combination of high-skilled and low-skilled workers that minimizes the total labor cost:

$$\min_{\bar{\ell}_c^S(k),\bar{\ell}_c^U(k)} W_c^S \bar{\ell}_c^S(k) + W_c^U \bar{\ell}_c^U(k)$$

$$s.t.\ A_c \left(\theta_c^S \left(\bar{\ell}_c^S(k)\right)^{\frac{\sigma_S-1}{\sigma_S}} + \left(1-\theta_c^S\right) \left(\bar{\ell}_c^U(k)\right)^{\frac{\sigma_S-1}{\sigma_S}} \right)^{\frac{\sigma_S}{\sigma_S-1}} \geq y_c(k).$$

The first-order conditions determine the optimal demand for efficient low-and high-skilled workers in firm k:

$$\bar{\ell}_c^S(k) = \frac{y_c(k)}{A_c} \left(\frac{\theta_c^S W_i}{W_c^S} \right)^{\sigma_S} \qquad \text{and} \qquad \bar{\ell}_c^U(k) = \frac{y_c(k)}{A_c} \left(\frac{(1-\theta_c^S) W_c}{W_c^U} \right)^{\sigma_S}, \tag{1.9}$$

where W_c is the ideal labor cost index, defined as:

$$W_c = \left[\left(\theta_c^S\right)^{\sigma_S} \left(W_c^S\right)^{1-\sigma_S} + (1-\theta_c^S)^{\sigma_S} \left(W_c^U\right)^{1-\sigma_S} \right]^{\frac{1}{1-\sigma_S}}. \tag{1.10}$$

Equations (1.9) show that the demand for each type of worker increases with $y_c(k)$, and decreases with the composite labor cost for this type of worker. Due to the imperfect substitution between inputs, the labor demand for each skill level is a function of all input prices (through the aggregate wage index W_c). Hence, the higher the elasticity of substitution between the two types of workforces, σ_S, the higher the demand for the relatively cheaper type of labor.

Second, each firm chooses the optimal combination of national and foreign workers within each education category, taking the total supply of efficient high- and low-skilled labor as given (see eq. (1.9)). Firms solve the following cost minimization for high-skilled workers:

$$\min_{\ell_c^H(k),\ell_c^h(k)} w_c^H \ell_c^H(k) + w_c^h \ell_c^h(k)$$

$$s.t.\ \left(\theta_c^M \left(\ell_c^H(k)\right)^{\frac{\sigma_M-1}{\sigma_M}} + \left(1-\theta_c^M\right) \left(\ell_c^h(k)\right)^{\frac{\sigma_M-1}{\sigma_M}} \right)^{\frac{\sigma_M}{\sigma_M-1}} \geq \bar{\ell}_c^S(k).$$

The optimal labor demand for skilled natives and migrants is then equal to:

$$\begin{aligned} \ell_c^H(k) &= \bar{\ell}_c^S(k) \left(\frac{\theta_c^M W_c^S}{w_c^H} \right)^{\sigma_M} \\ &= \frac{y_c(k)}{A_c} \left(\frac{\theta_c^S W_c}{W_c^S} \right)^{\sigma_S} \left(\frac{\theta_c^M W_c^S}{w_c^H} \right)^{\sigma_M}, \end{aligned} \tag{1.11}$$

and

$$\begin{aligned}\ell_c^h(k) &= \bar{\ell}_c^S(k)\left(\frac{(1-\theta_c^M)W_c^S}{w_c^h}\right)^{\sigma_M} \\ &= \frac{y_c(k)}{A_c}\left(\frac{\theta_c^S W_c}{W_c^S}\right)^{\sigma_S}\left(\frac{(1-\theta_c^M)W_c^S}{w_c^h}\right)^{\sigma_M},\end{aligned} \tag{1.12}$$

where W_c^S is the remuneration of the ideal high-skilled labor cost composite described by eq. (1.9), which we refer to as the ideal wage index for the high-skilled:

$$W_c^S = \left[\left(\theta_c^M\right)^{\sigma_M}\left(w_c^H\right)^{1-\sigma_M} + \left(1-\theta_c^M\right)^{\sigma_M}\left(w_c^h\right)^{1-\sigma_M}\right]^{\frac{1}{1-\sigma_M}}. \tag{1.13}$$

The labor demand and wage index for low-skilled natives and migrants are derived in a symmetric way and lead to the following ideal wage index:

$$W_c^U = \left[\left(\theta_c^M\right)^{\sigma_M}\left(w_c^L\right)^{1-\sigma_M} + \left(1-\theta_c^M\right)^{\sigma_M}\left(w_c^l\right)^{1-\sigma_M}\right]^{\frac{1}{1-\sigma_M}}. \tag{1.14}$$

The homogeneity of firms induces that $\ell_c^S(k) = \ell_c^S$ and $\ell_c^U(k) = \ell_c^U$ for all k. For the sake of clarity, we will then drop index k henceforth. Summing these values across all firms gives the aggregate labor demand for each type of worker.

The cost minimization problem described above determines the optimal unit cost of production for each firm:

$$C_c = \frac{w_c^H l_c^H + w_c^h l_c^h + w_c^L l_c^L + w_c^l l_c^l}{y_c} = \frac{W_c}{A_c}, \tag{1.15}$$

as well as the labor demand for the share of the workforce allocated to the production process and the total labor demand in the economy.

Notice that not all human resources are devoted to the production process, since each firm in country c faces a fixed entry cost, f_c, to enter the domestic market.[17] We follow the "new trade" literature by expressing fixed costs in units of efficient labor composite.[18] These costs can be interpreted as an investment that a firm must make to explore the market and differentiate its product. Therefore, the aggregated demand for labor also includes the one for workers who are employed for investment purposes. The amount of efficient labor required to create a mass B_c of firms (i.e. the fixed cost of entry) equals $B_c f_c$. Their total cost amounts to $B_c f_c W_c$. The total share of efficient labor devoted to creating firms is then $\xi \equiv \frac{f_c B_c W_c}{W_c \bar{L}_c^T} = \frac{1}{\epsilon}$ and the remaining share $1-\xi$ (i.e. $\frac{\epsilon-1}{\epsilon}$) of workers is employed to produce the final good.[19] Therefore, the efficient labor per firm, $\bar{\ell}_c^T$, can be written as:

$$\bar{\ell}_c^T = \frac{\epsilon-1}{\epsilon}\frac{\bar{L}_c^T}{B_c}, \tag{1.16}$$

[17] We assume that firms have perfect information about the costs of entry, thus they will be indifferent between paying the one-time investment cost $\bar{f}_c$ and the amortized, discounted, per-period portion of this cost $f_c = \bar{f}_c/d_c$. In a dynamic framework, d_c would be the expected age of a firm operating in country c.

[18] Expressing fixed costs in units of efficient labor has an impact on the size of the global gains from migration. Indeed, Iranzo and Peri (2009) formalize entry costs as a fixed amount of output that cannot be sold. They obtain a stronger effect of migration on productivity since, on average, migrants move to more efficient economies with lower fixed costs. Measuring fixed costs in units of output complicates the model and would reinforce our main conclusion that the between-country effects exceed the within-country ones.

[19] We assume that both the marginal entrepreneur and the marginal worker are remunerated identically, so that these two agents are indifferent between being employed and starting a firm.

Consequently, given that the share of labor allocated to firm creation is constant, the total efficient labor demand in the economy is defined as:

$$\bar{L}^T_{w,c} = B_c \left(f_c + \bar{\ell}^T_c \right).$$

The labor market clearing conditions imply that the aggregate labor demand for each type of worker $m \in \{L, H, l, h\}$ equals the exogenously given country endowment $L^m_{w,c}$.

$$\begin{aligned}
L^L_{w,c} &= \bar{L}^T_{w,c}(1-\theta^S_c)^{\sigma_S} \left(\theta^M_c\right)^{\sigma_M} (W_c)^{\sigma_S} \left(W^U_c\right)^{\sigma_M-\sigma_S} (w^L_c)^{-\sigma_M}, \\
L^H_{w,c} &= \bar{L}^T_{w,c} \left(\theta^S_c\right)^{\sigma_S} \left(\theta^M_c\right)^{\sigma_M} (W_c)^{\sigma_S} \left(W^S_c\right)^{\sigma_M-\sigma_S} \left(w^H_c\right)^{-\sigma_M}, \\
L^l_{w,c} &= \bar{L}^T_{w,c}(1-\theta^S_c)^{\sigma_S}(1-\theta^M_c)^{\sigma_M} (W_c)^{\sigma_S} \left(W^U_c\right)^{\sigma_M-\sigma_S} (w^l_c)^{-\sigma_M}, \\
L^h_{w,c} &= \bar{L}^T_{w,c} \left(\theta^S_c\right)^{\sigma_S} (1-\theta^M_c)^{\sigma_M} (W_c)^{\sigma_S} \left(W^S_c\right)^{\sigma_M-\sigma_S} (w^h_c)^{-\sigma_M}.
\end{aligned} \tag{1.17}$$

1.2.2.3 Optimal price and output

The firm's profit maximization determines the price and quantity produced per firm. Each firm produces a differentiated product and the love-of-variety assumption implies that each variety is consumed. At the same time, since we assume a continuum of firms, the effect of the pricing rule of each firm on the demand for another product is negligible. Therefore, each firm faces a residual demand curve with a constant elasticity of substitution equal to ϵ and then chooses the same markup $\epsilon/(\epsilon-1)$ which yields the following pricing rule:

$$p_c = \frac{\epsilon}{\epsilon-1} C_c = \frac{\epsilon}{\epsilon-1} \frac{W_c}{A_c}, \tag{1.18}$$

where C_c is the marginal cost of production defined by eq. (1.15). Moreover, a firm from country j can export its product to country c, but faces an iceberg trade cost $\tau_{cj} > 1 \; \forall \; c \neq j$ if it does so. Hence, the before-tax price paid by consumers in country c for the goods produced in country i equals to $p_{cj} = p_j \tau_{cj} \; \forall c \neq j$. Due to the love-of-variety property of the preferences, each firm exports to all foreign markets as long as the trade cost is finite.

The output per firm, y_c, is determined by profit maximization and the free entry condition. Indeed, when gains are positive, new firms enter the market, causing profits to fall, until they are driven to zero. In equilibrium, the profit of each firm is equal to zero:

$$\pi_c = (p_c - C_c)\, y_c - W_c f_c = 0. \tag{1.19}$$

By replacing the price by its value defined in eq. (1.18) in the zero profit condition, we derive the output per firm:

$$y_c = (\epsilon-1) A_c f_c. \tag{1.20}$$

Finally, we compute the mass of varieties B_c produced in economy c as a function of country size. To do so, we define the total production in economy c, that is $B_c y_c$. We then substitute eq. (1.16) for $\bar{\ell}^T_c$ into eq. (1.7) and equalize it to the value defined in eq. (1.20):

$$B_c y_c = B_c A_c \bar{\ell}^T_c = A_c \frac{\epsilon-1}{\epsilon} \bar{L}_c = B_c(\epsilon-1) A_c f_c.$$

The mass of varieties produced in a given country is then equal to:

$$B_c = \frac{\bar{L}^T_{w,c}}{\epsilon f_c}. \tag{1.21}$$

This result is similar to the one derived by Krugman (1980). The equilibrium number of firms in a particular country is proportional to the size of the country (measured here in efficiency units), $\bar{L}^T_c$, and inversely proportional to the fixed cost, f_c. In line with the recent literature (see Helpman et al., 2008), we assume a country-specific entry cost. Therefore, a reallocation of the population across countries may change the aggregate mass of varieties. Indeed, if the workforce moves to countries with a lower entry cost, the aggregate mass of varieties increases, potentially enhancing global welfare.

Given the zero profit condition, the goods market clearing condition implies that the total spending X_c defined in eq. (1.6) equals the value of domestic production. Finally, by aggregating the country-pair-specific expenditures, $p_{cj}q_{cj}$ from eq. (1.3), we obtain a simple representation of the exports from country j to country c as a function of the trade cost τ_{cj}:

$$\frac{X_{cj}}{X_j} = \frac{X_c \left(P_c/\tau_{cj}\right)^{\epsilon-1}}{\sum_{i=1}^{C} X_i \left(P_i/\tau_{ci}\right)^{\epsilon-1}}. \tag{1.22}$$

1.2.3 Government

Fiscal policy consists of two tax rates (a consumption tax rate υ_c, and a labor income tax rate t_c), a vector of type- and age-specific levels of public spending per inhabitant, $G^m_{a,c}$, and a vector of type- and age-specific transfers per inhabitant, $T^m_{a,c}$. The consumption tax rate increases the price of a good by a factor of $1 + \upsilon_c$, as shown in eq. (1.2). Natives and immigrants are taxed at the same rate, but differ with respect to their impact on public finances. Typically, $G^m_{a,c}$ includes final public expenditures, assumed to be identical for all groups of residents, and children's education expenditures, which are only allocated to working-age parents and vary with their education level and origin (immigrants versus natives). Public transfers $T^m_{a,c}$ include public health expenditures, family allowances, pension benefits, unemployment and other welfare payments; their amounts vary with age, education and origin. Public consumption and transfers are not taxed. Our fiscal bloc is a static version of Storesletten (2000) and Chojnicki et al. (2011), except we do not link pension benefits to wages and we rule out budget deficits.

Working-age individuals consume their net-of-tax labor income and transfers, whereas retirees do not work and only consume the transfers they receive from the government. We have:

$$\begin{aligned} \widetilde{\omega}^m_{w,c} &= w^m_c (1 - t_c) + T^m_{w,c} \ \forall m, \\ \widetilde{\omega}^m_{r,c} &= T^m_{r,c} \ \forall m. \end{aligned}$$

As far as public consumption is concerned, we assume that the government allocates public spending between goods as consumers do (see eq. (1.3)). In the benchmark scenario, we also assume that υ_c, $G^m_{a,c}$ and $T^m_{a,c}$ are exogenous for all a, m, c, and that the labor income tax rate t_c adjusts to balance the government budget, as in Chojnicki et al. (2011). The budget constraints is written as:

$$\sum_m L^m_{w,c} t_c w^m_c + \sum_m L^m_{w,c} \upsilon_c (1 - t_c) w^m_c + \sum_{m,a} L^m_{a,c} \upsilon_c T^m_{a,c} = \sum_{m,a} L^m_{a,c} T^m_{a,c} + G^m_{a,c} \tag{1.23}$$

In the benchmark scenario, we consider that the amount of public goods provided by the government is constant per person. This means that the aggregate production of public goods increases with population size (e.g. national defense, justice, and public infrastructure). Assuming a constant amount per person, we avoid large fiscal externalities linked to changes in population size. In line with Storesletten (2000) or Chojnicki et al. (2011), public consumption does not directly affect utility or productivity.

In the robustness check, we will consider an alternative scenario, assuming that all public spending is fixed, i.e. is not affected by population size (consider for example national defense or foreign affairs). Therefore, immigration allows sharing the cost of these goods among a greater number of individuals (a positive fiscal externality of migration), while emigration has the opposite effect. We will also consider a scenario with adjustments in the consumption tax rate, instead of the income tax rate.

1.2.4 Monopolistic competitive equilibrium

In the benchmark scenario, we have:

Definition 1.1. For a set of common parameters $\{\epsilon, \sigma_S, \sigma_M\}$, a set of country-specific parameters $\{\theta_c^S, \theta_c^M, A_c, f_c, \upsilon_c, T_{a,c}^m, G_{a,c}^m\}_{c\in C}$, the matrix of country-pair trade costs $[\tau_{cj}]_{c,j\in C}$, and country-specific numbers of people in the young and old generations, $L_{a,c}^m$, the *monopolistically competitive equilibrium* is a set $\{w_c^m, W_c, W_c^S, W_c^U, C_c, q_c, p_c, P_c, B_c, t_c\}_{c\in C}$ and $[X_{cj}]_{c,j\in C}$ such that the following conditions are satisfied: (i) consumers maximize their utility, (ii) firms maximize profits, (iii) the goods and factor markets clear, (iv) profits are equal to zero, and (v) the government budget is balanced in each economy $c \in C$. These conditions are reflected by the set of equations (1.3), (1.4), (1.10), (1.13), (1.14), (1.15), (1.17), (1.18), (1.21), (1.22), and (1.23).

When budget constraints are balanced and the goods and factor markets clear, the Walras law guarantees the equilibrium of the balance of payments for each country c (i.e. $\sum_j X_{cj} = \sum_j X_{jc}\ \forall c \in C$). Alternative scenarios with endogenous total factor productivity, alternative fiscal rules or an absence of trade will be considered in the robustness checks.

1.2.5 Disentangling welfare changes

The proposed model enables us to decompose the indirect utility function of working-age individuals and retirees of type m in country c, defined as the net income deflated by the ideal price index in eq. (1.5), as follows:

$$\frac{\Delta U_{w,c}^m}{U_{w,c}^m} = \frac{w_c^m(1-t_c)}{w_c^m(1-t_c)+T_{w,c}^m}\left[\frac{\Delta w_c^m}{w_c^m}+\frac{\Delta(1-t_c)}{(1-t_c)}\right]-\frac{\Delta P_c}{P_c},$$
$$\frac{\Delta U_{r,c}^m}{U_{r,c}^m} = -\frac{\Delta P_c}{P_c}.$$

The total change in welfare is then divided into four components altered by migration, the three main effects at work and a fourth one capturing general equilibrium interdependencies between them:

(i) The *labor market effect* is the most common channel highlighted in the literature. A change in the size and in the composition of the labor force must affect the nominal wages of heterogeneous agents (w_c^m), due to the fact that low- and high-skilled workers, as well as natives and migrants, are imperfect substitutes. By changing the skill structure of the labor force, migration changes the marginal productivity of non-migrant workers. In particular, low-skilled immigrants increase the wages of high-skilled workers and reduce the wages of their counterparts. Emigration leads to opposite effects.

(ii) The *fiscal effect* forms another channel which is identified in our model. Using eq. (1.23), we quantify the extent to which migration affects the labor income tax rate (t_c). The latter operates through a change in the number of beneficiaries and contributors to the fiscal scheme. The fiscal effect pertains to all workers but not to retirees, as we assume constant transfers per person.

(iii) The *market-size effect* operates through changes in the mass of entrepreneurs and varieties produced in all countries. This induces variations in the ideal price index (P_c), a weighted combination of domestic and foreign prices. Other things equal, an increase in the mass of varieties produced in country c leads to a fall in the price index, as reflected in eq. (1.4). Moreover, global migration may increase the total available mass of varieties, if the population moves towards more efficient economies (i.e. countries with lower entry costs or higher productivity), as shown in eq. (1.21). Therefore, in the presence of trade, the sending countries could gain from migration if the aggregate mass of varieties increases. Due to the presence of trade costs, this increase in demand is biased towards domestic varieties (at least if the wage differences across countries do not offset this advantage).

(iv) As nominal wages affect marginal costs and prices, interdependencies arise between channels. The difference between the total effect and the sum of the labor market, fiscal and market-size effects, taken in isolation, is referred to as the *general equilibrium effect*.

To quantify the relative magnitude of each transmission channel, we proceed as follows. First, for each type of worker, the labor market effect is computed as the change in the nominal wage caused by global migration. Given the interdependencies between the transmission channels, wage responses affect prices (through eq. (1.18)) and the income tax rate (through the fiscal base). To calculate the magnitude of the market-size and fiscal effects, we need to neutralize these interdependencies using partial equilibrium simulations. Second, we thus isolate the market-size effect by computing the response of the price index induced by the change in aggregate demand, keeping nominal wages and tax rates constant (therefore, the government budget constraints and labor market equilibria are violated). Third, we isolate the fiscal effect by computing the change in the income tax rate, keeping nominal wages and the mass of varieties constant (i.e. violating the government balances). Finally, the general equilibrium effect is computed as a residual (i.e. difference between the total welfare change and the sum of the three other effects taken in isolation).

1.3 Quantitative analysis

In this section, we calibrate the parameters of the model, using country-specific data and insights from the existing literature, and then describe the results of our numerical experiments. We explain our calibration strategy and examine its relevance in Section 1.3.1. Section 1.3.2 discusses our benchmark results. Finally, we conduct a large set of robustness checks in Section 1.3.3.

1.3.1 Parametrization

We calibrate our model for the 34 OECD countries and the rest of the world (ROW), the aggregation of all non-OECD countries, for the year 2010. This section describes our data sources and the approach used to calibrate the common and country-specific parameters.

Population data – Our model is static and our objective is study how the size and the structure by age and education of international migration affects the economy and the welfare of citizens in the OECD countries. We combine two data sources that allow us to characterize the effects of the stocks of recent and older migrants on the structure of the population in the year 2010. Obviously, other aspects of immigrants are likely to affect their contributions to the economy (such as the quality of education, age of arrival, return intentions, fertility, longevity, etc.) and are disregarded here. We use population data from the United Nations.[20] The database documents the total and immigrant populations of all countries by age group and by year. We extracted the 2000 and 2010 data for each OECD member state and we aggregated the rest of the world. We distinguish between the two age categories in our model, individuals aged 25 to 64 (the working-age group) and individuals aged 65 and over (the retirees).

As for the education structure of the population, we use the Database on Immigrants in OECD countries (DIOC) described in Arslan et al. (2015). The data are collected by country of destination and are mainly based on population censuses or administrative registers. The DIOC database provides detailed information on the demographic characteristics, level of education and labor market outcomes of the population of OECD member states. For the 2000 and 2010 census rounds, we extract information about the country of origin, age, and educational attainment. This allows us to quantify the bilateral stocks of immigrants from all world countries and the numbers of non-migrants in all OECD countries by education (college graduates and the less educated) and by age (25 to 64, and 65 and over).[21] These DIOC stocks are then rescaled to match the aggregate population data of the United Nations, giving our measures of $L^m_{a,c}$. For the rest of the world, we do not distinguish between natives and residents and use the population data from the United Nations, and the education data from Barro and Lee (2013).

Table 1.B1 in the Appendix 1.B gives the structure of the population aged 25 and over for all OECD member states in the year 2010. As far as emigration is concerned, we estimate the number of emigrants from each OECD member state by aggregating the bilateral stocks of migrants across destinations, by education level and age. Clearly, the size and structure of the population would have been different if all migrants had been unable to leave their home country. For each OECD country, Table 1.B2 shows the impact of global migration stocks (i.e. stocks of immigrants and emigrants) on the proportion of foreigners, on the old-age dependency ratio, and on the share of college graduates in the labor force in the year 2010.

As far as migration flows are concerned, we proceed as in Docquier et al. (2014) or Artuc et al. (2015), and proxy net migration flows over the period 2000-2010 by taking the difference between the stock in 2010 and the stock in 2000. As individuals usually move at a young age, we only consider the difference in the stock of migrants aged 25 to 64. The size and structure of the population would have also been different if these recent immigrants and emigrants had

[20] See: http://www.un.org/en/development/desa/population/migration/data/estimates2/estimatesage.shtml.

[21] Censuses sometimes account for undocumented immigrants, at least in some countries like the US. This is not the case in Europe. The Clandestino database gives lower-bound and upper-bound estimates of the stock of illegals in EU countries (see Kraler and Rogoz, 2011). These percentages are usually low. In addition, these data do not have any information on the origin, education levels, and age of migrants. For these reasons, we chose to ignore illegal migration.

been unable to move. For each OECD country, Table 1.B3 shows the impact of the 2000-10 net migration flows on the proportion of foreigners, on the old-age dependency ratio, and on the share of college graduates in the labor force. Finally, Figure 1.B2 compares the effect of global migration stocks (horizontal axis) and global migration flows (vertical axis) on population size, old-age dependency, and human capital. Although the effects of the stocks exceed by far the effects of the flows, they are strongly correlated (correlation rates of 0.70, 0.51 and 0.53 for population, dependency and human capital, respectively).

Fiscal data – To calibrate fiscal policy, we combine three databases. First, comparable aggregate data on public finances are obtained from the *Annual National Accounts* harmonized by the OECD.[22] These database reports aggregate public revenues and public expenditures by broad category, as percentage of GDP. As for revenues, we distinguish between taxes based on income (including social contributions and taxes on personal and corporate income), taxes based on consumption (VAT and excise duties), and other taxes. As for expenditures, we distinguish between social protection expenditures, education expenditures, and government consumption. For the rest of the world, we average the fiscal data from Brazil, China, and India. Since our model rules out the possibility of a budgetary deficit or surplus, we rescale all items so that the total government budget is equal to the mean of the observed shares of public revenues and expenditures in GDP for the year 2010. Second, we use the *Social Expenditure Database* (SOCX) of the OECD to decompose social protection expenditures by program.[23] The SOCX database includes internationally comparable statistics on public social expenditures at the program level, as well as net social spending indicators. We extract data on expenditures linked to sickness and disability, pension benefits, family and children, unemployment and other transfers, as percentage of total social protection expenditures.

Finally, we disaggregate education expenditures and all social protection expenditures by education level, age group, and legal status (natives versus foreigners) using the *European Union Statistics on Income and Living Conditions* (EU-SILC) provided by Eurostat for European countries, and the fiscal profiles used in Chojnicki et al. (2011) for the United States. We extract personal characteristics (such as country of birth, year of birth, and highest level of education attained), data on social benefits (sickness benefits, disability benefits, survivor benefits, old-age benefits, unemployment benefits, and education-related allowances), and the sampling weight of each individual.

We compute the amount of benefits received by the representative individual from the eight groups of residents distinguished in our model, and rescale each profile to match the aggregate level obtained from the SOCX database. The resulting profiles capture cross-country differences in the fiscal treatment of immigrants, their demand for social benefits (depending on age, age of arrival, education, fertility, intentions to return etc.), and their eligibility to welfare programs. For Canada, and Australia, we use the US profiles.[24] For other countries, we use the average OECD profiles, rescaled to match the aggregate public finance data of the country.

Table 1.B4 in the Appendix 1.B characterizes the fiscal policy of each OECD member state, as percentage of GDP. Column 1 gives the aggregate amount of fiscal revenues and expenditures under the balanced budget assumption. Columns 2 and 3 report the shares of income and consumption taxes in GDP (used to calibrate t_c and υ_c). Columns 6 to 9 give the structure of public expenditures. General public spending and education expenditures in columns 4 and 5 form the government consumption. To compute the $G^m_{a,c}$ profiles, we assume a constant amount of public

[22] See https://data.oecd.org/

[23] See https://data.oecd.org/socialexp/social-spending.htm

[24] On the effect of age of arrival and (endogenous) return intentions, see Kirdar (2012).

spending per inhabitant and use the EU-SILC profiles to allocate education expenditures across the four groups of working-age adults. As for the $T^m_{a,c}$ profiles, we aggregate health, old-age, unemployment and family benefits, which are allocated across groups of individuals using the EU-SILC profiles. We also include the residual category in column 10, which combines residual transfers minus residual taxes. For these other net transfers, we assume a constant amount per inhabitant.

The last two columns illustrate the net fiscal contribution of working-age individuals (column 11) and immigrants (column 12) for the year 2010. In all countries, public intervention involves a fiscal redistribution from working-age individuals to retirees, which varies between 5.0 percent of GDP in New Zealand and 17.5 percent in Luxembourg (the OECD average equals 10.8 percent). The last column gives the fiscal impact of the total stock of immigrants in 2010. It is positive in 20 countries and negative in 14 countries, under the benchmark assumption that government consumption is proportional to population size. The fiscal impact varies between -1.2 percent of GDP in Chile to 5.0 percent in Switzerland (the OECD average equals 0.3 percent).

Common parameters – The model includes three common parameters, $\{\epsilon,\ \sigma_S,\ \sigma_M\}$. The elasticity of substitution between varieties of goods, ϵ, is estimated in the range of 3 to 8.4 by Feenstra (1994). We take $\epsilon = 4$ as a benchmark value. As far as elasticities of substitution between groups of worker are concerned (σ_S and σ_M), we follow Docquier et al. (2014) and use their intermediate value: $\sigma_S = 1.75$ and $\sigma_M = 20$. We consider alternative levels in the robustness analysis.

Other parameters – The model also includes other parameters that vary across countries or country pairs. These include $\{f_c, \theta^S_c, \theta^M_c, A_c\}_{c\in C}$, and bilateral trade costs $[\tau_{cj}]_{c,j\in C}$.

As for the fixed cost of entry, f_c, we use the Doing Business database and the World Development Indicators from the World Bank (2010). We construct a synthetic indicator using three proxies for the cost of entry: the number of days needed to fulfill the formal requirements to establish a firm, the cost of starting a business (as percentage of GDP per capita), and the share of new firms registered. For a given f_c, we have $\Delta B_c/B_c = \Delta\bar{L}^T_c/\bar{L}^T_c$ from eq. (1.21). The level of the entry cost is important for the rest of the calibration (it affects income per capita and prices), but has no influence on the price and wage responsiveness to migration shocks. Without loss of generality, we normalize our synthetic indicator by its minimum value, obtained for Norway, since the model considers homothetic preferences and production. The values obtained for the other countries vary in the range of 1 to 3.64. For the rest of the world, we computed a GDP-weighted sum of the 33 largest non-OECD countries. The firm preferences for each group of workers (i.e. θ^S_c, θ^M_c) are computed to match the data on income disparities by education level and origin. The data on the wage ratio between college graduates and the less educated are taken from Hendricks (2004), while the data on the wage ratio between immigrants and non-migrants come from Büchel and Frick (2005). Combining these sources with data on relative population shares, we compute the firms' preference parameters that match the actual labor income shares in each country. Finally, the TFP residuals, A_c, are calibrated to fit the levels of nominal GDP. Our macroeconomic data and country-specific parameters are provided in Table 1.B5 in the Appendix 1.B.

Wages and total factor productivity determine the unit cost of production, the price of domestic goods (from eq. (1.15) and eq. (1.18)), and the total expenditures, X_c. Hence, the matrix of bilateral costs, τ_{cj}, can be calibrated to match the matrix of adjusted trade flows between countries (adjustments are needed to balance exports and imports).[25] These calibrated trade costs are instrumental to spreading shocks across countries; we consider them as exogenous.

Validation – Our parametrization strategy consists in calibrating country-specific parameters and trade costs so as to perfectly match the observed demographic, fiscal and economic characteristics of countries and trade flows. We use all the degrees of freedom of the data to identify the parameters needed. Consequently, our model is exactly "identified" and cannot produce a test of its assumptions. In order to establish the relevance of our parametrization method, we examine whether our identified parameters exhibit realistic correlations with the related explanatory variables, or reasonable properties:

- Our estimates of the fiscal impact of immigration exhibit a correlation of 0.45 with the levels reported in Table 3.7 in OECD (2013), although the OECD does not impose a balanced budget and constant tax rates across individuals.
- In our model, the variable B_c may be interpreted as an indicator of market size, and is highly correlated with the population level observed (correlation of 0.99).
- The TFP levels can be compared to the measures of labor efficiency.[26] The cross-country correlation between the TFP variable A_c and the actual data on labor productivity is equal to 0.72. One has to remember that the computed residual and TFP values incorporate more than just the level of technology or labor productivity. For instance, they may be affected by the quality of institutions, infrastructure, legislation, education, social capital, etc.
- The nominal wages predicted by the model are in line with the actual data. The composite wage rates W_c are correlated with the cross-section average annual wages reported in the *OECD database*. The correlation is 0.85.
- Finally, our bilateral trade costs, calibrated to match the bilateral trade flows, are well correlated with the traditional determinants of trade barriers. We have regressed our τ_{cj} on standard bilateral variables that affect the volume of exports, obtaining very similar results to those of Anderson and van Wincoop (2003), Silva and Tenreyro (2006), and other gravity-like analyses of international trade.[27]

1.3.2 Benchmark results

To quantify the impact of migration on welfare, we compare the observed utility levels, as defined in eq. (1.5), with counterfactual utility levels obtained when recent migrants were sent

[25] The correlation between our predicted bilateral trade flows and the actual (unadjusted) data equals 0.99. It is not equal to one because we adjust trade flows to balance exports and imports, and we constrain τ_{cj} to be larger than or equal to one.

[26] We consider the GDP per hour worked from the OECD database.

[27] In our regression, the set of controls includes geographic distances between any two countries and dummies for common border, common language, colonial ties, and the existence of a free trade agreement. The data are taken from the CEPII gravity dataset. The estimates of our OLS regression are equal to 0.156 for distance, -0.324 for common border, -0.215 for common language, -0.258 for colonial ties, and -0.025 for free trade agreements. They are all significant at the 1 percent threshold and the R^2 equals 0.200. Similar results are obtained when country-fixed effects are included.

back to their home countries. For each type of worker, the change in utility is expressed as a percentage deviation from the non-migration counterfactual:

$$\frac{\Delta U_{a,c}^m}{U_{a,c}^m} = \frac{\left(U_{a,c}^m\right)_{Reference} - \left(U_{a,c}^m\right)_{Counterfactual}}{\left(U_{a,c}^m\right)_{Counterfactual}}.$$

Hence, a positive difference implies a welfare gain due to global migration, while a negative one implies a welfare loss.

In the benchmark analysis, the counterfactual consists in repatriating all the migrants that arrived to their destination countries between 2000 and 2010. There are three reasons to focus on recent migration flows, instead of stocks. First, recent migrants are less assimilated and are likely to exhibit a stronger complementarity to native workers on the labor market. On the contrary, the immigration stock includes old waves of better assimilated immigrants who are now in retirement or have gradually become closer substitutes to natives on the labor market (by way of comparison, we simulate the effect of repatriating the total stock of migrants in Section 1.3.3). Second, recent empirical studies on the interactions between immigrants and native workers are usually based on recent flows of workers (see Card, 2009, Docquier et al., 2014, Ottaviano and Peri, 2012). Finally, recent legal migrants are younger and more educated than older immigrants. Focusing on newer immigration enables us to shed light on the current patterns of global migration.

The benchmark results are depicted in Figure 1.1. Countries are sorted in descending order with respect to the average (or total) welfare effect. In Figure 1.1a, we first provide the average welfare impact of global migration for non-migrants, and its distribution by individual type (low-skilled workers, high-skilled workers, and retirees). Figure 1.1b then focuses on the average welfare impact and distinguishes between intra-OECD and extra-OECD migration flows. Finally, we apply the welfare decomposition method described in Section 1.2.5 to disentangle the welfare impact on college-educated and less educated workers (see Figures 1.1c and 1.1d).

Winners and losers from global migration – Figure 1.1a identifies the winners and losers from recent global migration flows. The average effect on non-migrants is positive in 28 OECD countries, nil in France, and negative in 5 traditional countries of emigration. The greatest gains are obtained in Spain (8.1 percent), Australia (7.9 percent), Canada (4.6 percent), Switzerland (4.6 percent), Ireland (4.4 percent), and New Zealand (4.3 percent). Welfare losses are obtained in Turkey (-0.5 percent), Slovakia (-1.7 percent), Mexico (-1.8 percent), Estonia (-3.8 percent), and Poland (-3.8 percent). As stated above, we disregard remittances and overestimate the losses incurred in the latter countries. The magnitude of the average effect is highly correlated with the incidence of migration flows on population size (correlation of 0.91) and on the old-age dependency ratio (correlation of -0.89). On the contrary, it is poorly correlated with the migration-induced variation in the skill structure of the labor force (correlation of 0.20 with the change in the proportion of college-educated workers).

Within countries, the welfare effects are heterogeneous across types of individuals. They are positive for retirees in 31 countries (exceptions are Mexico, Estonia, and Poland). In our benchmark scenario, retirees do not work and only consume the transfers they receive from the government. They are only affected by the change in the ideal price index, which varies with the domestic market size and availability of additional varieties of foreign goods.[28] On the contrary, the effects on workers are also affected by fiscal and labor market effects (i.e. changes in

[28] This assumption will be relaxed in the robustness section, in which we consider a scenario with endogenous consumption tax rates.

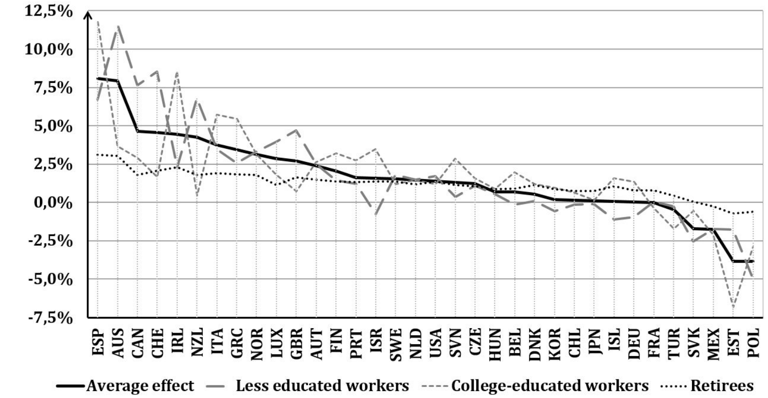
income tax rates and wages). Global migration is beneficial for college-educated natives in 28 countries (the same countries as above), and for the less educated in 22 countries only. Overall, we identify many winners and a few losers. More precisely, there are seven countries combining average welfare gains and welfare losses for the less educated. These are countries where recent migration flows are not too large (excluding strong market-size effects), and where recent migration has reduced the proportion of college graduates in the labor force (Israel, Belgium, Korea, Chile, Japan, Germany, and Iceland). Nevertheless, with the exception of Iceland and Germany (-1.0 percent in utility), the welfare losses for the low-skilled are close to zero.

Moreover, our simulations indicate that recent global migration flows have increased the average utility of non-migrants by 1.1 percent in the OECD (and by 0.8 percent if older cohorts of migrants are included in the average), and have decreased the average utility of those left behind by 0.3 percent in the rest of the world. Overall, a large majority of non-migrants in OECD countries have benefited from recent migration flows. With a few exceptions, the within-country effects are limited compared to the between-country ones. The correlation rates between the average and group-specific welfare impacts are equal to 0.81 for college-educated workers, 0.91 for less educated workers, and 0.98 for retirees.

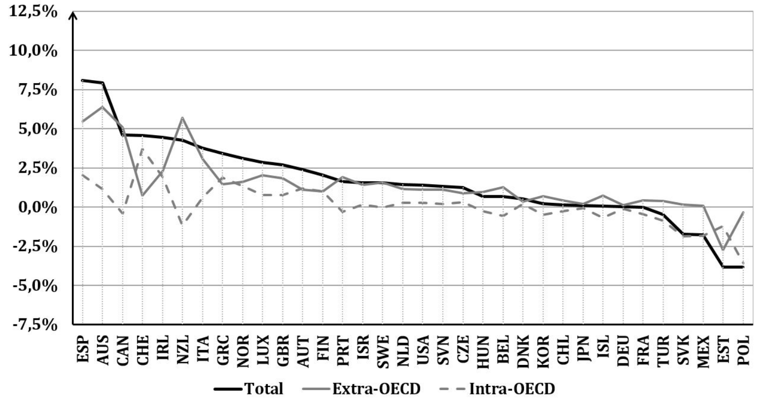
Intra-OECD vs Extra-OECD – In Figure 1.1b, we focus on the average welfare effect of migration flows (i.e. between-country disparities) and distinguish between intra-OECD and extra-OECD migration flows. Extra-OECD migration basically consists of an inflow of immigrants from non-OECD countries. On the contrary, intra-OECD migration is a zero-sum game involving net immigration and net emigration countries. Another difference is that intra-OECD migrants are on average more educated than extra-OECD migrants.

It comes out that the effect of extra-OECD migration is positive in 32 countries; the exceptions are Poland and Estonia (average welfare effects of -0.3 and -2.7 percent, respectively), two countries which send a substantial number of emigrants to Russia or other Eastern European destinations. As far as intra-OECD migration is concerned, we identify 17 winners and 16 losers (the effect is nil in Sweden). The effect is negative in traditional emigration countries (Turkey, Slovakia, Hungary, Mexico, Estonia, and Poland), but also in Canada, New Zealand, Portugal, Belgium, Korea, Chile, Japan, Iceland, Germany, and France. Welfare losses are usually small; the largest effect is obtained in New Zealand (-1.2 percent), Iceland (-0.7 percent), and Belgium (-0.6 percent). The gains are larger and mostly concentrated in a few countries (3.7 percent in Switzerland, 2.0 percent in Spain, 1.9 percent in Ireland, 1.3 percent in Norway, and 1.2 percent in Australia and Austria).

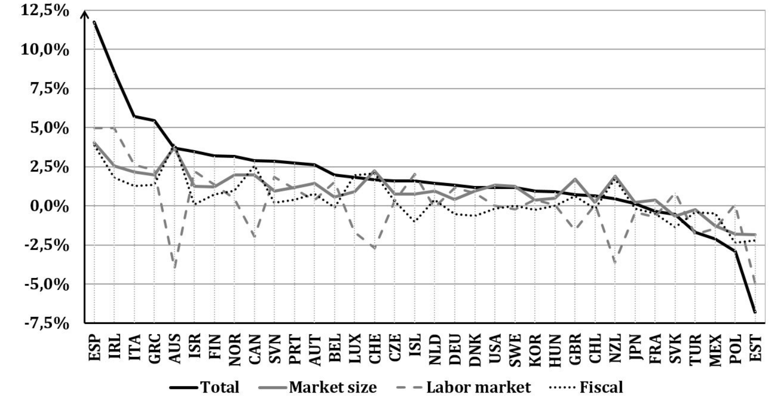
Overall, extra-OECD migration flows increase the average utility of non-migrants by 1.2 percent in the OECD (and by 0.9 percent if older cohorts of migrants are included in the average), and decrease the utility of those left behind by 0.3 percent in the rest of the world. Intra-OECD migration flows decrease the average utility of non-migrants by 0.1 percent in the OECD. Hence, the bulk of welfare gains from global migration is driven by extra-OECD migration, in line with Di Giovanni et al. (2015) or Iranzo and Peri (2009). As stated above, extra-OECD immigration is usually perceived in opinion poll surveys as a massive inflow of uneducated people trying to gain access to the labor markets and welfare systems of rich countries; intra-OECD migration is less frequently seen as problematic. As far as the economic effects are concerned, popular perceptions are clearly at odds with the predictions of our model.



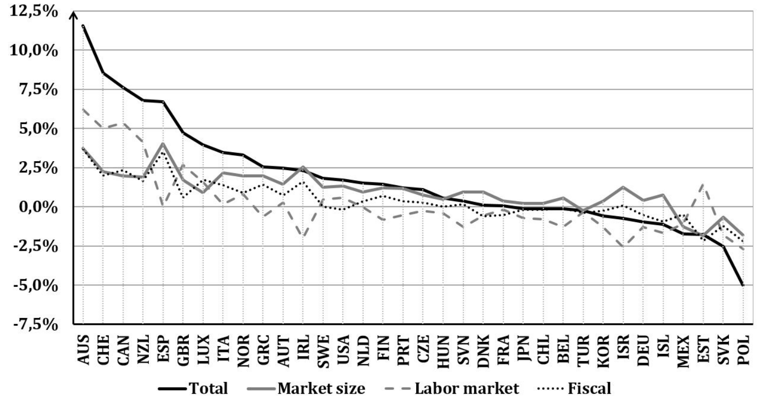
(A) Welfare impact by type of individual



(B) Average impact of intra-OECD and extra-OECD flows



(C) Disentangling the welfare impact on college-educated workers



(D) Disentangling the welfare impact on the less educated workers

FIGURE 1.1: Welfare impact of 2000-2010 migration net flows on non migrants.

Note: In each figure, countries are sorted in descending order of the average or total welfare impact on native, non migrants. The average effect in Fig. 1.1a and 1.1b is the weighted average of the welfare effect on the four groups of native non migrants. The decomposition depicted in Fig. 1.1c and 1.1d follows the strategy explained in Section 1.2.5.

Transmission channels – In Figures 1.1c and 1.1d, we disentangle the welfare impact on college graduates and less educated non-migrants using the decomposition method explained in Section 1.2.5. The residual general equilibrium effects are not reported here. Many studies conducted on the United States or on a few European countries have demonstrated that the labor market and fiscal effects of migration are relatively small. Our simulations show that these effects can be much larger in other countries.

The standard deviation in the market-size effect equals .013, to be compared with .022 and .014 for the labor market and fiscal effects, respectively. The labor market and fiscal channels are important sources of heterogeneity across countries. However, the market-size effect is the main source of welfare gains. Our simulations reveal that, on average, it increases the welfare of all workers by 1.0 percent in the OECD. This is greater than the average fiscal effect (0.4 percent) and the average labor market effects (0.2 percent for college graduates and 0.1 percent for the less educated).[29] In addition, the correlation between the market-size and total effects is large (0.85 for college-educated workers and 0.84 for the less educated).

Overall, focusing on the 28 countries where global migration has improved the welfare of college graduates, the market-size effect is dominant in 14 cases (to be compared with 11 cases for the labor market effect, and only 3 cases for the fiscal effect). Similarly, focusing on the 22 countries where global migration has improved the welfare of the less educated, the market-size effect is dominant in 16 cases (to be compared with 5 cases for the labor market effect, and 1 case for the fiscal effect). As the market-size effect affects the utility of all the residents of a given country identically, we conclude that the between-country consequences of global migration exceed the within-country ones. The market-size and love-of-variety mechanisms have been largely disregarded in the literature on the welfare consequences of migration (exceptions are Di Giovanni et al., 2015, Iranzo and Peri, 2009). Our results suggest that market size is an important missing ingredient in the existing literature.

1.3.3 Robustness checks

In this section, we conduct three types of robustness checks. First, we assess the robustness of our results to three mechanisms included or not in our model. We simulate the model without trade flows, with schooling externalities, or under alternative fiscal rules. Second, we analyze the sensitivity of our results to the choice of two important elasticities: the elasticity of substitution between goods in the utility function (governing the preference for variety), and the elasticity of substitution between native and immigrant workers in the production function (governing complementarities on the labor market). Figure 1.2 depicts the results of these two sets of robustness checks. Third, we simulate the welfare effect of a repatriation of the total stock of migrants (instead of recent migration flows) to their home country. The results of the stock simulation are depicted in Figure 1.3.

The role of trade – International trade is a channel through which the market-size effect is propagated across countries. A change in the mass of varieties in one country (due to a migration shock) affects the mass of varieties available in all of its trade partners, *ceteris paribus*. Hence, international trade is likely to mitigate the redistributive effects of global migration. To control for the role of international trade in propagating the gains from migration, we conduct the same counterfactual simulations assuming a closed-economy framework. We set all the pair-specific

[29] On average, the residual general equilibrium effect equals 0.2 percent.

trade costs to infinity ($\tau_{cj} = \infty \ \forall c \neq j$), such that the bilateral trade flows are zeroed before the shock ($X_{cj} = 0 \ \forall c \neq j$). Then, we simulate the effects of the repatriation counterfactual.

Figure 1.2a compares the welfare changes under autarky with those in the benchmark. We notice that the welfare effects with and without trade are almost identical. This is because our model has a single production sector, which aggregates the tradable and non-tradable sectors. Therefore, our calibrated trade costs are rather high. Distinguishing between a tradable and a non-tradable sector could increase the differences between the two scenarios (i.e. with and without trade) if market-size effects are larger in the tradable sector (i.e. if product differentiation is more important in the tradable sector). Moreover, in the absence of trade, both welfare gains in the most attractive countries and welfare losses in emigration countries are greater. Hence, existing trade flows slightly smooth the welfare impact of global migration.

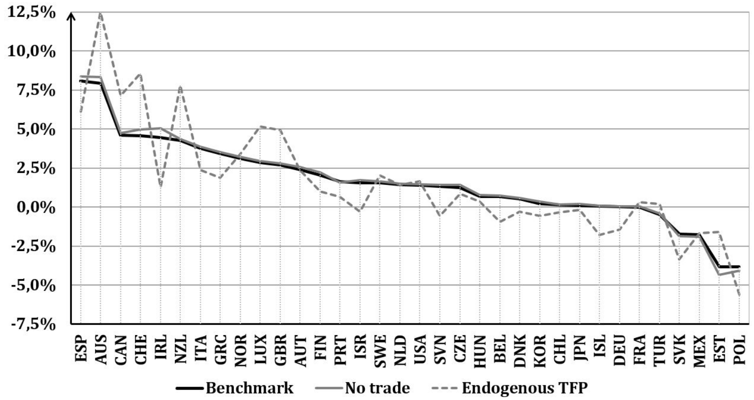
Schooling externalities – Our benchmark model assumes exogenous levels of TFP. However, recent evidence of a schooling externality on TFP has been identified at the country level (e.g. Benhabib and Spiegel, 2005, Vandenbussche et al., 2006), or at the metropolitan level (Acemoglu and Angrist, 2000, Ciccone and Peri, 2006, Iranzo and Peri, 2009, Moretti, 2004a,b). We thus simulate a variant of our model in which the economy-wide TFP level, A_c, is a concave function of the average proportion of high-skilled workers in the economy, κ_c:

$$A_c = \bar{A}_c \kappa_c^{\lambda}, \quad \text{with} \quad \kappa_c \equiv \frac{L^H_{w,c} + L^h_{w,c}}{L^T_{w,c}}, \tag{1.24}$$

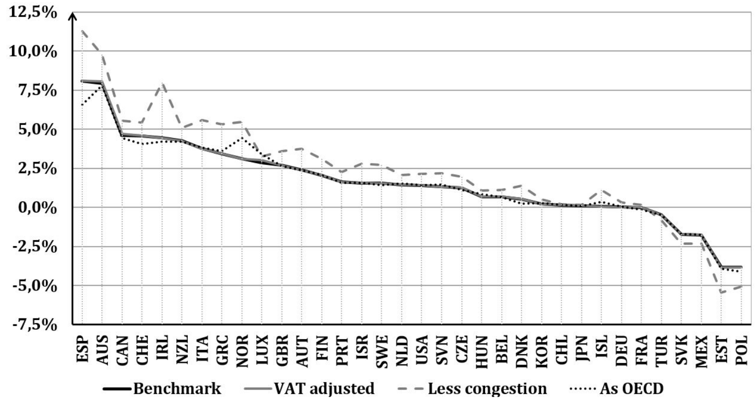
where λ is the elasticity of A_c with respect to κ_c, and $\bar{A}_c$ is an exogenous scale factor. As in De la Croix and Docquier (2012), we use $\lambda = 0.3$. This roughly corresponds to the average elasticity of A_c to κ_c in a simple cross-country OLS regression.

The results are presented in Figure 1.2a. Not surprisingly, schooling externalities change the magnitude of the effect in countries where global migration affects human capital. The gains are greater in countries such as Australia, Canada, Switzerland, and New Zealand, while the losses are more important in Belgium, Iceland, Germany, Israel, or Slovakia.

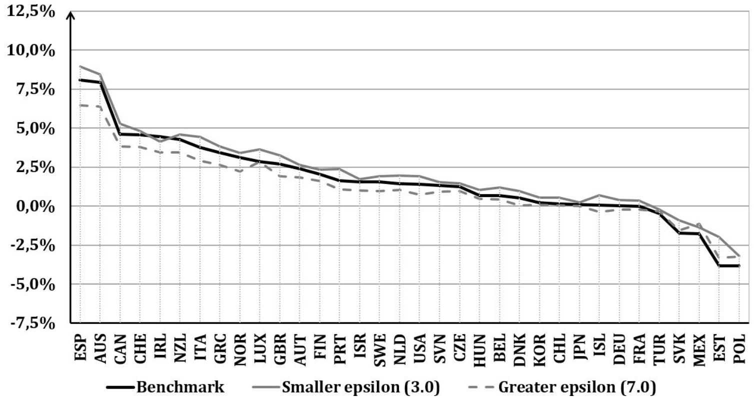
Assessment of the fiscal impact – In our benchmark simulation, the average fiscal impact amounts to 0.4 percent: it is smaller than the average market-size effect, but greater than the labor market effect. To assess the robustness of our results to the fiscal rule and to the calibration of the fiscal bloc, we consider three variants of fiscal policy. First, we assume that the income tax rate is constant and that the consumption tax rate adjusts to balance the government budget (see eq. (1.23)). Under this variant, labeled as "VAT adjusted", retirees are affected by the fiscal adjustment. Second, we assume that all public consumption expenditures (except education) are constant. Under this variant, labeled as "Less congestion", homothetic changes in population size induce variations in the tax rate. Finally, we introduce an exogenous income tax gap, t_c^g, between immigrants and natives (i.e. $t_c^{mig} = t_c^{nat} + t_c^{gap}$) and calibrate it so that our initial equilibrium in 2010 perfectly fits the estimated fiscal impact of immigration provided in Table 3.7 in OECD (2013). As stated above, in the benchmark, the correlation rate between our estimated fiscal impact of immigration and the OECD estimates was equal to 0.45. This variant is labeled as "As OECD". The results are depicted in Figure 1.2b. They are strongly robust to the choice of the fiscal rule and to the calibration of the initial fiscal impact of immigration, however they are more sensitive to the relationship between the amount of public spending and the population size. Not surprisingly, welfare gains are larger when a fraction of public spending is not affected by immigration. On the contrary, welfare losses are greater in net emigration countries under this scenario.



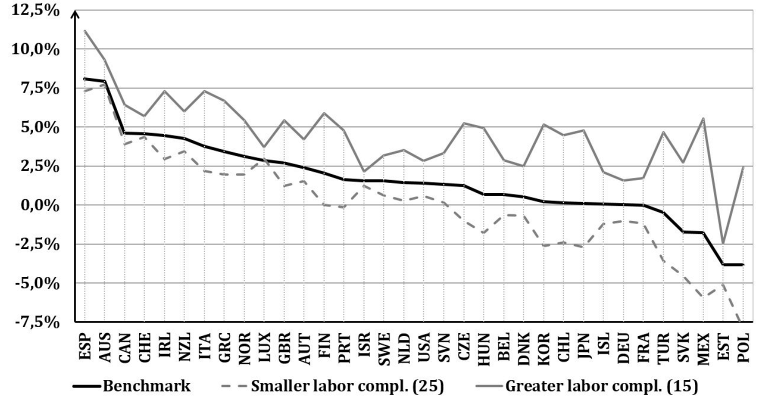
(A) Robustness to trade and schooling externalities



(B) Robustness to fiscal policy



(C) Robustness to love for variety



(D) Robustness to labor market complementarities

FIGURE 1.2: Sensitivity of the welfare impact of migration net flows.

Notes. In each figure, countries are sorted in descending order of the average or total welfare impact on native, non migrants. The benchmark effect is the weighted average of the welfare effect on the four groups of native non migrants.

Sensitivity to parameters – We now investigate the sensitivity of our results with respect to the calibration of the parameters. In Figure 1.2c, we let ϵ, the elasticity of substitution between varieties in eq. (1.1), vary between 3 and 7 (the benchmark value equals 4). This virtually covers the range of values provided in Feenstra (1994). In Figure 1.2d, we let σ_M, the elasticity of substitution between native and immigrant workers in eq. (1.8a-1.8b), vary between 15 and 25 (the benchmark value equals 20).

Even though a higher (lower) value of ϵ weakens (strengthens) the sensitivity of price indexes to shocks in the mass of varieties (which directly influences the magnitude of the market-size effect), our results are extremely robust to changes in ϵ. As far as labor complementarities are concerned, greater effects are identified when σ_M is smaller. The lower the substitution between different labor types, the stronger the reaction of efficient labor composites to the changes in supplies of workers, and the more dispersed the welfare effects of these shocks.

Global migration stocks – Finally, we consider a last counterfactual, which consists in repatriating the total stock of migrants (whatever their year of entry) to their source countries. This allows us to assess whether the negative opinions about immigration and emigration reported in opinion polls could be motivated by adverse effects of older waves of migration. The results of the stock simulation are depicted in Figure 1.3, which follows exactly the same structure as Figure 1.1.

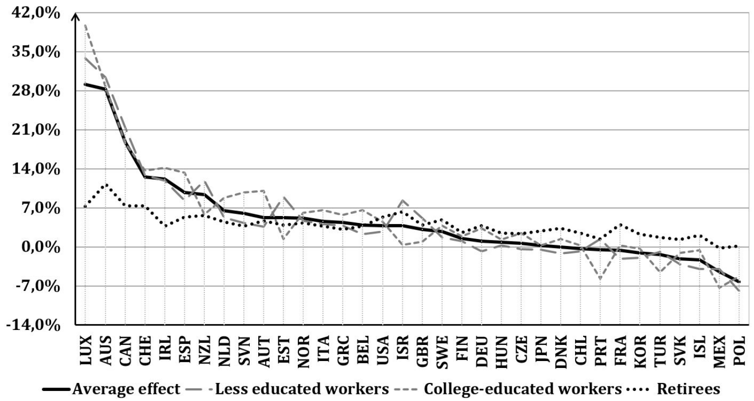
Figure 1.3a identifies the winners and losers from global migration stocks.[30] The average welfare impact is positive in 24 OECD countries (against 28 for the flow simulation) and its magnitude is usually greater than in the benchmark. The largest gains are obtained in Luxembourg, Australia, Canada, Switzerland, and Ireland. Welfare losses are obtained in Poland, Mexico, Slovakia, and Turkey, but also in richer countries such as Iceland, Korea, France, and Portugal. The magnitude of the average effect is highly correlated with the incidence of migration flows on population size (correlation of 0.77) and on the old-age dependency ratio (correlation of -0.32).

The welfare effects are heterogeneous across types of individuals. They are positive for retirees in 33 countries (the only exception is Mexico). Global migration is beneficial for college-educated natives in 22 countries, and for the less educated in 27 countries. Welfare losses are small, except in traditional emigration countries (including Portugal), but as stated above, we do not account for remittances.

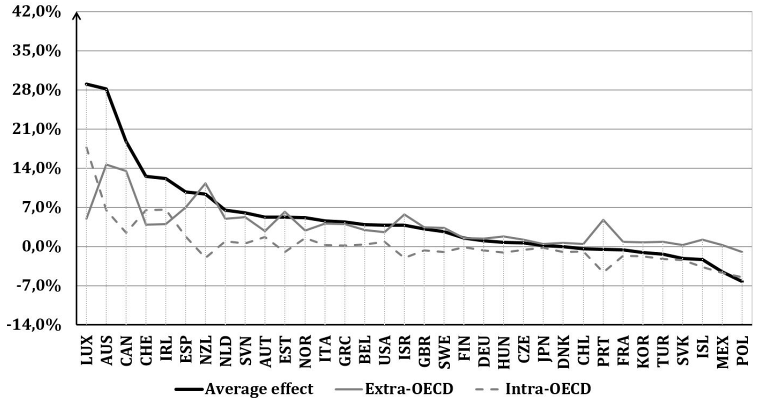
The correlation rates between the average and group-specific welfare impacts are equal to 0.96 for college-educated workers, 0.98 for less educated workers, and 0.87 for retirees. This confirms that with a few exceptions, within-country effects are limited compared to between-country effects.

Figure 1.3b distinguishes between intra-OECD and extra-OECD migration flows. As in the benchmark, extra-OECD migration increases the average welfare of non-migrants in 33 countries (the exception is Poland), whereas intra-OECD migration induces 14 winners and 20 losers. Overall, extra-OECD migration stocks increase the average utility of non-migrants by 2.4 percent in the OECD, and decrease the utility of those left behind by 1.7 percent in the rest of the world. Intra-OECD migration stocks decrease the average utility of non-migrants by 0.6 percent in the OECD. Again, the bulk of welfare gains from global migration are driven by extra-OECD migration.

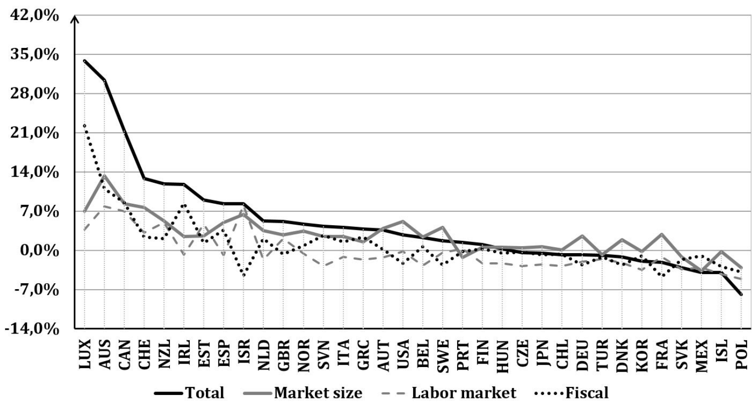
30 Figure 1.B3 in the Appendix 1.B compares the average welfare impact of migration stocks and migration flows. The correlation rate between these effects is equal to 0.71.



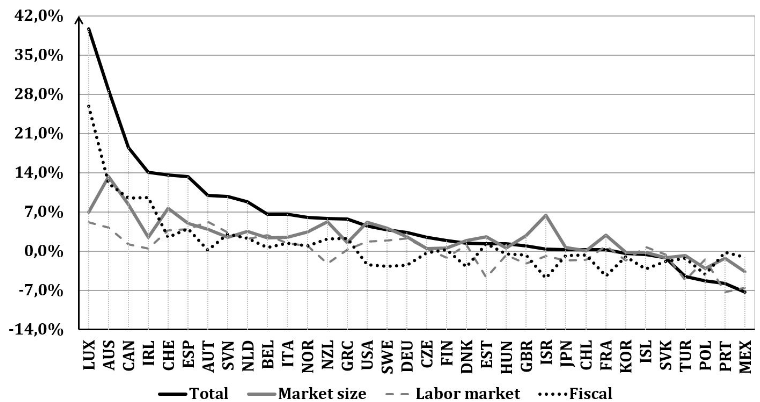
(A) Welfare impact by type of individual



(B) Average impact of intra-OECD and extra-OECD flows



(C) Disentangling the welfare impact on college-educated workers



(D) Disentangling the welfare impact on the less educated workers

FIGURE 1.3: Welfare impact of 2010 migration stocks on non migrants.

Notes. In each figure, countries are sorted in descending order of the average or total welfare impact on native, non migrants. The average effect depicted in Fig. 3.a and 3.b is the weighted average of the welfare effect on the four groups of native non migrants. The decomposition depicted in Fig. 3.c and 3.d follows the strategy explained in Section 1.2.5.

Figures 1.3c and 1.3d disentangle the welfare impact on college graduates and less educated citizens using the decomposition method explained in Section 1.2.5. For the stock simulation, the standard deviation in the market-size effect equals 0.034. For college graduates, standard deviations in fiscal and labor market effects equal 0.050 and 0.034; and for the less educated, they equal 0.057 and 0.030, respectively. However, the market size remains the main source of welfare gains. On average, it increases the welfare of all workers by 2.6 percent in the OECD. This is greater than the average fiscal effect (1.2 percent) and the average labor market effect (0.2 percent for the less educated and -0.4 percent for college graduates). The correlation between the market-size and total effects is large (0.84 for college-educated workers and 0.79 for the less educated). Overall, focusing on the 22 countries where global migration has improved the welfare of college graduates, the market-size effect is the dominant effect in 14 cases. Similarly, focusing on the 27 countries where global migration has improved the welfare of the less educated, the market-size effect is the dominant effect in 20 cases. This confirms that the market size is instrumental to explaining the welfare consequences of migration.

1.4 Conclusion

The current economic and demographic situation faced by many OECD countries has kindled debates over the economic impact of migration. Natives in developed countries predominantly see immigration as a source of adverse economic effects, not as a stimulus for greater competitiveness and welfare gains. This is especially the case for immigration flows from less developed countries. The academic literature has not confirmed these presumptions. Isolated studies of the labor market and fiscal impacts of migration have shown that the economic effects are rather small and presumably positive in many countries. However, with a few exceptions, the existing literature has imperfectly captured the complex interactions between the economic mechanisms through which global migration affects the welfare of non-migrants.

To assess the welfare impact of the current state of global migration (i.e. immigration of foreigners and emigration of natives) on OECD citizens, we develop a multi-country model that combines three economic transmission channels of migration shocks: the labor market effect, the fiscal effect, and the market-size effect. Borrowed from the trade literature, the latter arises from the relationship between the size of the aggregate demand (influenced by population movements) and the variety of goods available to consumers in a monopolistic environment with fixed entry costs.

Our integrated, open-economy model enables us to account for the interactions between these channels, as well as for the interdependencies between countries. It can be calibrated to perfectly fit the economic and demographic characteristics of the 34 OECD countries and the rest of the world, and the trade flows between them in the year 2010. We use the model to evaluate the utility level of non-migrant OECD citizens under the current allocation of the world population, and under a counterfactual allocation with no recent migration (as if the last decadal wave of migration had been nil). We show that recent global migration flows induced many winners and a few losers among OECD citizens. The group of winners represents 69.1 percent of the OECD non-migrant population aged 25 and over; this percentage increases to 83.0 percent if one only considers the 22 countries whose GDP per capita was above USD 30,000 in the year 2010. Although labor market and fiscal effects are non negligible in some countries, the greatest source of welfare gains comes from the market-size effect. It follows that the between-country consequences of global migration exceed the within-country ones. Welfare gains are obtained for virtually all citizens in traditional immigration countries. Welfare losses are essentially due to the (intra-OECD) emigration of a country's nationals. Using the estimated elasticities from the empirical literature, we find that the market size is instrumental in explaining the welfare consequences of migration. It is an important missing ingredient in the majority of studies on the welfare consequences of migration. Still our model with homogeneous preferences and competitive labor market structures leaves out a discussion of the employment effects of international migration. Accounting for labor market rigidities and origin-specific determinants of labor participation rates could help us refining the magnitude of the labor market, market size and fiscal impact of migration. We leave these challenging issues for further research.

Appendices

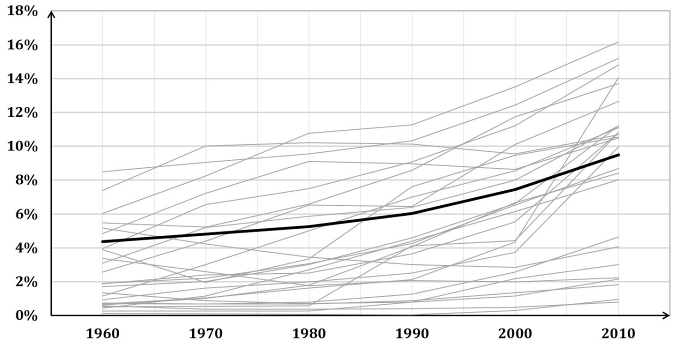
1.A Stylized facts 1960-2010

Concerns about migration have been correlated with the evolution of the magnitude of migration flows. Some stylized facts are provided in Figure 1.A1. On the one hand, the average share of immigrants in the population of OECD economies increased from 4.4 in 1960 to 9.5 percent in 2010 (see the bold line in Fig. 1.A1a). In particular, the average share of immigrants originating from developing countries increased from 1.4 to 5.6 percent.[31] By the year 2010, the proportion of foreigners in the population exceeded 10 percent in 21 countries, and was above 20 percent in 5 countries (Australia, Canada, Luxembourg, New Zealand, and Switzerland). On the other hand, the evolution of emigration has been less spectacular in OECD countries. On average, the ratio of the stock of emigrants to the population only increased from 3.0 to 3.9 percent between 1960 and 2010 (see the bold line in Fig. 1.A1b). However, disparities across countries are important. By the year 2010, five OECD member states exhibited emigration rates above 10 percent (Ireland, Luxembourg, Mexico, New Zealand, and Portugal) and 12 others exhibited rates above 5 percent. In most cases, emigrants are much more educated than those left behind, as shown in Artuc et al. (2015).

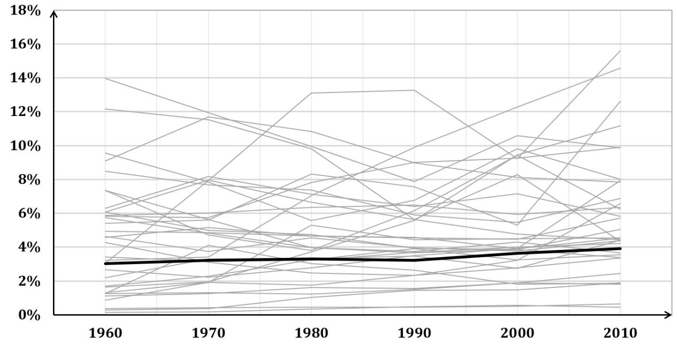
Such migration movements have a strong incidence on the socio-demographic characteristics of the 34 OECD member states. In Fig. 1.A1c, we focus on net migration flows (entries minus exits) observed between 2000 and 2010, and compute the effect of these flows on three variables of interest, the size of the population aged 25 and over, the old-age dependency ratio (i.e. ratio of the population aged 65+ over the population aged 25-64), and the proportion of college graduates in the population aged 25-64. The effect of migration flows on population size is positive in 29 cases and negative in 5 cases only (it varies between -7.5 percent in Estonia and 12.5 percent in Spain). It is negatively correlated with the effect on the dependency ratio, which varies between -4.5 percent in Spain and 2.8 percent in Estonia. As far as human capital is concerned, the effects are very heterogeneous. Recent migration flows increased the proportion of college graduates in six immigration countries (Australia, Canada, Luxembourg, New Zealand, Switzerland, and the United Kingdom) and Estonia (due to low-skilled emigration flows). It decreased human capital in 14 countries (Spain, Ireland, Italy, Greece, Israel, Finland, Slovenia, Iceland, Denmark, Belgium, Germany, Korea, Slovakia, and Poland), and induced negligible effects in the 13 other cases. Figure 1.A1d illustrates the effect of total migration stocks on the same variables of interest. With a few exceptions, the effects on old-age dependency and human capital are similar to those of migration flows. On the contrary, the effect on the size of the population aged 25 and over is much larger (it varies between -13.9 percent in Mexico to 45.1 percent in Australia).

By changing the size and structure of the population, immigration and emigration are sources of welfare costs and benefits for non-movers. Through the structure of the labor force, migration flows affect the relative wages of high-skilled and low-skilled workers, as well as the income gap between natives and older migrants. Through changes in the age and education structures of the population, they affect the number of net contributors to (and net beneficiaries from) the welfare state and other public interventions. Labor mobility also affects the geographic distribution of workers and the aggregate demand for domestic goods and services, which alters the number of entrepreneurs and products available for consumption in all countries. Skill-biased migration can also influence the speed of knowledge accumulation and innovation, governing the evolution of total factor productivity (TFP). The welfare impact of global migration results from the complex interactions between these effects.

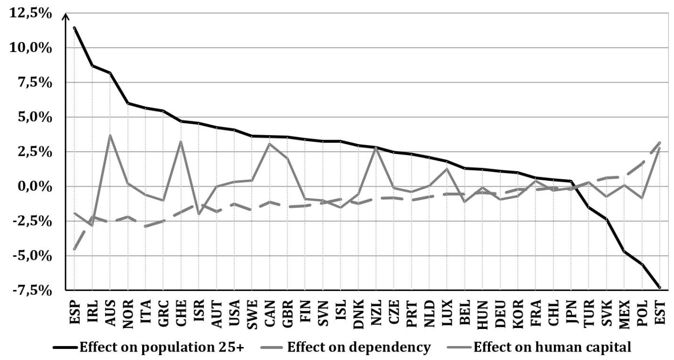
[31] More pronounced changes were observed in the richest OECD member states whose GDP per capita was above USD 30,000 in the year 2010.



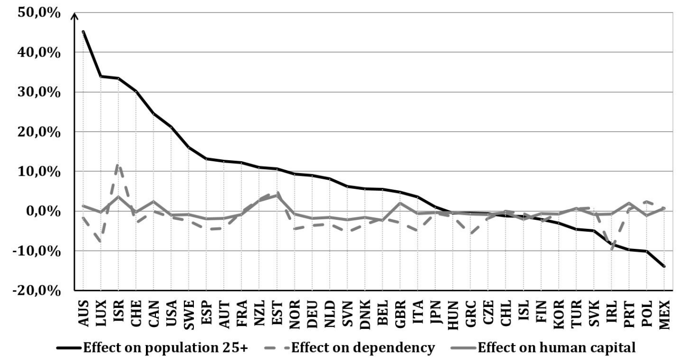
(A) Immigration-to-population ratio, 1960-2010



(B) Emigration-to-population ratio, 1960-2010



(C) Socio-demographic impact of 2000-10 migration flows



(D) Socio-demographic impact of 2010 migration stocks

FIGURE 1.A1: Stylized facts on global migration in the OECD countries.

Note: Fig. 1.A1a and 1.A1b depict the evolution of the ratio of immigration stock to population of OECD countries between 1960 and 2010 (Source: Özden et al., 2011). The bold line depicts the OECD average ratio, and the grey lines depict OECD countries. In Fig. 1.A1a, we exclude Israel, Luxembourg, Australia, New Zealand, Canada and Switzerland to limit the scale of the vertical axis. In Fig. 1.A1b, we exclude Ireland. Fig. 1.A1c and 1.A1d depict the effect of net immigration (immigration minus emigration) on the size of the population aged 25 and over, on the old-age dependency ratio (i.e. ratio of population aged 65 and over to population aged 25 to 64), and on the proportion of college graduates in the population aged 25 to 64. Results are expressed as percentage of deviation from the characteristics of the native population. Migration net flows are proxied as the difference between the stock in 2010 and the stock in 2000. Source: DIOC, OECD.

1.B Data appendix

Tables:

- 1.B1: Population size and structure in 2010 in the OECD member states
- 1.B2: Effect of migration stocks on the population structure
- 1.B3: Effect of 2000-10 migration net flows on the population structure
- 1.B4: Fiscal policy in the OECD member states
- 1.B5: Macroeconomic data and calibrated, country-specific parameters

Figures:

- 1.B2: Socio-demographic impact of 2010 migration stocks (X-axis) and 2000-10 migration flows (Y-Axis) as percentage of deviation from the no-migration counterfactual
- 1.B3: Average welfare impact of 2010 migration stocks (X-axis) vs 2000-10 migration flows (Y-Axis) as percentage of deviation from the no-migration

TABLE 1.B1: Population size and structure in 2010 in the OECD member states

Country	Natives					Immigrants					Total	
Age	Young		Old		All	Young		Old		All	Young	Old
Education	LS	HS	LS	HS	All	LS	HS	LS	HS	All	All	All
Australia	5.341	2.508	1.816	0.333	9.998	2.574	1.565	0.705	0.159	5.003	11.989	3.013
Austria	3.038	0.723	1.177	0.142	5.080	0.744	0.135	0.160	0.020	1.059	4.640	1.498
Belgium	3.486	1.687	1.532	0.224	6.930	0.594	0.130	0.113	0.009	0.845	5.897	1.878
Canada	7.389	7.100	2.559	1.028	18.075	1.797	2.794	0.801	0.443	5.835	19.080	4.831
Chile	6.498	2.106	1.425	0.126	10.156	0.174	0.042	0.019	0.004	0.239	8.820	1.575
Czech Republic	4.831	0.970	1.451	0.158	7.411	0.268	0.050	0.012	0.001	0.332	6.120	1.623
Denmark	1.747	0.846	0.740	0.144	3.478	0.263	0.088	0.031	0.009	0.392	2.944	0.925
Estonia	0.361	0.212	0.113	0.036	0.721	0.069	0.060	0.055	0.024	0.208	0.702	0.227
Finland	1.709	1.018	0.741	0.166	3.634	0.130	0.045	0.011	0.003	0.188	2.902	0.920
France	19.749	8.532	8.349	0.904	37.534	3.516	1.328	1.202	0.169	6.216	33.124	10.625
Germany	27.100	10.899	13.214	2.866	54.079	5.608	1.678	1.018	0.177	8.482	45.286	17.275
Greece	4.065	1.493	1.933	0.166	7.657	0.533	0.133	0.009	0.002	0.677	6.224	2.110
Hungary	4.223	1.129	1.407	0.184	6.943	0.188	0.086	0.064	0.019	0.357	5.625	1.675
Iceland	0.096	0.048	0.032	0.005	0.181	0.016	0.007	0.001	0.000	0.024	0.166	0.039
Ireland	1.410	0.657	0.431	0.050	2.548	0.223	0.161	0.018	0.006	0.408	2.451	0.506
Israel	1.325	1.017	0.139	0.062	2.543	0.716	0.447	0.416	0.157	1.736	3.505	0.774
Italy	25.069	5.021	11.461	0.583	42.133	3.043	0.524	0.207	0.029	3.803	33.657	12.279
Japan	40.951	25.822	25.823	3.236	95.832	1.126	0.439	0.165	0.019	1.749	68.338	29.243
Korea, Rep.	17.554	10.310	3.372	1.981	33.217	0.493	0.251	0.010	0.005	0.759	28.608	5.368
Luxembourg	0.133	0.037	0.052	0.004	0.226	0.086	0.031	0.013	0.002	0.132	0.287	0.071
Mexico	46.706	6.757	6.753	0.259	60.474	0.138	0.098	0.028	0.013	0.278	53.699	7.053
Netherlands	5.219	2.538	2.000	0.367	10.124	0.987	0.362	0.148	0.050	1.548	9.107	2.566
New Zealand	1.151	0.499	0.349	0.072	2.071	0.353	0.265	0.111	0.036	0.765	2.267	0.568
Norway	1.434	0.781	0.592	0.112	2.918	0.258	0.130	0.022	0.008	0.418	2.602	0.734
Poland	17.073	4.710	4.301	0.425	26.509	0.075	0.036	0.381	0.060	0.552	21.893	5.167
Portugal	4.371	0.927	1.772	0.080	7.150	0.464	0.163	0.047	0.009	0.684	5.926	1.908
Slovak Republic	2.455	0.609	0.570	0.059	3.692	0.077	0.020	0.034	0.006	0.136	3.160	0.669
Slovenia	0.770	0.248	0.279	0.030	1.327	0.153	0.018	0.029	0.005	0.204	1.189	0.342
Spain	14.725	7.386	6.850	0.620	29.581	3.544	0.985	0.319	0.109	4.958	26.640	7.899
Sweden	2.669	1.262	1.241	0.266	5.438	0.638	0.296	0.166	0.035	1.136	4.866	1.708
Switzerland	1.871	1.024	0.859	0.168	3.922	1.004	0.497	0.248	0.049	1.798	4.396	1.324
Turkey	30.034	4.096	4.698	0.145	38.973	0.782	0.265	0.203	0.040	1.291	35.178	5.086
United Kingdom	18.731	9.318	7.728	1.743	37.520	2.275	2.508	0.579	0.246	5.608	32.832	10.296
United States	81.270	52.355	26.362	8.736	168.723	20.882	11.049	4.311	1.385	37.627	165.556	40.794
Oecd total	404.550	174.646	142.123	25.478	746.797	53.793	26.687	11.657	3.308	95.445	659.676	182.566

Millions of individuals aged 25 and over. Source: United Nations database, and DIOC database (see Arslan et al., 2015)

TABLE 1.B2: Effect of migration stocks on the population structure

Country	Prop. of immigrants				Old-age dependency				Prop. of college			
Country	Obs	Tot	S-N	N-N	Obs	Tot	S-N	N-N	Obs	Tot	S-N	N-N
Australia	33.4	+33.4	+15.9	+11.5	25.1	-1.7	-2.8	+1.2	34.0	+1.3	+1.0	+0.1
Austria	17.2	+17.2	+8.7	+7.6	32.3	-4.4	-1.4	-2.7	18.5	-1.9	-1.0	-0.7
Belgium	10.9	+10.9	+4.8	+5.8	31.8	-1.8	-1.6	-0.2	30.8	-2.3	-0.6	-1.5
Canada	24.4	+24.4	+14.0	+8.1	25.3	+0.0	-1.9	+1.6	51.9	+2.3	+2.2	+0.1
Chile	2.3	+2.3	+2.0	+0.4	17.9	-0.1	-0.1	+0.1	24.4	-0.4	-0.1	-0.3
Czech Republic	4.3	+4.3	+2.2	+2.1	26.5	-1.9	-0.7	-1.1	16.7	-0.8	-0.1	-0.7
Denmark	10.1	+10.1	+4.9	+4.9	31.4	-3.3	-1.7	-1.5	31.7	-1.6	-0.6	-0.9
Estonia	22.4	+22.4	+21.7	+1.8	32.3	+5.1	+6.0	-0.5	38.8	+3.9	+3.6	+0.5
Finland	4.9	+4.9	+2.9	+2.1	31.7	-2.7	-0.9	-1.8	36.6	-0.6	-0.4	-0.2
France	14.2	+14.2	+8.7	+4.8	32.1	-0.2	-0.9	+0.7	29.8	-0.9	-0.1	-0.7
Germany	13.6	+13.6	+5.0	+7.9	38.1	-3.6	-1.7	-1.6	27.8	-1.8	+0.3	-1.9
Greece	8.1	+8.1	+6.1	+2.2	33.9	-5.8	-3.4	-2.3	26.1	-0.7	-0.5	-0.1
Hungary	4.9	+4.9	+3.7	+1.3	29.8	-1.3	-0.3	-1.1	21.6	-0.4	+0.3	-0.7
Iceland	11.6	+11.6	+3.6	+7.8	23.3	-0.6	-1.0	+0.3	33.1	-2.1	-0.3	-1.8
Ireland	13.8	+13.8	+3.8	+10.1	20.6	-9.7	-1.2	-8.2	33.4	-0.7	+0.6	-1.2
Israel	40.6	+40.6	+30.3	+7.0	22.1	+12.5	+7.5	+4.3	41.8	+3.5	+3.6	+0.0
Italy	8.3	+8.3	+6.3	+2.0	36.5	-4.9	-3.0	-1.8	16.5	-0.6	-0.2	-0.4
Japan	1.8	+1.8	+1.1	+0.7	42.8	-0.5	-0.6	+0.1	38.4	-0.4	-0.2	-0.2
Korea, Rep.	2.2	+2.2	+2.0	+0.3	18.8	-0.5	-0.4	-0.1	36.9	-0.8	-0.2	-0.6
Luxembourg	36.9	+36.9	+5.1	+27.9	24.8	-7.8	-1.8	-4.9	23.8	-0.3	+0.0	-0.2
Mexico	0.5	+0.5	+0.2	+0.3	13.1	+0.7	+0.0	+0.7	12.8	+0.7	+0.1	+0.6
Netherlands	13.3	+13.3	+8.3	+4.6	28.2	-3.2	-1.8	-1.3	31.8	-1.5	-0.5	-0.9
New Zealand	27.0	+27.0	+14.7	+11.3	25.1	+2.9	-2.0	+3.9	33.7	+2.6	+1.7	+0.9
Norway	12.5	+12.5	+6.0	+6.0	28.2	-4.4	-2.1	-2.1	35.0	-0.7	-0.5	-0.2
Poland	2.0	+2.0	+1.6	+0.6	23.6	+2.4	+1.6	+1.0	21.7	-1.1	+0.1	-1.2
Portugal	8.7	+8.7	+6.7	+2.8	32.2	+0.5	-1.7	+1.9	18.4	+2.0	+0.8	+1.2
Slovak Republic	3.6	+3.6	+0.6	+3.0	21.2	+0.9	+0.1	+0.8	19.9	-0.8	+0.1	-0.9
Slovenia	13.3	+13.3	+12.0	+1.7	28.8	-5.3	-2.5	-2.5	22.4	-2.1	-1.8	-0.4
Spain	14.4	+14.4	+9.5	+4.1	29.7	-4.6	-3.8	-0.6	31.4	-1.9	-2.1	+0.2
Sweden	17.3	+17.3	+8.1	+7.9	35.1	-2.4	-3.3	+1.0	32.0	-0.9	+0.0	-0.8
Switzerland	31.4	+31.4	+9.1	+18.2	30.1	-3.0	-1.0	-1.5	34.6	-0.3	-1.9	1.6
Turkey	3.2	+3.2	+2.3	+1.0	14.5	+0.6	+0.1	+0.5	12.4	+0.7	+0.2	+0.5
United Kingdom	13.0	+13.0	+7.9	+5.0	31.4	-2.9	-1.9	-1.0	36.0	+2.1	+1.7	+0.3
United States	18.2	+18.2	+9.3	+7.2	24.6	-1.6	-0.9	-0.6	38.3	-1.0	+0.6	-1.4
Oecd average	11.3	+11.3	+6.4	+4.7	27.7	-1.0	-1.0	0.0	30.5	+0.5	+0.5	+0.0

As percentage of deviation from the counterfactual. Source: authors' own calculations based on United Nations database, and DIOC database (see Arslan et al., 2015).

TABLE 1.B3: Effect of 2000-10 migration net flows on the population structure

Country	Prop. of immigrants				Old-age dependency				Prop. of college			
	Obs	Tot	S-N	N-N	Obs	Tot	S-N	N-N	Obs	Tot	S-N	N-N
Australia	33.4	+5.9	+5.0	+0.7	25.1	-2.6	-2.4	-0.2	34.0	+3.7	+2.0	+1.5
Austria	17.2	+2.8	+1.9	+0.8	32.3	-1.8	-1.0	-0.8	18.5	+0.0	-0.3	+0.3
Belgium	10.9	+2.1	+1.9	+0.1	31.8	-0.5	-0.8	+0.3	30.8	-1.1	-0.5	-0.6
Canada	24.4	+3.2	+3.7	-0.4	25.3	-1.2	-1.6	+0.4	51.9	+3.1	+2.3	+0.8
Chile	2.3	+1.2	+1.0	+0.2	17.9	-0.1	-0.2	+0.1	24.4	-0.3	-0.1	-0.2
Czech Republic	4.3	+2.1	+1.7	+0.4	26.5	-0.8	-0.6	-0.2	16.7	-0.1	-0.1	+0.0
Denmark	10.1	+2.6	+1.5	+1.1	31.4	-1.2	-0.7	-0.5	31.7	-0.6	-0.2	-0.4
Estonia	22.4	-2.0	-2.8	+0.8	32.3	+3.2	+2.2	+1.1	38.8	+2.8	+2.4	+0.5
Finland	4.9	+2.4	+1.5	+0.9	31.7	-1.4	-0.6	-0.7	36.6	-0.9	-0.2	-0.7
France	14.2	+1.1	+1.1	+0.1	32.1	-0.3	-0.5	+0.2	29.8	+0.4	+0.4	+0.0
Germany	13.6	+1.4	+0.2	+1.2	38.1	-0.6	-0.1	-0.4	27.8	-0.9	+0.0	-0.9
Greece	8.1	+2.5	+2.1	+0.3	33.9	-2.5	-1.1	-1.4	26.1	-1.0	-0.4	-0.6
Hungary	4.9	+1.4	+1.1	+0.2	29.8	-0.5	-0.5	+0.0	21.6	-0.1	+0.2	-0.3
Iceland	11.6	+5.8	+2.1	+3.7	23.3	-0.9	-0.7	-0.3	33.1	-1.5	-0.2	-1.3
Ireland	13.8	+4.0	+2.3	+1.5	20.6	-2.2	-0.6	-1.5	33.4	-2.8	+0.2	-3.0
Israel	40.6	+0.8	-0.6	+1.3	22.1	-1.2	-1.2	-0.1	41.8	-2.0	-1.8	-0.2
Italy	8.3	+4.4	+4.0	+0.3	36.5	-2.9	-2.3	-0.5	16.5	-0.6	-0.2	-0.4
Japan	1.8	+0.4	+0.5	+0.0	42.8	-0.2	-0.3	+0.1	38.4	-0.1	-0.1	+0.0
Korea, Rep.	2.2	+1.7	+1.5	+0.1	18.8	-0.2	-0.3	+0.1	36.9	-0.7	-0.2	-0.5
Luxembourg	36.9	+4.1	+1.7	+2.4	24.8	-0.6	-0.8	+0.2	23.8	+1.3	+0.4	+0.9
Mexico	0.5	+0.2	+0.0	+0.2	13.1	+0.7	+0.0	+0.7	12.8	+0.1	+0.1	+0.0
Netherlands	13.3	+1.9	+1.5	+0.4	28.2	-0.8	-0.6	-0.2	31.8	+0.0	+0.2	-0.2
New Zealand	27.0	+6.5	+4.9	+1.6	25.1	-0.9	-2.0	+1.0	33.7	+2.8	+2.8	+0.1
Norway	12.5	+5.2	+2.7	+2.4	28.2	-2.2	-1.1	-1.0	35.0	+0.2	+0.2	+0.0
Poland	2.0	-0.7	-0.6	-0.1	23.6	+1.6	+0.2	+1.4	21.7	-0.8	+0.1	-0.9
Portugal	8.7	+2.3	+1.7	+0.6	32.2	-1.0	-1.0	+0.0	18.4	-0.4	+0.1	-0.5
Slovak Republic	3.6	+0.5	+0.2	+0.4	21.2	+0.6	-0.1	+0.7	19.9	-0.7	+0.0	-0.8
Slovenia	13.3	+2.0	+1.9	+0.1	28.8	-1.2	-0.9	-0.3	22.4	-1.0	-0.5	-0.5
Spain	14.4	+9.4	+6.9	+2.1	29.7	-4.5	-3.3	-1.0	31.4	-1.9	-2.0	+0.1
Sweden	17.3	+3.5	+2.9	+0.6	35.1	-1.7	-1.7	-0.1	32.0	+0.4	+0.3	+0.1
Switzerland	31.4	+4.6	+0.4	+4.1	30.1	-1.9	-0.2	-1.6	34.6	+3.2	+0.7	+2.5
Turkey	3.2	+0.9	+0.7	+0.2	14.5	+0.2	-0.1	+0.3	12.4	+0.3	+0.1	+0.2
United Kingdom	13.0	+3.4	+2.2	+1.2	31.4	-1.5	-0.9	-0.5	36.0	+2.0	+1.5	+0.4
United States	18.2	+3.6	+2.2	+1.4	24.6	-1.3	-0.8	-0.4	38.3	+0.3	+0.6	-0.2
Oecd average	11.3	+2.6	+1.8	+0.8	27.7	-0.7	-0.7	+0.0	30.5	+0.3	+0.3	+0.0

Millions of individuals aged 25 and over. Source: authors' own calculations based on United Nations database, and DIOC database (see Arslan et al., 2015).

TABLE 1.B4: Fiscal policy in the OECD member states

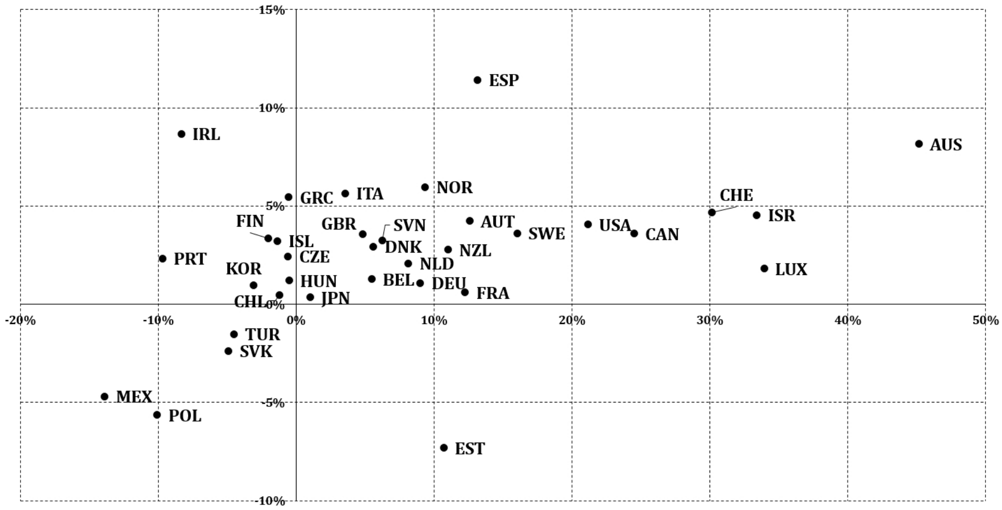
Country	Balanced	Revenues		Gov Exp						Others	Net contr.	
	budget	Income	VAT	Public	Educ	Health	Old age	Unemp	Family	Net	Young	Immig
Australia	34.5	18.8	14.1	16.5	7.6	3.5	4.4	0.5	1.6	1.2	+8.2	+0.3
Austria	50.6	32.5	17.2	23.2	5.7	2.0	12.9	1.4	2.7	-1.8	+14.7	+0.3
Belgium	50.3	32.6	14.4	24.9	6.2	2.6	8.3	2.5	2.4	-0.1	+14.6	+0.9
Canada	40.8	25.4	15.4	19.5	8.9	5.0	3.3	0.8	0.9	-2.4	+9.3	+0.5
Chile	23.3	13.3	9.8	11.2	5.1	2.2	2.4	0.3	1.0	-0.9	+6.4	-1.2
Czech Republic	40.8	26.7	14.0	22.3	4.8	2.5	7.7	0.4	1.6	-1.4	+10.1	+0.1
Denmark	55.7	34.5	19.6	22.4	8.0	5.4	7.7	3.7	5.4	-1.5	+9.6	+0.9
Estonia	40.6	23.7	16.7	19.2	6.8	2.5	8.0	1.5	2.1	-0.3	+14.4	-0.7
Finland	53.5	36.2	17.0	22.8	6.6	4.7	10.8	2.5	3.4	-2.4	+15.4	+0.2
France	53.1	32.9	17.7	23.0	6.0	2.8	13.2	1.9	2.5	-1.2	+13.8	+1.1
Germany	45.1	30.7	12.8	20.4	4.3	2.9	9.8	2.8	1.7	-1.6	+7.4	-1.9
Greece	46.6	26.3	17.2	24.4	3.9	1.7	13.1	1.0	1.0	1.6	+14.4	+0.5
Hungary	47.5	25.1	22.2	24.0	5.6	3.9	7.5	0.8	2.7	-2.8	+14.1	-1.5
Iceland	44.1	25.9	18.0	24.6	8.3	2.8	2.1	1.7	2.7	-1.7	+10.9	-0.8
Ireland	49.9	28.3	18.8	26.9	6.0	3.6	4.3	3.5	2.8	0.0	+10.4	-0.2
Israel	39.3	19.2	18.9	20.2	7.3	3.3	5.4	0.3	1.7	0.1	+9.0	+1.2
Italy	47.7	30.6	16.3	22.8	4.5	1.8	13.7	0.9	1.0	-2.2	+11.5	+0.6
Japan	36.6	24.7	10.7	15.8	3.6	0.9	11.3	0.4	1.7	-1.7	+9.1	+3.1
Korea, Rep.	31.5	17.4	13.7	23.0	4.7	1.7	1.1	0.3	0.3	0.0	+5.9	-3.8
Luxembourg	43.7	28.7	13.8	20.0	5.2	2.1	10.5	1.2	3.8	0.3	+17.5	-0.1
Mexico	23.3	13.3	9.8	11.2	5.1	2.5	1.7	0.1	1.1	-1.4	+6.1	-0.0
Netherlands	45.7	30.4	14.2	22.6	5.9	5.1	6.4	1.8	1.3	-1.5	+9.3	+0.3
New Zealand	44.0	24.0	18.0	21.1	9.6	5.3	4.5	0.6	2.2	1.3	+5.0	+0.8
Norway	50.5	36.1	14.3	26.8	5.9	6.5	5.6	0.5	3.5	-1.6	+8.0	+0.1
Poland	42.1	23.4	17.9	19.6	5.7	2.9	9.7	0.9	1.3	-1.2	+13.0	-0.9
Portugal	46.2	23.5	18.2	21.1	6.5	1.5	11.4	1.4	1.4	1.6	+13.3	+0.7
Slovak Republic	38.3	24.3	13.7	21.6	4.5	2.0	6.6	0.2	1.6	-1.5	+12.3	-1.5
Slovenia	46.4	28.7	17.4	21.2	6.6	2.7	9.8	0.9	2.4	-2.5	+13.5	-0.9
Spain	40.9	27.3	13.1	19.0	4.9	2.5	7.6	3.2	0.8	-2.4	+10.2	+4.3
Sweden	52.0	26.1	25.8	23.6	7.0	4.6	11.3	1.5	2.4	-1.5	+10.7	+1.8
Switzerland	33.1	25.2	7.8	14.3	3.7	3.5	7.6	1.6	0.6	-1.7	+9.1	+5.0
Turkey	38.8	21.5	16.9	19.6	3.4	5.5	8.7	0.1	0.0	-1.1	+13.6	-0.1
United Kingdom	43.8	27.7	15.1	19.0	6.9	2.9	8.4	0.4	2.4	-2.8	+8.4	+0.6
United States	30.6	20.4	8.9	14.6	6.7	3.8	4.2	0.6	0.3	0.9	+6.3	-0.1
Oecd (average)	42.7	26.0	15.6	20.7	5.2	3.2	7.7	1.2	1.9	-1.7	+10.8	+0.3

As percentage of GDP. Sources: OECD database (https://data.oecd.org/), SOCX database (http://www.oecd.org/social/expenditure.htm), and the EU-SILC micro database from Eurostat.

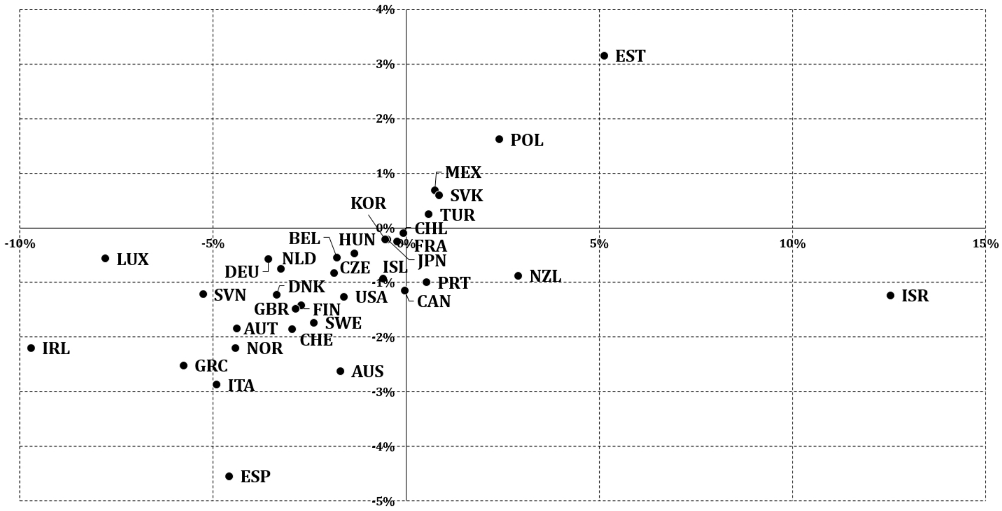
TABLE 1.B5: Macroeconomic data and calbrated, country-specific parameters

Country	Macroeconomic data			Calibrated parameters			
	GDP in bln USD	w_c^S/w_c^U	w_c^H/w_c^h	f_c	A_c	θ_c^S	θ_c^M
Australia	1,141.3	1.490	0.820	1.245	194.854	0.506	0.460
Austria	389.7	1.772	1.077	1.866	171.183	0.432	0.536
Belgium	484.4	1.341	1.011	2.445	193.498	0.458	0.525
Canada	1,614.1	1.564	0.844	1.394	194.658	0.622	0.475
Chile	217.5	1.663	1.008	2.077	38.850	0.465	0.547
Czech Republic	207.0	2.682	1.018	2.168	74.411	0.517	0.540
Denmark	319.8	1.261	1.369	1.335	181.219	0.450	0.601
Estonia	19.5	1.452	0.940	2.572	75.615	0.528	0.505
Finland	247.8	1.267	1.014	1.787	207.523	0.481	0.536
France	2,646.8	1.537	1.265	1.895	153.510	0.485	0.580
Germany	3,412.0	1.553	1.251	2.079	98.048	0.475	0.575
Greece	299.6	1.717	0.953	2.652	206.707	0.486	0.513
Hungary	129.6	2.188	1.013	3.561	50.789	0.511	0.542
Iceland	13.3	1.579	1.279	1.377	224.933	0.514	0.583
Ireland	218.4	1.458	0.740	1.974	174.016	0.498	0.448
Israel	232.9	1.782	0.963	1.727	169.714	0.596	0.498
Italy	2,126.6	1.632	0.963	2.715	132.759	0.392	0.517
Japan	5,495.4	1.850	0.988	2.024	127.414	0.586	0.542
Korea, Rep.	1,094.4	1.862	0.939	1.965	62.854	0.578	0.529
Luxembourg	52.1	1.907	1.000	2.161	387.165	0.495	0.506
Mexico	1,052.6	1.663	0.784	2.377	33.849	0.357	0.512
Netherlands	836.4	1.647	0.971	1.907	159.902	0.516	0.513
New Zealand	143.5	1.360	0.820	1.410	161.826	0.483	0.465
Norway	420.9	1.353	1.132	1.000	219.571	0.487	0.552
Poland	476.7	2.656	1.001	2.263	42.976	0.560	0.568
Portugal	238.3	2.162	0.903	2.766	164.446	0.481	0.502
Slovak Republic	89.0	2.273	0.954	3.049	79.086	0.506	0.532
Slovenia	47.9	2.283	1.044	2.500	133.041	0.529	0.531
Spain	1,431.6	1.509	0.937	3.440	140.344	0.491	0.502
Sweden	488.4	1.327	1.197	1.562	173.074	0.463	0.562
Switzerland	581.2	2.040	1.014	1.997	284.582	0.586	0.511
Turkey	731.2	2.159	0.861	3.235	55.338	0.415	0.508
United Kingdom	2,407.0	1.884	1.030	1.650	143.951	0.575	0.534
United States	14,964.4	2.272	1.272	1.359	151.314	0.635	0.577

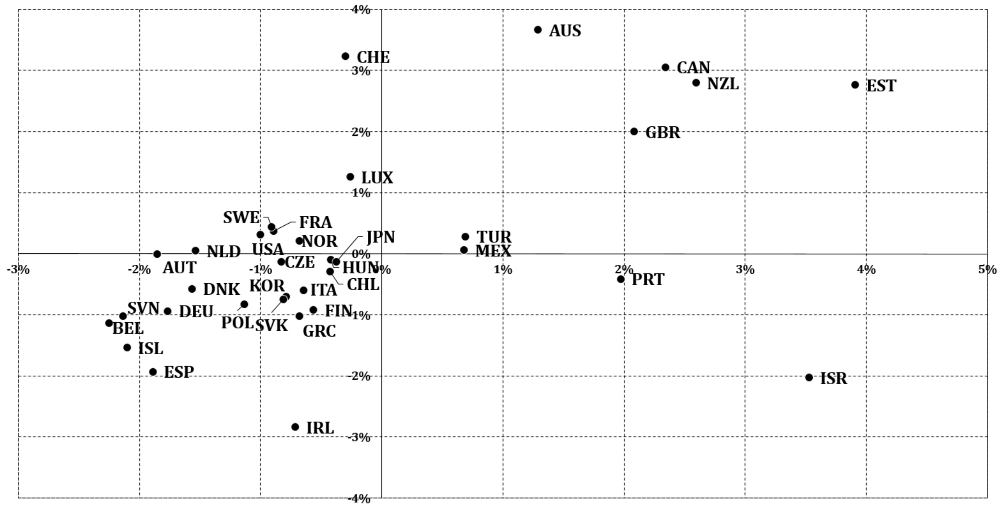
Sources: GDP data for the year 2010 in column 1 are taken from the World Bank. Data on the wage ratio between college graduates and the less educated (w_c^S/w_c^U) are obtained from Hendricks (2004). Data on the wage ratio between natives and immigrants ($w_c^H/w_c^h = w_c^L/w_c^l$) are obtained from Büchel and Frick (2005), completed by Docquier et al. (2014). Data on fixed costs of entry are computed using the Doing Business Indicator from the World Bank. Total factor productivity (A_c), and relative productivity parameters (θ_c^S and θ_c^M) are calibrated to match total GDP levels and the wage ratios



(A) Effect on population size



(B) Effect on the dependency ratio



(C) Effect on the proportion of college graduates in the labor force

FIGURE 1.B2: Socio-demographic impact of 2010 migration stocks (X-axis) and 2000-10 migration flows (Y-Axis) as percentage of deviation from the no-migration counterfactual.

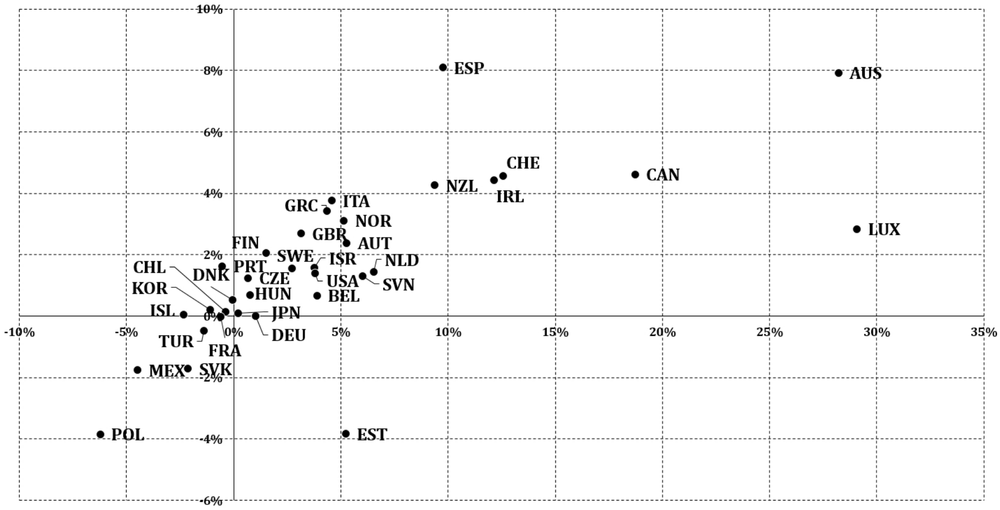


FIGURE 1.B3: Average welfare impact of 2010 migration stocks (X-axis) vs 2000-10 migration flows (Y-Axis) as percentage of deviation from the no-migration counterfactual.

Chapter 2

Trading Goods or Human Capital: The Gains and Losses from Economic Integration

Abstract[1]

The chapter quantifies the economic consequences of liberalizing migration in the OECD and compares them to a hypothetical liberalization of trade across the OECD. Firstly, I investigate the bilateral migration and trade agreements between the EU and Australia, Canada, the US, Turkey, and Japan, which are of major importance in the current political debate. Secondly, I show that the overall impact of reducing all legal restrictions on migration in the OECD is moderate (1.6 percent in real GDP), whereas the gains from zeroing tariff and non-tariff barriers to trade among all the OECD economies are slightly lower (1.1 percent in real GDP). Less restrictive trade leads to a reduction in inequalities among countries, while free migration is beneficial for only a couple of rich economies, and increases the disparities among the OECD members. In addition to theoretical findings, the numerical results allow to examine the relations between trade and migration. Their direction (either substitutability or complementarity) depends on the type of shock imposed in the system.

Keywords: migration, international trade, computational general equilibrium, liberalization.

JEL: C68, F22, J24.

2.1 Introduction

The members of the OECD constitute one of the world's most integrated economic systems. Despite this fact, reducing the legal barriers for goods' and population mobility, at the regional and global levels, is currently a negotiated issue within political and economic forums. Both decision-makers and scientists discuss intensively the possibility of implementing policies that would deepen the consolidation of the OECD economic area in terms of labor movement and international trade. This chapter provides quantitative arguments for this debate. I investigate

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the economic consequences of a hypothetical partial and full economic integration among the OECD countries, understood as removing the formal visa barriers for international migration, and tariff and non-tariff restrictions for international trade.

Until recently, many political and economic actions have already been undertaken to facilitate the international flows of goods. As early as in 1960, the European Free Trade Agreement was established by the western-European nations. This path-breaking treaty encouraged other authorities to develop local trade agreements and to strengthen the regional integration of economies. On the contrary, multi-country free migration unions are rather rare (apart from the EU states or the bilateral Australia - New Zealand treaty), indicating that the liberalization of migration is not a commonly preferred policy. Today, during the ongoing discussions about the liberalizing of trade, capital flows (and, possibly in the future, migration) between the European Union and other major partners (the United States, Canada, Japan or Turkey) the question of gains from abandoning the legal trade (and migration) barriers is being re-investigated. In fact, in 2014 the EU concluded the dialog on a vital agreement with Canada which removes tariff and non-tariff barriers to trade for more than 99 percent of products. Simultaneously, intensive bilateral negotiations with the US, Japan and Turkey give rise to the expectation that consecutive treaties would be signed in the future.[2] Turkey is the only non-EU country which is involved in bilateral discussions concerning the elimination of visa barriers.[3] The academic literature on the evaluation of the proposed trade and migration policies is limited, which suggests that the arguments for or against entering into particular partnerships are more political rather than economic. This chapter tries to fill this research gap by providing an assessment of economic consequences of international agreements, using a multi-country model of migration and trade.

The research questions addressed in this chapter oscillate around analyzing the economic effects of liberalizing migration and trade. In particular, the main goal is a quantitative assessment of a hypothetical reduction of formal visa restrictions across the OECD, relative to the potential gains from removing (non-)tariff barriers among the OECD countries. According to the current political strategy of the EU, I shall consider the scenarios of regional migration and trade agreements between the EU and five potential partners (Australia, Canada, Japan, Turkey and the US). Several simulations are run, in order to assess the economic implications for the natives living in Europe and in the partner countries. The results of these exercises show that preferential trade agreements have a moderate impact on the macroeconomic performance of the European economies. Furthermore, they are mutually beneficial for both partners. By contrast, a liberalization of migration barriers induces more visible effects, which are positive for destinations (namely: Australia, Canada and the US) and harmful for sending countries (that is Turkey and, to a lesser extent, Japan). The gains from migration are exclusive, which implies that in some cases the natives in the EU may lose significantly.

Another scenario assumes the elimination of visas and (non-)tariff barriers among all the OECD economies. Interestingly, the results demonstrate that the first policy produces substantially positive consequences for only a few states,[4] whereas a full liberalization of trade is advantageous for all the OECD members. However, at the aggregate, migration liberalization has once again stronger effects than the intra-OECD free trade agreement. Assuming the benchmark parametrization, the former scenario brings an overall gain of 1.6 percent in terms of the real GDP of the OECD, whereas the latter increases real GDP by 1.1 percent. The main conclusion

[2] Details on the currently negotiated agreements between the EU and all the partners mentioned in this chapter may be found on the European Commission's web page.

[3] The document called "Roadmap towards a visa-free regime with Turkey" is published on the EC website.

[4] The gains in real wages above 1 percent are obtained for: New Zealand, Australia, Canada, Switzerland and the US.

from these exercises may be summarized as follows. The removal of legal barriers to migration and trade among the OECD countries has roughly similar aggregated economic effects, but has various distributive consequences for the particular states. What is more, a shock imposed on one phenomenon causes an endogenous reaction of the other.

This study differs from the previous ones in several aspects. In order to quantify and compare the effects of hypothetical liberalization policies, a general equilibrium model is proposed. I assume endogenous migration and trade among 34 OECD countries and the Rest of the World, heterogeneous labor (low/high-skilled and domestic/foreign workers) and homogeneous firms within a given country. In the simulations, the wages, prices, trade and migration flows, and the masses of varieties of goods are endogenized. I base on the approach towards modeling international trade, inspired by Di Giovanni et al. (2015) and developed in Aubry et al. (2014). Global flows of migrants are described using a random utility model in the spirit of McFadden (1984), which was implemented for a global economy by Docquier et al. (2015). The proposed framework enables to conduct analysis of various liberalization policies concerning both international trade and migration. The novelty of this approach consists in the possibility of comparing the relative magnitudes of both phenomena in a unified, multi-country, general equilibrium framework. Secondly, I use alternative calibration strategies to the ones presented in Di Giovanni et al. (2015) (concerning international trade module) and Docquier et al. (2015) (when it comes to modeling international migration). Finally, I take advantage of the possibility to model trade and migration simultaneously, and I contribute to the literature on relations between migration and trade (see Felbermayr et al., 2012). The nexus between flows of goods and flows of people is investigated in a general equilibrium context, making use of analytical and numerical methods. The results show that substitutability or complementarity between the two phenomena depends on the type of shock introduced in the system (either to bilateral migration or trade costs).

The remainder of the chapter is organized as follows. Section 2.2 reviews the related literature. In Section 2.3 the theoretical model is introduced. Section 2.4 discusses the data, and the calibration procedure. The results of simulations are delivered in Section 2.5. Section 2.6 summarizes some robustness checks, and Section 2.7 concludes.

2.2 Related literature

The literature on the consequences of liberalizing migration is fairly scarce. There are some extremely optimistic estimates of gains (at the world level) from global reduction in barriers to labor mobility, which range from over 40 percent to even 150 percent in terms of welfare (Clemens, 2011, Hamilton and Whalley, 1984, Iregui, 2003, Klein and Ventura, 2007, 2009, Moses and Letnes, 2004). However, the recent evidence by Docquier et al. (2015) gives rise to a conjecture that these huge benefits are only illusory, since the existence of bilateral, private (non-visa) migration costs diminishes the overall gains up to 7-18 percent at most. According to their approach, the liberalization of migration means reducing the legal (visa) barriers for labor mobility. Using a dynamic model, with endogenous fertility and education, Delogu et al. (2014) find that in the short run the effects of global liberalization of labor movements may bring up to 20 percent in GDP per capita. The long term impact of free migration is substantially greater, and amounts at 50 percent of GDP per worker in the next 50 years. Di Giovanni et al. (2015) construct a multi-country model with exogenous migration and endogenous trade, including remittances. They find that the realized levels of migration are beneficial for both receiving as well as sending countries (the welfare impacts are up to 5 to 10 percent).

Plenty of theoretical and empirical studies quantify the macroeconomic consequences of liberalizing trade in the global context. Estimates range from practically no positive effects to benefits of a magnitude of several percentage points (Anderson and Yotov, 2011, Francois et al., 2005). Some developments of the New Trade Theory magnify these results.[5] Eaton and Kortum (2002) and Caliendo and Parro (2014) depart from the monopolistically competitive framework by proposing a Ricardian model with which they evaluate the counterfactual scenarios of eliminating geographical and tariff barriers to trade. In the literature, there is a consensus that bilateral trade tariffs constitute a small fraction of contemporary trade barriers. The majority is due to the non-tariff restrictions. For instance, Anderson and Neary (2003, 2005) and Looi Kee et al. (2009) quantify tariff and non-tariff barriers for international trade and compute the potential gains from removing both types of restrictions.

In recent years, we observe an intensification of the debate concerning the liberalization of both trade and migration between the United States and the European Union. The potential gains from reducing all trade barriers between these two partners were calculated by the CEPR for the European Commission.[6] A report published by Francois et al. (2013b) states that the benefits from the Transatlantic Trade and Investment Partnership (TTIP) for the EU are estimated at the level of 150 billion dollars (each year), whereas the US would get about 130 billion dollars.[7] The increase in GDP in the rest of the world's countries may reach almost 130 billion dollars. The authors conclude that EU exports to the US would rise by 28 percent, which translates into a 6 percent increase in total EU exports. A report by Ecorys for the European Commission (Francois et al., 2013a) finds that the elimination of all (tariff and non-tariff) barriers between the two parties would bring growth 0.7 percent for the EU and 0.3 percent for the US in terms of GDP in five years. When it comes to individual incomes, the changes are similar to the previous results: 0.8 percent for the EU and 0.3 percent in terms of lifetime earnings. Trade is also expected to increase. Exports from the EU would rise by 2.1 percent, while exports from the US would go up by 6.1 percent. Additionally, the report elaborates on the effects of TTIP for different sectors of both economies. The recent paper by Aichele et al. (2014) estimates the economic consequences of imposing the TTIP in a Ricardian model grounding on Eaton and Kortum (2002). By considering various scenarios of deep and shallow integration, the authors investigate the general equilibrium implications of reducing both tariff and non-tariff barriers to trade. In a multi-country and multi-industry model, they find that the long-run changes in per capita income range between 2.1 percent to 2.7 percent for the EU and the US respectively. On top of that, signing the transatlantic trade partnership would bring positive consequences for the rest of the world, at the level of 1.3 percent. Unfortunately, there is a lack of similar quantitative arguments for the discussion concerning liberalization policies between the EU and other partners considered in this chapter. Moreover, no estimates are available for the potential consequences of liberalizing migration between the EU and the US.

2.3 The model

Consider a multi-country version of the model developed by Krugman (1980).[8] I set up a system of N, one-sector economies in which skill-heterogeneous labor is the only input for production.

[5] The literature proposed a wide range of trade externalities, such as: firm heterogeneity, endogenous markups, TFP externatities, (Arkolakis et al., 2012, Costinot and Rodríguez-Clare, 2013, Feenstra, 2010, Markusen, 2013, Melitz, 2003, Melitz and Ottaviano, 2008, Melitz and Redding, 2014, 2015, Melitz and Trefler, 2012)

[6] For more information, see the memo by EC: *http://europa.eu/rapid/press-release_MEMO-13-211_en.htm*

[7] Expressed as the changes in nominal GDP, these gains equal 1 percent for the EU and 0.8 percent for the US.

[8] The equations of the model and the definition of competitive equilibrium are outlined in Appendix 2.B.

An individual consumes a basket of horizontally differentiated goods, each of which is produced by a single manufacturer. In every country a continuum of homogeneous firms operates on a monopolistically competitive market. The general equilibrium in the system of N economies comprises an equalization of labor demand and supply, setting the mass of entrepreneurs and clearing the goods market which makes the trade flows balanced in every country.[9]

A similar model is proposed by Di Giovanni et al. (2015), who assume two-sector economies (traded and non-traded goods), heterogeneous firms and a differentiation between the short-run and long-run impact of (exogenous) migration shocks. The authors also include the flows of remittances.[10] A simplified version of the model developed in this chapter is presented in Aubry et al. (2014). In contrast to what is analyzed in Di Giovanni et al. (2015) and Aubry et al. (2014), I concentrate here on endogenous flows of both migration and trade, triggered by the liberalizations of legal (reducible) barriers to migration and trade. These two papers quantify the welfare impact of actual migration flows, disregarding individuals' endogenous decisions about migration. In the proposed approach, the key assumption is that individuals can freely choose their place of living, by comparing real wages and bilateral migration costs across countries, as in Docquier et al. (2015). In contrast to Docquier et al. (2015), I take into account endogenous trade flows in a general equilibrium framework, whereas these authors construct a partial equilibrium model without trade. Therefore, considering this approach, a shock to any bilateral, legal migration barrier or any bilateral tariff or non-tariff barrier to trade, induces cross-country labor reallocation, in the sense that some agents respond to it via migration. Finally, the relations between migration and trade after imposing exogenous shocks in the global economy are investigated.

2.3.1 Preferences and demand

An agent, who is characterized by either low or high education level (labeled by superscripts $s \in \{l, h\}$ for non-college or college-education respectively), born in country j, and living in country i, strives to maximize her nested utility function, given by:

$$U_{ij}^{s} = \ln\left[\left(1 - c_{ij}^{s}\right) u_{i}^{s}\right] + \xi_{ij}^{s}, \tag{2.1}$$

where c_{ij}^{s} describes the skill-specific, effort to migrate from country j to country i. Following Docquier et al. (2015), all those country-pair-specific values are decomposed into the cost of obtaining a visa (a legal barrier) and other private costs. The additive term ξ_{ij} is an individual-specific and country-pair-specific stochastic variable, which stands for the subjective taste for emigrating from country j to i. Furthermore, the inner utility function, u_{i}^{s}, represents the gain from consuming a bundle of goods by a resident in country i. Assume that the agent's preferences towards different consumption goods are homothetic, and are mapped by a CES utility

[9] Having in mind the conclusions from Costinot and Rodríguez-Clare (2013) and Melitz and Redding (2015), I nevertheless decided to consider a relatively simple approach towards modeling international trade due to several arguments. Firstly, I propose a framework that is certainly characterized by a unique general equilibrium. Adding endogenous migration to a model with TFP externalities to trade may lead to multiple equilibria. Then, I would like to calibrate the model imposing the minimal number of parameter values. With many sectors and a distribution of firms' TFP, one would need another set of cross-demand elasticities and distribution parameters which are not well identified for all the countries of interest. Finally, using this approach, one is able to draw simple analytical solutions concerning the relations between trade and migration.

[10] Since in this model I deal only with developed countries, and the migration shock is an intra-OECD one (so that the North-North migration is predominantly affected) the flows of remittances are of less importance in comparison to the sample used by Di Giovanni et al. (2015).

function defined over a set of continuum varieties available in the destination country.[11] Therefore, consumers of type s in country i maximize the explicit inner utility function:

$$u_i^s = \left[\sum_{n=1}^{N} \int_0^{B_n} x_{in}^s(k)^{\frac{\epsilon-1}{\epsilon}} dk \right]^{\frac{\epsilon}{\epsilon-1}}, \tag{2.2}$$

where $x_{in}^s(k)$ stands for the amount of variety k produced in country n, exported to country i, and then consumed by an individual, who belongs to group s. B_n is the measure of the set of varieties manufactured in country n, and ϵ represents the elasticity of substitution between any two varieties.

Solving for the individual's indirect utility function, and plugging it into (2.1), one obtains that the optimal utility depends on the real wage net of bilateral migration cost. This value measures the welfare of a particular type of worker living in country i:[12]

$$U_{ij}^s = \begin{cases} \ln\left[\frac{w_i^s}{P_i}\right] + \xi_{ii}, & \text{if} \quad j = i, \\ \ln\left[\left(1 - c_{ij}^s\right)\frac{w_{-i}^s}{P_i}\right] + \xi_{ij}, & \text{if} \quad j \neq i. \end{cases} \tag{2.3}$$

The aggregate variable: P_i is a country-specific measure of a cost of consumption baskets optimally chosen by all individuals living in country i. Thus, it may be interpreted as an indicator of prices in i, or simply a price index.

2.3.2 Production and firms

In each economy i there is a continuum of homogeneous firms that choose to produce different varieties of the consumption good (indexed by $k \in [0, B_i]$). Consider a monopolistically competitive framework under the assumption of a single input required for production (which is heterogeneous labor). Low/high-skilled and natives/migrants are imperfect substitutes, which leads to a nested CES production function (for further details see Appendix 2.B). Firms decide about the demand for different types of workers by solving a cost minimization problem, and select the optimal input of low or high-skilled, native or foreign labor, taking the equilibrium

[11] A CES utility function over differentiated consumption goods is general enough to capture the love for variety, through an imperfect substitution of goods. Since the elasticity of substitution between all goods is identical across all the pairs of countries (unconditionally on the origin of a particular variety), one can relate ϵ to the elasticity of trade value with respect to the trade cost τ_{ij}, see eq. 2.4. Although this parameter is aggregated across all goods, the literature provides its precise measure, which, indirectly, allows to draw conclusions about the value of ϵ. The same type comment (related to the empirical quantification of the parameters that represent elasticities) relates to the definitions of production function and efficient labor supply.

[12] This measure of welfare of natives and migrants considers not only the gains due to changes in nominal remunerations and the price effects of migration, but also the updating of idiosyncratic values of ξ_{ij}. Therefore, a full measure of welfare change (not only due to quantifiable economic determinants, represented by real wages, but also to unobservable components - that is the fact that one has an opportunity to live in a country j which she prefers more than her homeland: $\xi_{ij} > \xi_{ii}$) would be equal to conditional expected utility from living in country i. Following De Palma and Kilani (2007), who prove a stronger property of equalization of conditional distributions across choices, this variable is equal to: $E(U_i^s) = \ln \sum_{k=1}^{N} \exp U_{ik}^s$. In this chapter, I concentrate only on the economic effects of migration, disregarding the potential gains from this ''better match'' between people's preferences towards destinations and countries. Therefore, from now on, the term ''welfare gains'' refers to the gains in real wages only.

wages as given.[13] After maximizing operational profits, exploiting the information on the consumers demand, they decide on the level of prices, and set them equal to a constant margin plus the marginal cost of production.

Countries are characterized by entry barriers for the entrepreneurs. In order to run their production, each firm has to spend a certain amount on (human) resources paid out exclusively for non-production purposes. Since the entry is free, in the equilibrium, the operational profits are equal to the value of the fixed cost. After aggregating across all firms in country i, one obtains the following expression: $B_i = \bar{L}_i^T / \epsilon f_i$, where $\bar{L}_i^T$ stands for the supply of efficient labor in country i (which is a nested CES composite of all types of workers employed for both production purposes and to cover the entry cost) and f_i is the fixed cost of entry expressed as a number of efficient labor units.

In the equilibrium, the consumption good market clears and trade is balanced in each country. Individuals are not allowed to save and all the firms earn zero profits, so that the total wage bill equals the value added (GDP) $X_i = W_i \bar{L}_i^T$. Considering the balanced trade condition, one arrives at a well known formulation of the gravity equation:

$$\frac{X_{ij}}{X_j} = \frac{X_i \left(P_i/\tau_{ij}\right)^{\epsilon-1}}{\sum_{n=1}^{N} X_n \left(P_n/\tau_{nj}\right)^{\epsilon-1}}, \tag{2.4}$$

which imposes that the ratio of exports from country j to i to the GDP level in country j is a function of country i's size, its price level and the bilateral costs of trade τ_{ij}. Finally, the labor market clears, which is equivalent to determining the equilibrium wages for each labor type: (w_i^l, w_i^h, w_{-i}^l, w_{-i}^h respectively).[14]

2.3.3 Endogenizing migration decisions

Let us now define the process of endogenous cross-country labor flows as a consequence of individual reactions to economic incentives. The decision concerning the choice of the country of residence is reached by comparing the real wage levels net of migration costs (see eq. 2.3). In particular, as in the previous analysis, the utility is a sum of a deterministic and a random component. The first term is equivalent to the value of indirect utility (derived in the previous section) net of migration cost. As such, the bilateral cost of migration is expressed as a share of real income which is lost due to moving expenditures or legal restrictions. Notice that $\forall i, s\ c_{ii}^s = 0$. Explicitly, I assume that each person is perfectly informed about the quality of life in all of the analyzed countries and the effort attributed to potential emigration.

The last term in the utility function (2.3), that is the random component: ξ_{ij}, models individual tastes towards emigration that are different across individuals. Assume that ξ_{ij} is drawn from a Type I Extreme Value Distribution (EVD) with a zero location parameter (mode) and scale

[13] The wages are determined in such a way that variable unit cost of production equals the marginal cost. Marginal costs are identical across firms in a given country i: $c_i(k) = c_i = W_i/A_i$, taking A_i as a country-specific, exogenous TFP level. As a robustness check, the TFP factor is assumed to be modeled as a Lucas externality (Lucas, 1988) - dependent on the share of high-skilled workers in population.

[14] The model does not assume unemployment among native and foreign workers. This simplification is motivated by the fact that, with constant share of people who search for jobs in all groups, the probability of being employed would be incorporated in the wage rate. Since there are mixed evidence about the actual unemployment rates in different groups of immigrants - generally higher (lower) in the group of low-(high-)skilled workers - I decided to reduce the scope of this chapter by not explicitly considering labor market frictions.

parameter set to $1/\mu$.[15] Thus, an individual faces a problem of choosing a destination country, taking into consideration the objective welfare measures (real wages less migration costs) and subjective propensity towards living in a particular state (stochastic, individual-specific term). This problem boils down to a discrete choice program analyzed by McFadden (1984). Applying the McFadden's theorem, the probability that a person of skill s, who is born in country j, migrates to country i is equal to:

$$\pi_{ij}^s = \Pr[U_{ij}^s = \max_{n \in N} \left(U_{nj}^s\right)] = \frac{\exp\left(U_{ij}^s\right)}{\sum_{n=1}^N \exp\left(U_{nj}^s\right)}. \tag{2.5}$$

Concentrating on the aggregated, equilibrium stocks of migrants, let M_{ij}^l (M_{ij}^h) denote the number of low-skilled (high-skilled respectively) people born in country j, who emigrated and live in country i. In the same manner, the number of natives who actually live in their country of birth, j, is expressed by: M_{jj}^s for $s \in \{l, h\}$. Using the above-derived probabilities to migrate and the exact form of the logarithmic utility function, one can calculate the ratio of emigrants from j to i to stayers in j:

$$\frac{M_{ij}^s}{M_{jj}^s} = \left(\frac{w_{-i}^s/P_i}{w_j^s/P_j}\left(1 - c_{ij}^s\right)\right)^\mu. \tag{2.6}$$

The higher the real wage ratio between the destination i and the source j, the larger the actual share of migrants from j to i. These figures are dependent not only on the bilateral (nominal) wages, but also on the price indexes in both countries.[16] Using the data on bilateral migration and the country-specific endogenous nominal wages and price indexes, one can solve eq. (2.6) for c_{ij}^s. It is possible to identify fully the matrix of bilateral (skill-specific) migration costs for a given scale parameter μ (which represents in fact the elasticity of the ratio of migrants with respect to the net real wage ratio). Further decompositions of migration costs and the choice of the actual value of μ will be investigated in the following section.

2.4 Modeling strategy

In this section, I discuss the calibration of the model. First, I shall present a short summary of parametrization, followed by the calibration algorithm. Then, I will describe the identification of migration and trade liberalization policies.

2.4.1 Data and values of parameters

The model is calibrated to represent the state of the world economy in the year 2010. This choice is dictated by the availability of international migration data. The comprehensive dataset describing global, skill-specific, cross-country stocks of workers is provided by Artuc et al. (2015). Since it dates back to 2000, I have decided to restrict the sample of destination countries to the OECD economies, and use the 2010 DIOC database published by the OECD. However,

[15] It can be proved that standardizing the distribution of the stochastic term $\tilde{\xi}_{ij}$ to unit scale parameter is equivalent to considering a modified utility function with parameter μ: $V_{ij}^s = \mu \ln\left[\left(1 - c_{ij}^s\right) u_{ij}^s\right] + \tilde{\xi}_{ij}^s$. The EVD is chosen in order to ensure that the maximum of random variables ξ_{ij} has also an EVD.

[16] This means that the country's location in the global international trade network plays an important role in determining migration. It is a consequence of the fact that, according to eq. (2.B6), P_i is a function of the bilateral trade costs between country i and all of the countries that export to i.

the DIOC dataset does not provide a full migration matrix of all the OECD countries (it partially lacks data on immigration to Austria, Chile, Israel, South Korea and Turkey). Therefore, I have filled in those missing observations using the number of migrants from the UN migration dataset by Department of Economic and Social Affairs, and the skill structure from Artuc et al. (2015).

Three types of exogenously given parameters can be distinguished in the proposed model: (1) the common; (2) the country-specific; (3) and the country-pair-specific values. The first group of parameters is identical for all the countries in the analyzed system. The values are taken from the literature and are rather consensual, as described below.

The elasticity of substitution between varieties of goods, ϵ, is estimated by Feenstra (1994) in the range of 3 to 8, and by Broda and Weinstein (2006). In the theoretical framework at work, this parameter determines the elasticity of trade with respect to trade barriers (see equation 2.4), which, as in the model by Krugman (1980), equals $1 - \epsilon$. According to the recent findings by Simonovska and Waugh (2014), a drop in bilateral trade barriers by 1 percent increases the trade flows on average by 2.79 to 4.46 percent. This implies that $\epsilon \in [3.79; 5.46]$. Considering all these estimates, in the benchmark parametrization I assume that $\epsilon = 4$. However, two robustness checks are run, taking $\epsilon = 2$ and $\epsilon = 6$. For the elasticities of substitution between different types of labor (either σ_S - between low-skilled and high-skilled or σ_N - between natives and immigrants, the definition of production function is available in Appendix 2.B) I take the values reported by Ottaviano and Peri (2012) and assumed by Docquier et al. (2014), that is: $\sigma_S = 1.75$ and $\sigma_N = 20$. In order to see the importance of these parameters for the final results, I also consider: $\sigma_S = 0.9$ and $\sigma_S = 2.6$, as well as $\sigma_N = 10$ and $\sigma_N = 30$.[17] The parameter describing the sensitivity of migration flows to the ratio of real income, μ, is assumed to be equal to 1 in the reference scenario. As a robustness check I take $\mu = 0.7$ (in line with some of my estimations, and identical to the value obtained by Bertoli et al. (2013)), which makes individuals less responsive to exogenous shocks. Similarly, I verify what the results would be, if μ was equal to 1.3.

As for the second group of parameters, I take the country-specific shares of value added provided by different types of labor. The values of shares of high-skilled (θ_i^S) and the shares of migrants (θ_i^N) are calculated using the data describing the wage ratios between either the low/high-skilled workers or migrants/natives taken from Hendricks (2004) and Büchel and Frick (2005) respectively.

The country-pair-specific parameters are those that describe the bilateral costs of migration (for low and high-skilled separately) and the iceberg costs of trade. These values are fitted using the general equilibrium conditions: the random utility eq. (2.6) for migration costs, and the system of gravity eq. (2.4) for trade. Then, the obtained total costs of migration and trade are decomposed into their reducible and non-reducible parts, using econometric techniques described in the following sections. All in all, the calibration process is perfectly identified. The number of unknown parameters is exactly equal to the number of equations, and there are no additional degrees of freedom. For a detailed description of calibration algorithm, please consult Appendix 2.C.

[17] Imperfect substitution between all types of workers gives a richer wages effects after the shocks to local labor markets. Assuming perfect substitution between natives and foreigners would force the wages in two groups to be equal, and would rule out all the general equilibrium adjustments on labor markets. Quantitative effects of assuming different elasticities are depicted in Appendix 2.E, Table 2.E2.

2.4.2 Decomposition of migration costs

The total cost of migration is a combination of several aspects of migration decisions.[18] Keeping in mind its standard, microeconomic interpretation (as a sum of individual moving, visa and psychological costs), this figure can be modeled from a macroeconomic perspective. What is proposed as the reference identification strategy, is an estimation of the impact of legal migration barriers on the actual bilateral migration flows.[19] Let us consider the logarithm of eq. (2.6):

$$\ln\left(\frac{M_{ij}^s}{M_{jj}^s}\right) = \mu \ln\left(\frac{w_{-i}^s/P_i}{w_j^s/P_j}\right) + \mu \ln\left(1 - c_{ij}^s\right). \tag{2.7}$$

The goal is to calculate the extent to which $1 - c_{ij}^s$ is explained by the legal migration costs (that is all the migration barriers which are designed by the authorities to restrict migration flows, i.e. the visa costs). Assume that these limitations may be described by a dummy variable which indicates the existence of restrictions to free mobility of people. If the binary indicator $Visa_{ij}$ takes the value of 1, then there are legal restrictions to migrate permanently from country j to country i. On the contrary, $Visa_{ij} = 0$ may be interpreted as a free mobility agreement between countries j and i (for example as it is defined in the EU or between Australia and New Zealand). To identify the extent to which formal migration barriers influence bilateral migration decisions, several estimations of eq. (2.7) are provided (see Table 2.1 for the cost ascribed to the low-skilled and Table 2.2 for the case of the high-skilled).

Apart from the real wage ratios and a visa dummy, the bilateral cost of migration is determined by the distance between sending and receiving countries, common language, border and country-specific characteristics captured by fixed effects. As a by-product of these estimations, one can explicitly identify the sensitivity of migration with respect to the wage ratio, μ. Considering the results, I decided to impose $\mu = 1$ in the benchmark scenario and validate the robustness of results by assuming two alternative values: $\mu = 0.7$ and $\mu = 1.3$.

The panel data cover all the OECD country-pairs in years 2000 and 2010. The stocks of migrants are identical to those used in the calibration procedure, whereas the real wage ratios are the outcomes of model calibration (for both years separately). Standard gravity variables are taken from the CEPII database by Head and Mayer (2013). To control for time effect, a binary indicator of year is also added (taking the value $Year2000 = 1$ for year 2000). The estimation has been done using a standard fixed effect OLS estimator, as well as the Poisson Pseudo Maximum Likelihood (Anderson, 2010, Anderson and Van Wincoop, 2004, Silva and Tenreyro, 2006). The first four columns of Table 2.1 and Table 2.2 report the coefficients of OLS estimation with or without origin and destination fixed effects. The last four columns present the results of PPML estimations.

[18] Since the model is static and represents a long-run equilibrium those values should be interpreted more like costs of living abroad, rather than costs of moving abroad. Consequently, visa costs would be computed as a part of the total costs of living in a foreign country.

[19] An alternative way of identifying migration costs is proposed by Docquier et al. (2015). The costs are calibrated using the data from Gallup Survey which is conducted in almost 150 countries. The authors are particularly interested in the responses to the questions about people's preferences to emigrate and their choices of potential destination countries. The problem with Gallup data is that the Gallup Institute asks about the intentions for migration, and not whether the decision is actually reached, so there is no way of verifying that a potential migrant has actually emigrated. Furthermore, in the data I find positive stocks of intra-EU potential migrants. Since everyone may migrate freely across all the EU countries, one cannot account these people as being restricted by legal barriers.

TABLE 2.1: Estimation of legal bilateral migration cost for the low-skilled

	Dependent variable: $\ln\left(M^l_{ij}/M^l_{jj}\right)$				*Dependent variable:* M^l_{ij}/M^l_{jj}			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	OLS	OLS	OLS	OLS	PPML	PPML	PPML	PPML
Log wage ratio	1.096***	0.689***	0.696***	0.674***	0.928***	0.735***	0.723***	0.781***
	(0.055)	(0.085)	(0.080)	(0.079)	(0.010)	(0.181)	(0.129)	(0.138)
Log distance	-0.423***			-0.680***	0.047			-0.737***
	(0.061)			(0.071)	(0.108)			(0.124)
Visa	-0.916***	-1.003***	-0.807***	-0.402***	-0.728***	-1.758***	-1.214***	-0.518**
	(0.139)	(0.131)	(0.124)	(0.129)	(0.282)	(0.303)	(0.263)	(0.254)
Border	1.632***		2.258***	1.528***	1.731***		1.835***	0.961***
	(0.240)		(0.165)	(0.179)	(0.476)		(0.176)	(0.218)
Language	2.435***		0.735***	0.642***	1.413***		1.063***	1.221***
	(0.201)		(0.159)	(0.156)	(0.325)		(0.141)	(0.156)
Year2000	-0.809***	-0.734***	-0.776***	-0.857***	-0.245	-0.148	-0.202	-0.281**
	(0.107)	(0.082)	(0.077)	(0.076)	(0.195)	(0.227)	(0.139)	(0.140)
Constant	-5.239***	-6.846***	-7.223***	-1.601**	-7.045***	-3.613***	-4.602***	-0.763
	(0.464)	(0.279)	(0.264)	(0.642)	(0.863)	(0.591)	(0.539)	(1.097)
Origin FE	NO	YES	YES	YES	NO	YES	YES	YES
Destination FE	NO	YES	YES	YES	NO	YES	YES	YES
Observations	2,244	2,244	2,244	2,244	2,244	2,244	2,244	2,244
R-squared	0.320	0.636	0.678	0.691	0.251	0.353	0.674	0.700

Note: * p < 0.1; ** p < 0.05; *** p < 0.01, standard errors in parenthesis. *Log wage ratio* is a log of the ratio of wages for the low-skilled in the destination and in the source. *Log distance* is a log of a weighted distance between the destination and the source. *Visa*, *Border*, *Language* are binary indicators that take the value 1, if the destination and the source impose a visa, share a common border, or have the same official language, respectively. *Year2000* is a dummy for year 2000. Source: own calculations.

The reference regressions in Tables 2.1 and 2.2 are depicted in columns (8). These models are estimated using the PPML technique and they consider all the relevant explanatory variables and origin/destination fixed effects. Introducing a full free migration agreement would increase the share of bilateral migrants by more than 100 percent.[20] In the easily interpretable case of fixed effect OLS regression (column 4), the elasticity of migration share with respect to the distance is close to -0.7 for the non-college educated and slightly lower for the high-skilled (-0.6). The elasticity of migration share with respect to the real wage ratio is very close to the reference value of the corresponding parameter $\mu = 1$, without accounting for origin and destination fixed effects (column 1). Otherwise, this sensitivity takes values near 0.7. Highly skilled workers are less responsive to those monetary incentives. They are also less vulnerable to the visa restrictions, although the official language in the destination country seems to be more important in their migration decisions.[21]

[20] This is because in all the cases the impact of migration barriers on the ratio of migrants to stayers (taking the average value of coefficient Visa across all eight estimates) is: $\exp(0.918) \approx 2.5$ for the low-skilled and $\exp(0.724) \approx 2$ for the college educated.

[21] Another way of specifying migration costs would be to take into consideration the fact that several receiving countries developed selective migration policies. More precisely, Australia, New Zealand and Canada have introduced point systems which enable the screening of candidates for immigration in terms of their skill level, knowledge of official languages and their background on the labor market. In effect, these procedures allow the destination countries to admit those workers who are suited for the requirements of local labor markets. After accounting for another dummy variable $point\ system$, the results of regressions for both education levels stay unchanged. The $point\ system$ dummy takes negative values and is significant in PPML regressions for both types of workers. Its magnitude ranges from -0.3 to -1.4 for the low-skilled and -0.4 to -1.6 for the high-skilled, meaning that the potential gains from liberalizing migration for Australia, Canada and New Zealand may be up to 2 times higher than in the reference scenario.

TABLE 2.2: Estimation of legal bilateral migration cost for the high-skilled

	Dependent variable: $\ln\left(M^h_{ij}/M^h_{jj}\right)$				*Dependent variable:* M^h_{ij}/M^h_{jj}			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	OLS	OLS	OLS	OLS	PPML	PPML	PPML	PPML
Log wage ratio	0.975***	0.417***	0.427***	0.400***	0.648***	0.819***	0.672***	0.669***
	(0.061)	(0.104)	(0.100)	(0.098)	(0.079)	(0.205)	(0.169)	(0.169)
Log distance	-0.265***			-0.591***	0.217***			-0.107
	(0.061)			(0.068)	(0.074)			(0.131)
Visa	-0.791***	-0.843***	-0.687***	-0.335***	-0.709**	-1.031***	-0.770***	-0.627***
	(0.138)	(0.123)	(0.118)	(0.123)	(0.299)	(0.268)	(0.225)	(0.231)
Border	1.140***		1.626***	0.992***	0.929***		1.073***	0.952***
	(0.239)		(0.157)	(0.170)	(0.360)		(0.224)	(0.266)
Language	2.478***		0.846***	0.765***	1.758***		1.355***	1.361***
	(0.199)		(0.151)	(0.148)	(0.301)		(0.181)	(0.182)
Year2000	-1.139***	-1.039***	-1.073***	-1.142***	-0.385**	-0.355**	-0.355**	-0.367**
	(0.106)	(0.077)	(0.074)	(0.073)	(0.161)	(0.171)	(0.140)	(0.145)
Constant	-5.230***	-5.776***	-6.099***	-1.213**	-7.060***	-4.142***	-4.539***	-3.761***
	(0.461)	(0.261)	(0.251)	(0.611)	(0.560)	(0.266)	(0.282)	(1.026)
Origin FE	NO	YES	YES	YES	NO	YES	YES	YES
Destination FE	NO	YES	YES	YES	NO	YES	YES	YES
Observations	2,244	2,244	2,244	2,244	2,244	2,244	2,244	2,244
R-squared	0.262	0.651	0.681	0.692	0.143	0.423	0.532	0.544

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$, standard errors in parenthesis. *Log wage ratio* is a log of the ratio of wages for the low-skilled in the destination and in the source. *Log distance* is a log of a weighted distance between the destination and the source. *Visa*, *Border*, *Language* are binary indicators that take the value 1, if the destination and the source impose a visa, share a common border, or have the same official language, respectively. *Year2000* is a dummy for year 2000. Source: own calculations.

The above estimates are in line with the latest results presented in the literature. In the paper by Bertoli and Moraga (2013) the authors regress the quarterly migration rate to Spain in 1997 - 2009 on real GDP p.c. and visa requirement dummy. The magnitude of their coefficient, which ranges from -0.5 to -1.3, is very close to the values obtained in the analyzed regressions. Grogger and Hanson (2011) estimate the linear version of equation (2.7). They find that the explained variable (which is the log ratio of emigrants in the destination to the population in the source) depends significantly on both visa requirement and Schengen dummies. The estimates, taking the difference in pre-tax real wages as the main regressors, are equal to 0.335 and 0.430 respectively. Finally, Beine et al. (2011) determine the importance of migration diasporas on bilateral migration flows using a gravity representation and controlling for belonging to the Schengen Area. Their estimates of a Schengen dummy range from 0.06 to 0.60 for the migration flows to the OECD countries in 2000.

The migration liberalization scenarios are designed as follows. Migration costs between selected pairs of countries with visa requirements are reduced by a value corresponding to the estimated Visa coefficients, normalized by the $Log\ wage\ ratio$ coefficient (see Table 2.3). In the simulations, I consider three independent scenarios in terms of the impact of abolishing the legal barriers on the overall migration cost (see Tables 2.1 and 2.2 for exact values). The reference scenario (let us call it MID for middle values) assumes the liberalization parameter is equal to -0.663 for the low-skilled and -0.937 for the high-skilled. Then, to be able to get the impression of the sensitivity of results with respect to these values, I consider two other scenarios (labeled by MIN for minimal values and MAX for maximal values) in which I take the lower and upper bound of the legal migration barrier estimate. After updating migration cost matrices, one can generate new equilibrium migration stocks.

TABLE 2.3: The parametrization of the sensitivity of migration cost to legal migration barriers

Estimated Parameter		Low-skilled			High-skilled		
		MIN	MID	MAX	MIN	MID	MAX
Visa coefficient	μc_{ij}^{visa}	-0.402	-0.518	-1.214	-0.335	-0.627	-0.770
Log wage ratio coefficient	μ	0.674	0.781	0.723	0.400	0.669	0.672
Migration liberalization parameter	c_{ij}^{visa}	-0.596	-0.663	-1.679	-0.838	-0.937	-1.146

Source: own calculations.

2.4.3 Decomposition of trade costs

The second type of counterfactual simulation is related to trade liberalization. Once again, the aim is to identify the part of the bilateral trade cost which is the consequence of formal restrictions. Following Anderson and Neary (2003, 2005), apart from considering the tariffs imposed on imported goods, I also analyze the non-tariff barriers for trade (which, according to recent findings, constitute the majority of contemporary trade restrictions). To identify them I use the estimates by Looi Kee et al. (2009) who compute implied tariff rates that would be equivalent (in terms of the value of import/export) to the observed non-tariff barriers. These numbers represent the average across all importers/exporters from/to a particular country.

The identification strategy assumes estimating the impact of legal trade barriers by using simple regressions. However, the dependent variable is now the (logarithm of) bilateral trade cost, τ_{ij}, which was numerically fitted to match the trade data. Apart from the tariff and non-tariff restrictions, I regress it on the logarithm of the distance between exporting and importing countries (to control for distance-related transportation costs), common border, language and year dummy. The reference regression in Table 2.4 is labeled with (8).

Both legal barriers (the sum of tariff and non-tariff restrictions) and the distance raise the bilateral trade cost. An increase in the barrier equivalent by 1 percentage point enlarges the bilateral trade cost by 0.6-0.9 percent. The elasticity of τ_{ij} with respect to the distance oscillates around 0.2 and 0.4. Common border and common language facilitate trade by decreasing its bilateral cost.

The result above matches well with the estimates of the impact of trade liberalization on bilateral trade flows in the literature. What I obtain in the equilibrium is an aggregate increase of 17 percent in trade flows among the OECD countries after simulating the reference scenario.[22] Silva and Tenreyro (2006) estimate the impact of free trade agreements on trade for 136 countries in 1990 at the level of 66 percent in a standard OLS model and 20 percent using the Poisson Pseudo Maximum Likelihood method Olivero and Yotov (2012) construct a dynamic gravity model for the Eurozone. Using a GMM estimator they find that the free trade agreement raises the bilateral trade by 14 percent. Helpman et al. (2008) estimate gravity equations for the set of bilateral trade flows between 158 countries in year 1986. With a two-stage method, they find that a free trade agreement increases the trade flows on average by 41 percent (in a probit model), 13 percent (in a nonlinear least squares model) and 27 percent (assuming a polynomial model). Finally, Baier and Bergstrand (2007) quantify the implications of free trade agreements on bilateral trade using a 1960 - 2000 panel data for 96 potential trading partners. According to their results, an access to a free trade region may increase the trade from 14 percent (OLS estimate without fixed or time effects) to 100 percent (OLS with time and bilateral fixed effects) in 10 years.

[22] After including trade with the rest of the world, the change goes down to 8 percent.

TABLE 2.4: Estimation of formal bilateral trade cost

	Dependent variable: $\ln \tau_{ij}$				Dependent variable: τ_{ij}			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	OLS	OLS	OLS	OLS	PPML	PPML	PPML	PPML
Tariff and	0.922***	0.035	1.603***	0.622***	0.711***	0.470**	1.512***	0.837***
non-tariff barriers	(0.181)	(0.133)	(0.156)	(0.113)	(0.248)	(0.194)	(0.195)	(0.144)
Log distance	0.213***	0.334***	0.143***	0.360***	0.216***	0.367***	0.127***	0.374***
	(0.017)	(0.012)	(0.016)	(0.012)	(0.022)	(0.017)	(0.019)	(0.018)
Border	-0.304***	-0.122***	-0.203***	-0.054**	-0.415***	-0.039	-0.293***	0.047
	(0.067)	(0.032)	(0.062)	(0.028)	(0.087)	(0.077)	(0.082)	(0.071)
Language	-0.277***	-0.158***	-0.196***	-0.075***	-0.379***	-0.194***	-0.261***	-0.097**
	(0.055)	(0.028)	(0.051)	(0.024)	(0.063)	(0.047)	(0.058)	(0.041)
Year2000	-0.094***	-0.025			-0.108**	-0.089***		
	(0.032)	(0.016)			(0.043)	(0.024)		
Log trade			-0.075***	-0.027***			-0.088***	-0.038***
			(0.004)	(0.002)			(0.005)	(0.003)
Constant	0.207	-1.003***	1.867***	-0.430***	0.478***	-1.410***	2.437***	-0.423***
	(0.132)	(0.114)	(0.144)	(0.105)	(0.168)	(0.163)	(0.179)	(0.154)
Origin FE	NO	YES	NO	YES	NO	YES	NO	YES
Destination FE	NO	YES	NO	YES	NO	YES	NO	YES
Observations	2,244	2,244	2,244	2,244	2,244	2,244	2,244	2,244
R-squared	0.221	0.855	0.341	0.893	0.111	0.818	0.228	0.877

Note: * p < 0.1; ** p < 0.05; *** p < 0.01, standard errors in parenthesis. *Tariff and non-tariff barriers* is a percent equivalent of formal trade barriers from Looi Kee et al. (2009). *Log distance* is a log of a weighted distance between the destination and the source. *Border*, *Language* are binary indicators that take the value 1, if the destination and the source share a common border, or have the same official language, respectively. *Year2000* is a dummy for year 2000. *Log trade* is a log of bilateral trade flow. Source: own calculations.

The simulations of the trade liberalization are conducted in the same way as the preceding ones. Again, I assume three scenarios, characterized by a small, medium and large sensitivity parameter, which is now the semi-elasticity of trade cost in respect of the level of tariff and non-tariff barriers (see Table 2.4 for all the values). Table 2.5 summarizes the values of this parameter. In order to liberalize trade I set all tariff and non-tariff equivalents to 0. This would immediately decrease the values of τ_{ij} for those country pairs, which have no preferential trade agreement. Consequently, as it was the case while liberalizing migration, there is no change in the policy parameter among the EU countries.

TABLE 2.5: The parametrization of sensitivity of trade cost to tariffs

Estimated Parameter		MIN	MID	MAX
Trade liberalization parameter	τ_{ij}	0.470	0.837	1.512

Source: own calculations.

2.5 The results of simulations

In this section, I investigate the economic consequences of several liberalization policies concerning migration and trade across the OECD countries. Firstly, I quantify the impact of liberalizing flows of goods and people between the EU and five partners (Australia, Canada, Japan, Turkey and the US). This exercise allows to assess the profitability of these regional agreements for the countries in question. It would also highlight the potential threats in terms of the changes in the natives' real wages, owing to a possibly substantial movement of people across the developed economies. Secondly, I impose a liberalization policy among all the OECD countries, separately in terms of migration and trade. Since this scenario is less likely to take place in reality, I consider the obtained results more as an academic discussion. However, I then use it to examine the relations between migration and trade, after imposing exogenous shocks in the analyzed economic system.

2.5.1 The implications of regional migration and trade agreements

Internal cohesion and external cooperation with international partners is one of the most emphasized goals of the European Union. Being one of the world's largest economies in terms of gross value added, the EU is a crucial trade partner and a popular destination for emigrants from many developed and developing countries. Consequently, the potential gains from liberalizing trade have always been expected to be significant. The outcomes of freeing up migration flows have never been estimated for the EU alone, and there is no consensus even concerning the direction of this effect, not to mention its magnitude. Having said this, the question of gains from liberalizing migration and trade between the EU and other significant partners has to be answered, not only for the sake of economic curiosity, but also in order to be aware of the potential consequences of future European policy. The aggregated results after designing hypothetical, preferential trade and migration agreements are gathered in Table 2.6.

TABLE 2.6: Aggregated gains from liberalizing trade and migration between the EU and Partner countries:

Migration	EU						Partner country					
	GDP	Popul	w_i^l/P_i	w_i^h/P_i	Imp	Exp	GDP	Popul	w_i^l/P_i	w_i^h/P_i	Imp	Exp
TUR	0.56%	0.50%	0.12%	0.26%	0.43%	0.40%	-4.73%	-3.68%	-1.14%	-0.80%	-1.90%	-2.17%
JPN	0.04%	0.03%	0.02%	-0.03%	-0.17%	-0.19%	-0.18%	-0.10%	-0.10%	0.10%	-0.03%	-0.08%
AUS	-0.70%	-0.43%	-0.27%	-0.18%	-0.65%	-0.62%	15.95%	10.44%	4.63%	2.76%	7.39%	7.44%
CAN	-0.70%	-0.44%	-0.31%	0.20%	-0.70%	-0.71%	9.99%	6.54%	3.66%	0.48%	4.73%	4.82%
USA	-1.50%	-0.98%	-0.61%	0.56%	-1.58%	-1.59%	1.74%	1.59%	0.64%	0.30%	0.04%	0.12%
Trade	**EU**						**Partner country**					
	GDP	Popul	w_i^l/P_i	w_i^h/P_i	Imp	Exp	GDP	Popul	w_i^l/P_i	w_i^h/P_i	Imp	Exp
USA	0.25%	0.03%	0.22%	0.23%	1.84%	1.72%	0.29%	0.04%	0.26%	0.26%	10.62%	10.58%
TUR	0.07%	0.00%	0.07%	0.07%	0.44%	0.34%	1.00%	0.07%	0.93%	0.88%	37.87%	39.41%
JPN	0.07%	0.01%	0.07%	0.07%	0.44%	0.49%	0.27%	0.01%	0.27%	0.26%	10.73%	9.68%
CAN	0.04%	0.00%	0.03%	0.03%	0.12%	0.11%	0.64%	0.13%	0.52%	0.45%	4.48%	4.23%
AUS	0.02%	0.00%	0.02%	0.02%	0.00%	0.17%	0.80%	0.20%	0.59%	0.57%	11.34%	6.51%

Note: The table provides the percent changes in real GDP, total population (low-skilled and high-skilled natives/immigrants), real wages of low-skilled natives and high-skilled natives, value of imports and exports after liberalizing migration and trade between the EU and other partners, considering MID scenario. Source: own calculations.

In terms of liberalizing migration flows, the only two scenarios which are beneficial for the EU are the partnerships with Japan and Turkey. As it is reported in the upper part of Table 2.6, a free migration agreement between the EU and Turkey would induce a substantial wave of new immigrants to the EU (more precisely: an inflow of mainly low-skilled workers to Germany, Austria and the Netherlands). This strong shock may have some adverse consequences for the country of origin. The model predicts that Turkish real GDP would drop by over 4.7 percent, and the stayers would lose about 1 percent of their real wages. Simultaneously, the economic effects for the EU are significantly positive: 0.6 percent in terms of GDP and 0.1-0.3 percent when accounting for native's wages. After liberalizing migration between the EU and Japan, the economic implications are insignificant. In fact, one can observe a slight net inflow of immigrants to the EU; however the wage impact of this process is less than 0.03 percent (positive for the low-skilled and negative for the high-skilled).

In the three remaining cases, the EU loses after liberalizing migration, which is an expected result, because Australia, Canada and the US are the net receivers of European emigrants. Indeed, the real GDP, population and real wages of EU natives drop significantly after liberalizing migration with Australia. Many people from the EU (almost 2 million) are now deciding to emigrate which, due to a negative market size effect, has an adverse impact on the economic conditions in Europe. And, to the contrary, Australia gains tremendously in terms of the aggregated output, the real wages of natives and international trade with all OECD partners.

A similar case is Canada, which has introduced a point system to attract quality workers from abroad. Thus, the consequences of liberalizing migration are qualitatively (and apparently quantitatively) close to what is reported in the former scenario. The only difference with respect to the case of Australia is that the high-skilled workers in the EU are about to gain. This is a direct consequence of a more selective migration flow to Canada. Once again, the EU's partner gains substantially from liberalizing migration, considering all the macroeconomic indicators.

The liberalization of migration between the EU and the US is harmful for the European economy. The real GDP may plunge by 1.5 percent, and the real wage of low-skilled stayers would drop by 0.6 percent. Because emigration to the US is expected to be highly skill-biased, the supply of college-educated labor in the EU shrinks, bringing large positive effects for the high-skilled stayers (over 0.5 percent in real wage). On the contrary, the US gain over 1.7 percent in terms of real GDP and the natives are better off by 0.3-0.6 percent.

Moving to the second part of results, depicted in the bottom part of Table 2.6, liberalizing trade is beneficial for both counter-parties, in all of the analyzed cases. The observed gains are almost equally distributed across skill levels, since the overall price indexes are decreasing after lowering the trade costs, without imposing large shifts in the skill-specific nominal wages. Freeing the exchange of goods increases the real GDP's and the real wages in the EU and the US by almost 0.3 percent. Notice that both partners experience an additional inflow of labor. Their relative attractiveness is visibly improved, which results in more people keen on emigrating either to the EU or the US.

Trade liberalization between the EU and Turkey increases the Turkish GDP by 1 percent. Since the EU is the largest trade partner for Turkey, its exports and imports surge. Consequently, lower costs of trading, along with a greater variety of products, directly reduce the price index, which translates into higher real wage ratio for all Turkish citizens. The EU experiences only a slight effect in terms of real GDP and real wages. The natives in the EU member countries may gain less than 0.1 percent in terms of their real wages. A quantitatively similar result may be observed after imposing an EU-Japan trade agreement. However, reducing the legal barriers to trade causes the real wages in Japan to rise by about 0.3 percent, which is not that pronounced as in the case of Turkey due to less intensive trade linkages between the two economies.

Since the barriers to trade between the EU and Australia and Canada are rather negligible in comparison to large transportation costs, the potential gains from freeing trade are close to none for the EU and moderate for the two partner countries (0.6-0.8 percent in real GDP and about 0.5 percent in natives wages). Notice that the magnitudes in the trade scenarios are significantly smaller than the ones observed in the case of migration liberalization.

2.5.2 Liberalization of migration and trade across the OECD

Let us now move to a more academic topic of a full liberalization of migration and trade among all the OECD countries. The removal of migration barriers causes a substantial increase in population mobility across the OECD. The number of immigrants in all the member countries rises from 110 to 137 million people (9 million of these 27 million new immigrants are college-educated). This means that in the reference scenario the share of immigrants in the OECD goes up from 10.83 percent to 13.54 percent. The main destinations are the US (16 million), Canada, Australia and Germany (2.5, 2.2 and 1.4 million respectively). The highest increases in the number of immigrants, as a share of actual populations, are observed in Switzerland (14.8 percent), Australia, New Zealand and Canada (9-12 percent).

The largest outflows of workers are reported for Mexico (9 million) the UK, Korea, Turkey and Germany (about 2 million each). However, in relative terms, the largest losses can be observed for Mexico (-11.2 percent), Portugal, Turkey and the UK (about -5 percent). Table 2.7 gathers the aggregated results for all three scenarios. In all these cases, the liberalization of migration is positive for the overall level of real GDP in the OECD, but harmful for the EU economy. Considering the reference scenario of liberalizing migration among all the OECD countries, the total real GDP in the OECD increases by 1.60 percent.

TABLE 2.7: Aggregated gains from liberalizing migration

	EU							OECD						
	GDP	L_i^l	L_i^h	L_{-i}^l	L_{-i}^h	Imp	Exp	GDP	L_i^l	L_i^h	L_{-i}^l	L_{-i}^h	Imp	Exp
MIN	-2.08%	-1.47%	-6.93%	5.68%	8.10%	-1.94%	-1.85%	1.39%	-2.16%	-4.62%	20.22%	24.96%	-0.94%	-0.94%
MID	-2.41%	-1.69%	-8.06%	6.50%	9.48%	-2.22%	-2.10%	1.60%	-2.48%	-5.39%	23.20%	29.10%	-1.05%	-1.05%
MAX	-6.25%	-7.08%	-11.63%	27.96%	10.40%	-4.97%	-4.62%	4.64%	-9.38%	-7.76%	87.80%	43.36%	-2.19%	-2.19%

Note: The table provides the percent changes in real GDP, population of natives (low-skilled and high-skilled), population of immigrants (low-skilled and high-skilled), value of imports and exports in the EU and the OECD after liberalizing migration across all the OECD countries, considering 3 scenarios: MIN, MID and MAX. Source: own calculations.

This shows that, accepting all the assumptions of the model, the potential gains from reducing the migration barriers are not negligible. In the MAX scenario, these overall benefits rise up to 4.64 percent. The European Union, on the contrary, encounters serious losses after abandoning visa restrictions. In the benchmark case, real GDP drops by -2.41 percent, whereas in the MAX scenario the loss is -6.25 percent. These severe consequences are due mainly to the large outflow of Europeans to the North American and Oceania countries. Indeed, even though the population of residents increases, the exodus from the EU is decisive. Finally, both imports and exports decrease after imposing a no-visa policy. Let us concentrate on the results obtained from the reference scenario (MID), depicted on Figure 2.1. The detailed, country-specific outcomes are available in Table 2.A1 in Appendix 2.A.

In the analysis, light is shed on the overall effect on the aggregated wage index, as well as skill and origin specific real wages and populations of all types of workers. The first striking observation is that the majority of OECD countries lose after the liberalization of migration. The ultimate winners are New Zealand, Australia, Canada, Switzerland and the US, with an increase in overall welfare indexes ranging from 1.7 to over 4.5 percent. The residents of Mexico observe a decrease in their real wages by 3.2 percent. In the majority of countries, especially the losing ones, high-skilled workers are relatively better off (that concerns both natives and immigrants); therefore the within-country inequalities increase. A simple explanation may be the positive selection of new emigrants. An intensive outflow of the high-skilled workers from the drained countries automatically raises the nominal wages of the high-skilled stayers (as a

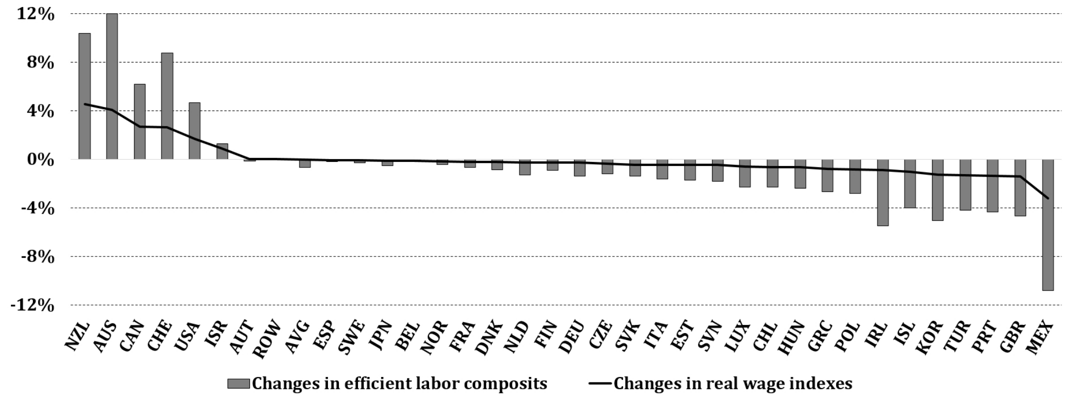

FIGURE 2.1: The aggregated consequences of liberalizing migration among all OECD countries.
Source: own calculations.

consequence of an imperfect substitution between non-college and college-educated labor). An extreme example may be Chile, where the low-skilled natives lose 1.19 percent and the high-skilled gain 3.66 percent.

All of the analyzed countries experience an outflow of their citizens, which is an expected consequence of freeing up labor mobility. Therefore, in order to provide post-liberalization benefits, not only a country needs to attract new immigrants, it also has to discourage natives from emigrating. For example, large exoduses of high-skilled workers take place in all the winning countries. Despite this, the natives in Australia or Canada gain about 1-4 percent. Potential losses from emigration are more than compensated for by new waves of immigration. Mediterranean and Eastern European countries, on the contrary, which experience substantial emigration, are not the most popular destinations for new immigrants from other OECD countries. Consequently, the real wages of natives decrease after liberalization.

To sum up this part of results: the necessary condition for providing benefits from migration liberalization is to retain the stock of (mainly high-skilled) workers, either by convincing them not to emigrate, or by inviting their close substitutes from abroad. Otherwise, the emigration of well educated people causes an increase in within-country inequality. Furthermore, the model predicts a continuous brain-drain effect from the relatively poorer to the relatively wealthier economies. The benefits caused by the liberalization of intra-OECD migration are concentrated in only a few countries, so the cross-country inequality comes to be more pronounced. The key message for the remaining OECD members is that they need to provide incentives which would accelerate the accumulation of human capital.

A full liberalization of international trade in the OECD is a potentially desirable scenario. In fact, the actual barriers to trade among the most developed economies are rather small; new agreements have been reached in the recent years, and many more are still to be negotiated. In the results, I study three trade liberalization scenarios which allow us to assess the sensitivity of the model with respect to trade liberalization parameter. In the reference (MID) case, the countries that increase their trade the most (imports and exports change in the same way due to balanced trade requirement) are Mexico (40 percent), New Zealand and Canada (about 30 percent). Large positive deviations may be observed for the emerging economies such as Turkey and Chile (27 percent). On the contrary, the well integrated European economies: Belgium, Luxembourg or Norway see their trade value raising by less than 1 percent. Zeroing trade barriers results in the migration of an additional 0.5 million workers in the OECD. Table 2.8 shows the aggregated gains from liberalizing trade, which are positive for the EU and the OECD.[23]

TABLE 2.8: Aggregated gains from liberalizing trade

	EU							OECD						
	GDP	L_i^l	L_i^h	L_{-i}^l	L_{-i}^h	Imp	Exp	GDP	L_i^l	L_i^h	L_{-i}^l	L_{-i}^h	Imp	Exp
MIN	0.27%	-0.01%	-0.04%	0.16%	0.09%	2.04%	2.25%	0.55%	0.01%	0.00%	0.22%	0.38%	8.84%	8.84%
MID	0.50%	-0.03%	-0.08%	0.30%	0.16%	4.05%	4.46%	1.07%	0.03%	0.01%	0.41%	0.73%	17.00%	17.00%
MAX	1.03%	-0.06%	-0.16%	0.61%	0.32%	8.40%	9.20%	2.24%	0.07%	0.02%	0.78%	1.49%	34.73%	34.73%

Note: The table provides the percent changes in real GDP, population of natives (low-skilled and high-skilled), population of residents (low-skilled and high-skilled), value of imports and exports in the EU and the OECD after liberalizing trade among all the OECD countries, considering 3 scenarios: MIN, MID and MAX. Source: own calculations.

In the reference scenario, the overall increase in real GDP by the OECD countries is 1.1 percent, and comprises 2/3 of what was obtained for liberalizing migration. In contrast to the previous results, the EU now gains 0.5 percent in terms of real GDP. Taking the upper bound of the estimates, increases the benefits to 2.2 percent for the OECD and 1.0 percent for the EU.

One can observe an intensification of trade flows either for the EU countries (over 4 percent) and the OECD countries (17 percent). Additionally, the trade balance for the EU ameliorates vis-a-vis all the OECD members. The fact is that in 2010 the OECD economies were already well integrated, and the tariff barriers were rather low. However, the non-tariff barriers were still substantial. All the changes in real GDPs are smaller (in their absolute values) than the corresponding values obtained in the migration liberalization scenarios. This would mean that the potential gains from reducing the trade barriers are significantly lower than the potential gains or losses from intra-OECD no-visa policy.

Analyzing the country-specific macroeconomic indicators (see Table 2.A2 in Appendix 2.A and Figure 2.2), one sees all the OECD countries experience a growth in their equilibrium real wage levels. The macroeconomic gains from trade range from about 0.1-0.3 percent for the Mediterranean countries (Portugal, Spain, Greece and Italy) to up to 4 percent for the traditional trade countries and above 2 percent for the relatively less integrated countries like Chile, Korea and Mexico. The mechanism which stands behind these results boils down to a positive price effect, which concerns mainly those economies whose trade value constitutes a large share of output. A decline in bilateral tariffs and non-tariff restrictions spurs exports, which indirectly raises welfare. Simultaneously, the trade liberalization policies lower the prices of imported goods, which directly reflects higher real wages.

The endogenous process of human migration follows the expected pattern. People flow to the countries which gain the most from reducing trade barriers. Therefore, the highest increases in the stock of migrants may be observed in Canada, Switzerland or New Zealand. This phenomenon is dictated by the decision rule that governs the choice of destination, in which individuals compare the wage levels in all possible destinations. The highly developed countries which do not take advantage of the reduction of tariffs (such as Luxembourg, the UK or the Scandinavian countries) are actually becoming relatively less attractive for foreign OECD workers. Such a result depends on the fact that these economies are already well integrated in the global trade network, their barriers for trade are low (especially vis-a-vis their major trade partners), and there is no further room for gains from liberalization. As a consequence, they cannot benefit

[23] For the changes in values, see Appendix 2.D.

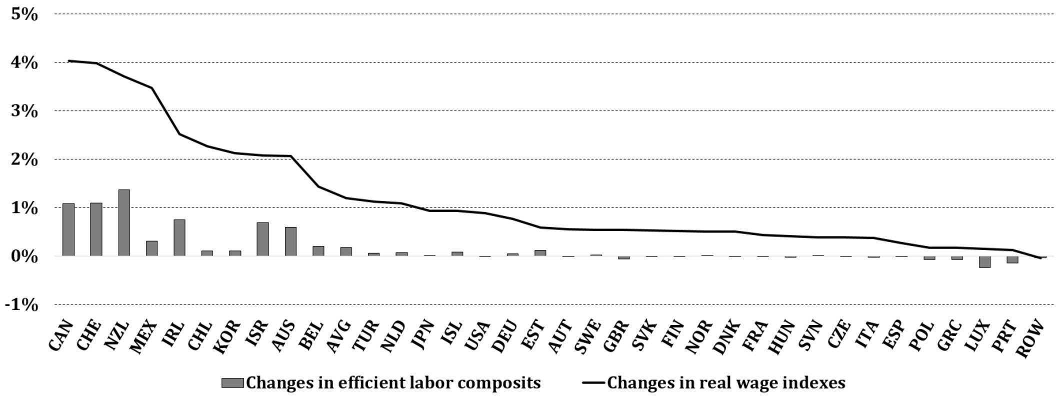

FIGURE 2.2: The aggregated consequences of liberalizing trade among all OECD countries. Source: own calculations.

from zeroing the trade limitations, which in fact causes their relative attractiveness to diminish. Thus, the liberalization of trade accelerates convergence and reduces the inequality in real wages among OECD members.

2.5.3 Relations between trade and migration

The final question addressed in the chapter concerns the relations between trade and migration. I shall investigate whether migration is a substitute for trade (so that the number of migrants decreases with bilateral trade flows) or whether these two processes are complements (in a sense that higher migration is followed by a higher trade flow between two particular countries). The literature does not provide a clear-cut solution to this issue. Depending on the assumptions and the structure of a model, both situations are possible.

The Heckscher-Ohlin model of international factor movement (see for example Heckscher and Ohlin 1991 or Feenstra 2003) conjectures that mobility of different factors is substitutive.[24] Given that there are no international barriers, trade, migration and capital flows cause the international equalization of prices, wages and interest rates which, in turn, results in a decrease in the incentives for factor mobility. The Heckscher-Ohlin-Vanek proposition states that a country's export is intensive in the products manufactured using abundant factors, whereas the products created using scarce factors are mainly imported. Therefore, the indirect trade in factors of production (such as migration or FDI) results in the equalization of differences in factor abundance between countries, which leads to factor price convergence and a reduction in trade.

On the contrary, a departure from the classical assumptions of the Heckscher-Ohlin model, may bring a completely opposite result. For example, Markusen (1983) proves that migration and trade may be complementary in a system of two economies with different technology endowments. In terms of empirical research, there is a rich literature that supports the conjecture that migration and trade are complements. A comprehensive literature review may be found in Felbermayr et al. (2012). The problem is analyzed taking into consideration three potential mechanisms: information, preference and network channels. Gould (1994) was the first who addressed this question in a quantitative way. He analyzed the impact of both preference and

[24] In the stronger, quantitative sense, which implies its weaker form: through the convergence of factor prices.

information channels on US imports and exports.[25] This paper, as well as others in the field, emphasizes the role of migration in creating bilateral trade between sending and receiving countries (both imports and exports). What the authors underline is that both effects help to establish informal links between the trading partners.[26]

The proposed general equilibrium model allows to answer the question about the relations between migration and trade in a framework without endogeneity problems.[27] In fact, one is able to study two types of processes: the reaction of migration to the liberalization of trade cost, and the reaction of trade to the liberalization of migration cost (without imposing explicit network effects of migration on trade, in the reference scenario). In what follows, I quantify the direction and the magnitude of relations between bilateral migration and bilateral trade caused by independent shocks on legal barriers to international exchange. Due to the fact that trade and migration are endogenous in the analyzed model, both aggregates are driven only by the general equilibrium forces in the system. In terms of theoretical predictions, one can derive the following properties.

Proposition 2.1. Keeping all other things unchanged,

(a) a bilateral liberalization of migration between a sending country j and a receiving country i causes an increase in trade from country j to country i. Migration and trade are **complements**.

(b) a bilateral liberalization of trade between a sending country j and a receiving country i causes a decrease in migration from country j to country i. Migration and trade are **substitutes**.

Proof. See Appendix 2.B. □

Having said this, the results suggest that the analyzed multi-country model with endogenous trade and migration is capable of producing different patterns of relation between trade and migration, depending on the type of shock imposed in the system of economies.[28] The mechanism behind the first result (complementarity when liberalizing migration) is a consequence of pure market size effects (that is, the impact of population size in a country on total demand and the number of varieties consumed). The second result comes from a decrease in prices of goods, which (apart from the effect on price indexes) changes the overall allocation of resources and production schemes in both countries. To support the theoretical results, I run a quantitative experiment to give evidence about their credibility.

[25] Similar studies (for different countries) are conducted by, inter alia, Head and Ries (1998) and Wagner et al. (2002) for Canadian provinces, Combes et al. (2005) for French regions, Tai (2009) for Switzerland, Bruder (2004) for Germany. A quantitative estimation is provided by Parsons (2012) and Egger et al. (2012). Genc et al. (2012) conduct a meta-analysis.

[26] As Gaston and Nelson (2013) summarize the hitherto findings: "there is strong and consistent support for immigration having a positive effect on trade. [...] However, because these analyzes are never carried out in the context of a structural analysis that permits an evaluation of the relative price effects that drive the general equilibrium analysis standard in the trade theoretic accounts, these results neither permit comparison with the trade theoretic claims, nor do they speak directly (or unambiguously) to the issues of whether trade and migration are substitutes or complements."

[27] Notice, however, that in this model I treat international exchange as trade in consumption good, which alters the context of this analysis with respect to the classical analysis of factor exchange.

[28] The outcomes of this model are richer than the ones presented by classical international trade literature, i.e. in Costinot and Rodríguez-Clare (2013). Endogenizing migration has a crucial impact on the behavior of the key macro variables, and the exact magnitudes of general equilibrium effects are hard to describe analytically. Thus, in what follows, I turn to a numerical exercise that may depict the generic mechanisms of the model.

In Table 2.9 the changes in the shares of trade (either imports or exports) are regressed on the changes in the shares of migration between two countries, assuming two different types of shocks: exogenous migration liberalization (in the first two columns) and exogenous trade liberalization (in the last two columns).[29] Consider the first two columns of Table 2.9, which represent the correlation between the changes in shares of trade and migration after imposing an exogenous shock to migration costs. The outcome suggests that migration and trade are complementary. This result is in line with the empirical findings reported in the literature, and supports the conjecture in the Proposition.[30] On the contrary, liberalizing trade brings opposite results (see two last columns of Table 2.9). Now trade and migration are substitutes, which once again favors the hypothesis in the Proposition.

TABLE 2.9: Regressions of changes in trade share on changes in migration share

	Migration liberalization		Trade liberalization	
Dependent variable:	Trade from i to j	Trade from j to i	Trade from i to j	Trade from j to i
Low-skilled from i to j	0.05***	-0.01	-15.11***	-1.16
	(0.007)	(0.007)	(0.643)	(0.785)
High-skilled from i to j	0.01***	-0.00	-10.44***	-0.28
	(0.003)	(0.003)	(0.560)	(0.641)

Note: The table shows the OLS estimates of regressions: $\Delta Trade_{ij(ji)} = \beta_0 + \beta_1 \Delta Migration_{ij}$, where $\Delta Trade_{ij}$ is the change in the share of trade from country j to country i to the total GDP in country i in percentage points, and $\Delta Migration_{ij}$ is the change in the share of immigrants from country j in country i to the population in country i, in percentage points. The regressions are run separately for low and high-skilled workers. Standard errors in parenthesis. Source: own calculations.

The fact is, that in the last twenty years the majority of exogenous international shocks experienced by the OECD have been linked to trade in goods. Many countries, among the most developed economies, decided to sign preferential trade agreements with their most important partners. Simultaneously, migration between the majority of country pairs is still heavily restricted. Therefore, according to the results, one would expect that migration and trade would act as substitutes. But, as the large body of empirical research convincingly suggests, this is generally not the case. The observed complementarity between trade and migration is, consequently, very likely to be caused by additional (i.e. network) effects of migration. The results of the above-described quantitative exercise may constitute an argument for the presence of such indirect, additional externalities. However, one has to bear in mind that the effect of complementarity between migration and trade is also explained by a crude market size effect of migration propagated through the general equilibrium effects.

2.6 Robustness checks

To verify the results, I relate this approach to some previous works in the field. For a detailed description of the robustness checks and a full results of all additional simulations, consult Appendix 2.E. All the numbers (in a condensed form) are presented in Table 2.E2 and are compared to the reference scenario with a benchmark parametrization, full liberalization of migration and

[29] The sample consists of 1122 OECD country pairs. The absolute values of coefficients suggest that after having liberalized migration, the changes in bilateral trade shares are about twenty times lower than the changes in migration shares. Conversely, after liberalizing trade, the changes in trade shares are about fifteen times larger than the changes in migration shares.

[30] Notice that in this version of the model I do not account for cost-reducing network effects of migration. This additional pro-complementary effect is introduced in one of the robustness checks, and increases the values of all the estimates.

trade across all the OECD countries, assuming the MID values of policy variables. I start by running a set of simulations with different values of some crucial parameters (labor elasticities and the variety elasticity). Sensitivity of the results with respect to the elasticity of substitution between low and high-skilled workers and the elasticity between natives and immigrants is rather negligible. Moving the elasticity of substitution between different varieties of consumption good may have a more visible effect on the level of the results, however the value of this parameter is pinned down near the benchmark value by many empirical studies. Decreasing (increasing) the elasticity of utility with respect to real wage in the random utility model makes the results less (more) dispersed. Adding a TFP externality deepens the differences between winning and losing economies. Congestion effects of migration have little impact on the quantitative findings, whereas the network effects of migration (for trade and migration costs) may bring some important gains for both receiving and, more importantly, sending countries. Brain waste seems to be a quantitatively less important problem.

2.7 Conclusion

This chapter develops a multi-country general equilibrium model which allows to compare the effects of removing migration barriers with the implications of regional trade agreements. I compute the gains from reducing visa restrictions between the EU and Australia, Canada, Japan, Turkey, and the US. The conclusion is, that this policy is positive for natives of the EU-member states only in the case of agreement with Turkey (an increase in their real wages by 0.1-0.3 percent) and Japan (minor gains). The remaining scenarios bring substantial costs for the EU in terms of total population (which decreases by up to 1.5 percent) and the real wages (reductions assessed at the level of 0-0.6 percent). Pursuing the contemporary discussions about signing free trade treaties between the EU and several key partners, the chapter shows that the elimination of bilateral tariff and non-tariff barriers brings some small (relative to migration), but mutually positive outcomes. These gains do not exceed 0.25 percent for the EU and 0.6 percent for the partner countries. In the case of a full liberalization among all the OECD countries, the group gains 1.6 percent of real GDP after reducing barriers to migration. However, in the sample of 34 OECD members, there are only several winners from the liberalization of migration. Concerning the consequences of intra-OECD trade liberalization, this policy provides a change in real GDP at the level of 1.1 percent for the OECD. In contrast to freeing migration, all the states share the gains resulting from the reduction of trade barriers. Comparing these two academic scenarios, liberalizing migration brings larger, but unequally distributed economic effects. Finally, considering the theoretical and quantitative results, reducing the costs of labor mobility, induces growth in bilateral migration and trade. Both phenomena are complementary to each other. On the contrary, a decrease in bilateral tariff and non-tariff barriers spurs trade, but diminishes migration. Thus, in this case migration and trade are substitutes. Therefore, the correlation between these two variables depends not only on the assumptions of the theoretical model, but also on the type of exogenous shock one imposes in a complex general equilibrium system.

Acknowledgments

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Appendices

2.A Detailed results of simulations

TABLE 2.A1: The real wage and demographic effects of migration liberalization (MID scenario)

ISO	Change in real wage					Change in labor force				
Code	W_i/P_i	w_i^l/P_i	w_i^h/P_i	w_{-i}^l/P_i	w_{-i}^h/P_i	$\bar{L}_i^T$	L_i^l	L_i^h	L_{-i}^l	L_{-i}^h
NZL	4.54%	5.18%	-0.83%	3.82%	-3.71%	10.37%	-1.32%	-21.15%	28.21%	42.13%
AUS	4.10%	4.38%	3.40%	2.78%	1.22%	12.07%	-1.34%	-7.86%	34.16%	41.05%
CAN	2.67%	3.19%	1.23%	1.43%	-1.17%	6.21%	-2.82%	-14.80%	37.03%	37.63%
CHE	2.67%	3.84%	-0.37%	1.42%	-4.30%	8.75%	-6.27%	-18.21%	50.49%	83.15%
USA	1.69%	1.43%	2.03%	-0.29%	0.26%	4.65%	-0.37%	-1.43%	40.00%	39.74%
ISR	0.88%	0.83%	1.00%	0.02%	-0.75%	1.26%	-3.46%	-15.77%	13.43%	19.56%
AUT	0.01%	-0.51%	3.11%	-1.26%	2.25%	-0.12%	-1.28%	-9.06%	14.80%	7.45%
ROW	0.01%	0.00%	0.01%	0.07%	0.50%	0.00%	0.01%	0.00%	-1.39%	-9.17%
AVG	**-0.04%**	**-0.36%**	**1.14%**	**-0.98%**	**-0.12%**	**-0.65%**	**-2.21%**	**-8.79%**	**11.66%**	**18.61%**
ESP	-0.06%	-0.13%	0.18%	-0.25%	-0.28%	-0.18%	-0.38%	-2.22%	1.95%	7.12%
SWE	-0.10%	-0.44%	1.23%	-0.79%	0.52%	-0.29%	-0.59%	-5.19%	6.52%	9.09%
JPN	-0.11%	-0.43%	0.59%	-1.61%	-1.64%	-0.54%	-0.32%	-2.52%	26.31%	52.80%
BEL	-0.12%	-0.60%	1.24%	-0.96%	0.80%	-0.13%	-0.63%	-3.64%	6.88%	5.27%
NOR	-0.15%	-0.38%	1.04%	-0.73%	0.22%	-0.45%	-0.72%	-5.84%	6.37%	10.79%
FRA	-0.20%	-0.54%	1.75%	-0.77%	0.99%	-0.67%	-0.47%	-6.73%	4.13%	8.37%
DNK	-0.22%	-0.69%	1.46%	-1.24%	0.51%	-0.85%	-0.90%	-5.31%	10.76%	14.36%
NLD	-0.25%	-0.86%	1.53%	-1.48%	0.58%	-1.31%	-1.74%	-7.13%	11.35%	12.04%
FIN	-0.26%	-0.61%	1.34%	-0.85%	0.81%	-0.91%	-0.54%	-4.32%	4.52%	6.18%
DEU	-0.26%	-1.02%	2.58%	-1.75%	1.52%	-1.38%	-1.90%	-9.02%	13.78%	11.91%
CZE	-0.38%	-0.81%	1.91%	-0.87%	1.46%	-1.18%	-0.50%	-5.99%	0.67%	2.79%
SVK	-0.44%	-0.93%	2.09%	-0.96%	1.87%	-1.40%	-0.56%	-5.86%	0.05%	-1.73%
ITA	-0.45%	-0.67%	1.33%	-0.96%	0.42%	-1.63%	-1.74%	-7.03%	4.15%	11.54%
EST	-0.46%	-0.87%	0.67%	-0.88%	0.36%	-1.72%	-1.02%	-5.13%	-0.71%	0.77%
SVN	-0.47%	-0.87%	0.69%	-0.93%	0.35%	-1.81%	-1.28%	-4.35%	-0.23%	2.27%
LUX	-0.58%	-1.13%	0.79%	-1.17%	0.41%	-2.31%	-1.72%	-8.01%	-0.99%	-0.68%
CHL	-0.65%	-1.19%	3.66%	-1.57%	1.40%	-2.28%	-1.46%	-12.16%	6.35%	36.59%
HUN	-0.66%	-1.32%	1.03%	-1.42%	0.51%	-2.41%	-1.35%	-5.87%	0.60%	4.34%
GRC	-0.78%	-0.85%	-0.65%	-1.26%	-1.44%	-2.68%	-3.77%	-4.44%	4.53%	12.08%
POL	-0.85%	-1.68%	1.82%	-1.73%	1.25%	-2.80%	-1.41%	-7.46%	-0.42%	3.52%
IRL	-0.88%	-1.78%	0.76%	-2.09%	0.04%	-5.47%	-5.35%	-11.82%	0.91%	1.70%
ISL	-1.02%	-1.96%	2.01%	-2.23%	0.88%	-3.99%	-2.86%	-11.59%	2.62%	10.58%
KOR	-1.27%	-2.37%	-0.17%	-2.57%	-1.94%	-5.04%	-3.33%	-7.74%	0.70%	31.93%
TUR	-1.30%	-1.52%	0.30%	-2.17%	-1.36%	-4.18%	-4.22%	-10.05%	9.32%	25.61%
PRT	-1.35%	-1.48%	1.99%	-1.74%	0.57%	-4.34%	-4.43%	-22.01%	0.72%	3.32%
GBR	-1.39%	-2.20%	1.51%	-2.50%	-0.01%	-4.69%	-3.77%	-17.99%	2.32%	10.79%
MEX	-3.20%	-3.13%	-3.50%	-5.79%	-6.55%	-10.80%	-11.29%	-11.27%	55.08%	68.69%

Note: The table presents changes in: real wage indexes, real wages of four types of workers, efficient labor composite and stocks of low/high-skilled natives/foreigners after liberalizing migration, considering MID scenario. AVG is the simple average of all the OECD countries. ROW stands for the rest of the world. Source: own calculations.

TABLE 2.A2: The real wage and demographic effects of trade liberalization (MID scenario)

ISO	Change in real wage					Change in labor force				
Code	W_i/P_i	w_i^l/P_i	w_{-i}^l/P_i	w_{-i}^h/P_i	w_i^h/P_i	$\bar{L}_i^T$	L_i^l	L_i^h	L_{-i}^l	L_{-i}^h
CAN	4.03%	4.16%	3.68%	3.98%	3.53%	1.08%	0.11%	0.33%	3.70%	3.14%
CHE	3.99%	4.05%	3.85%	3.88%	3.71%	1.09%	0.28%	0.44%	3.58%	3.08%
NZL	3.71%	3.76%	3.27%	3.61%	3.18%	1.36%	0.31%	0.87%	3.33%	2.57%
MEX	3.47%	3.46%	3.52%	3.34%	3.39%	0.31%	0.32%	0.20%	2.66%	2.76%
IRL	2.51%	2.53%	2.48%	2.45%	2.40%	0.74%	0.32%	0.38%	2.06%	1.84%
CHL	2.27%	2.28%	2.17%	2.17%	2.09%	0.10%	0.06%	0.17%	2.10%	1.71%
KOR	2.13%	2.13%	2.12%	2.03%	2.04%	0.10%	0.05%	0.07%	2.03%	1.68%
ISR	2.07%	2.13%	1.94%	2.03%	1.87%	0.69%	0.07%	0.18%	1.96%	1.63%
AUS	2.07%	2.09%	2.02%	2.01%	1.96%	0.59%	0.02%	0.08%	1.52%	1.40%
BEL	1.43%	1.42%	1.45%	1.37%	1.40%	0.20%	0.03%	0.05%	1.04%	0.93%
AVG	**1.19%**	**1.20%**	**1.17%**	**1.16%**	**1.14%**	**0.17%**	**0.03%**	**0.02%**	**0.87%**	**0.69%**
TUR	1.13%	1.13%	1.10%	1.08%	1.07%	0.06%	0.02%	0.02%	1.02%	0.78%
NLD	1.08%	1.08%	1.08%	1.04%	1.05%	0.07%	-0.01%	-0.03%	0.77%	0.61%
JPN	0.94%	0.94%	0.94%	0.92%	0.93%	0.00%	0.00%	0.00%	0.34%	0.14%
ISL	0.93%	0.93%	0.92%	0.90%	0.91%	0.08%	0.02%	0.05%	0.61%	0.37%
USA	0.88%	0.90%	0.86%	0.92%	0.85%	-0.02%	0.00%	-0.01%	-0.34%	0.23%
DEU	0.77%	0.76%	0.78%	0.74%	0.76%	0.04%	-0.01%	-0.05%	0.45%	0.37%
EST	0.59%	0.59%	0.59%	0.56%	0.57%	0.12%	0.03%	0.00%	0.60%	0.43%
AUT	0.56%	0.55%	0.58%	0.54%	0.57%	0.00%	-0.02%	-0.11%	0.20%	0.13%
SWE	0.54%	0.54%	0.56%	0.53%	0.55%	0.02%	0.00%	-0.03%	0.24%	0.13%
GBR	0.54%	0.53%	0.58%	0.52%	0.56%	-0.06%	-0.06%	-0.23%	0.17%	0.10%
SVK	0.53%	0.53%	0.56%	0.52%	0.55%	-0.01%	0.00%	-0.07%	0.17%	0.10%
FIN	0.51%	0.51%	0.53%	0.50%	0.52%	0.00%	-0.01%	-0.04%	0.24%	0.13%
NOR	0.51%	0.51%	0.53%	0.49%	0.52%	0.01%	-0.01%	-0.03%	0.22%	0.02%
DNK	0.51%	0.50%	0.53%	0.50%	0.53%	-0.01%	-0.02%	-0.05%	0.14%	-0.03%
FRA	0.43%	0.42%	0.46%	0.41%	0.46%	0.00%	-0.01%	-0.09%	0.21%	0.04%
HUN	0.41%	0.40%	0.43%	0.39%	0.42%	-0.03%	-0.03%	-0.07%	0.25%	0.12%
SVN	0.39%	0.38%	0.41%	0.37%	0.40%	0.01%	-0.02%	-0.03%	0.34%	0.14%
CZE	0.38%	0.37%	0.42%	0.37%	0.42%	-0.02%	-0.02%	-0.10%	0.11%	-0.02%
ITA	0.37%	0.37%	0.40%	0.36%	0.40%	-0.03%	-0.04%	-0.09%	0.12%	-0.04%
ESP	0.26%	0.26%	0.29%	0.25%	0.30%	-0.01%	-0.01%	-0.03%	0.11%	-0.19%
POL	0.17%	0.15%	0.21%	0.15%	0.20%	-0.08%	-0.06%	-0.15%	0.01%	-0.04%
GRC	0.16%	0.16%	0.16%	0.16%	0.18%	-0.08%	-0.09%	-0.06%	0.00%	-0.30%
LUX	0.15%	0.12%	0.21%	0.13%	0.22%	-0.24%	-0.12%	-0.20%	-0.27%	-0.48%
PRT	0.12%	0.11%	0.24%	0.11%	0.22%	-0.15%	-0.15%	-0.51%	-0.04%	-0.19%
ROW	-0.05%	-0.06%	0.00%	-0.01%	0.04%	-0.03%	-0.01%	-0.11%	-0.92%	-1.06%

Note: The table presents changes in: real wage indexes, real wages of four types of workers, efficient labor composite and stocks of low/high-skilled natives/foreigners after liberalizing trade, considering MID scenario. AVG is the simple average of all the OECD countries. ROW stands for the rest of the world. Source: own calculations.

2.B Detailed model description

In what follows, I summarize the main equations of the model.

Preferences and demand

Individuals solve their utility maximization problem:

$$\max_{x_{ijh}^s(k)} \left\{ \ln \left[\left(1 - c_{ij}^s\right) \left(\sum_{n=1}^{N} \int_0^{B_n} x_{ijn}^s(k)^{\frac{\epsilon-1}{\epsilon}} dk \right)^{\frac{\epsilon}{\epsilon-1}} \right] + \xi_{ij} \right\} \tag{2.B1}$$

under the budget constraint:

$$\sum_{n=1}^{N}\int_{0}^{B_n} p_{in}(k)\cdot x_{ijn}^{s}(k)dk = w_{ij}^{s}, \qquad \text{where:} \quad w_{ij}^{s} = \begin{cases} w_i^s & \text{if} \quad j=i \\ w_{-i}^s & \text{if} \quad j\neq i \end{cases} \tag{2.B2}$$

The solution, that is the individual demand function, boils down to:

$$x_{ijn}(k) = \frac{p_{in}(k)^{-\epsilon}}{\sum_{n=1}^{N} B_n \left(\tau_{in}p_n\right)^{1-\epsilon}} X_i. \tag{2.B3}$$

Solving for the indirect utility function:

$$U_{ij}^{s} = \ln\left[\left(1-c_{ij}^{s}\right)u_{ij}^{s}\right] + \xi_{ij} \tag{2.B4}$$

where:

$$u_{ij}^{s} = \left(\sum_{h=1}^{N}\int_{0}^{B_h}\left(\frac{p_{ih}(k)^{-\epsilon}}{P_i^{1-\epsilon}}w_{ij}^{s}\right)^{\frac{\epsilon-1}{\epsilon}} dk\right)^{\frac{\epsilon}{\epsilon-1}} = \frac{w_{ij}^{s}}{P_i}, \tag{2.B5}$$

and

$$P_i = \left[\sum_{n=1}^{N}\int_{0}^{B_n} p_{in}(k)^{1-\epsilon}dk\right]^{\frac{1}{1-\epsilon}} = \left[\sum_{n=1}^{N} B_n \left(\tau_{in}p_n\right)^{1-\epsilon}\right]^{\frac{1}{1-\epsilon}}. \tag{2.B6}$$

Production

The production function of firm k in country i is defined as a nested CES function of employed labor. The upper level production function determines the quantity of efficient high-skilled and low-skilled components needed to produce a given output $y_i(k)$:

$$y_i(k) = A_i\bar{\ell}_i^T(k) = A_i\left(\theta_i^S\left(\bar{\ell}_i^h(k)\right)^{\frac{\sigma_S-1}{\sigma_S}} + \left(1-\theta_i^S\right)\left(\bar{\ell}_i^l(k)\right)^{\frac{\sigma_S-1}{\sigma_S}}\right)^{\frac{\sigma_S}{\sigma_S-1}}, \tag{2.B7}$$

where A_i is the exogenous country-specific level of total factor productivity (in the robustness check it is modeled endogenously as a Lucas externality, so that: $A_i = \bar{A}_i g_i^{\lambda}$, $g_i \equiv \left(L_i^h + L_{-i}^h\right)/L_i^T$).[31]

The lower level production functions define the efficient labor composites for each level of education, as a CES combinations of native and foreign workers:

$$\begin{aligned} \bar{\ell}_i^l(k) &= \left[\theta_i^N\left(\ell_i^l(k)\right)^{\frac{\sigma_N-1}{\sigma_N}} + \left(1-\theta_i^N\right)\left(\ell_{-i}^l(k)\right)^{\frac{\sigma_N-1}{\sigma_N}}\right]^{\frac{\sigma_N}{\sigma_N-1}}, \\ \bar{\ell}_i^h(k) &= \left[\theta_i^N\left(\ell_i^h(k)\right)^{\frac{\sigma_N-1}{\sigma_N}} + \left(1-\theta_i^N\right)\left(\ell_{-i}^h(k)\right)^{\frac{\sigma_N-1}{\sigma_N}}\right]^{\frac{\sigma_N}{\sigma_N-1}}. \end{aligned} \tag{2.B8}$$

[31] Consider the following notation for $s \in \{l, h\}$: L_i^s and L_{-i}^s are the numbers of native and foreign workers of skill s, who reside in country i, so their total supply in country i is: $L_i^T = L_i^l + L_i^h + L_{-i}^l + L_{-i}^h$. Considering firms' demand for workers, let: $\ell_i^s(k)$ be the number of s-skilled natives employed by firm k in country i.

Firstly, for a given production level $y_i(k)$, each firm chooses the optimal combination of high-skilled and low-skilled efficient composites, that minimizes the total labor cost:

$$\min_{\bar{\ell}_i^h(k),\bar{\ell}_i^l(k)} W_i^h \bar{\ell}_i^h(k) + W_i^l \bar{\ell}_i^l(k)$$

$$s.t.\ A_i \left(\theta_i^S \left(\bar{\ell}_i^h(k) \right)^{\frac{\sigma_S - 1}{\sigma_S}} + \left(1-\theta_i^S\right) \left(\bar{\ell}_i^l(k) \right)^{\frac{\sigma_S - 1}{\sigma_S}} \right)^{\frac{\sigma_S}{\sigma_S - 1}} \geq y_i(k).$$

The first-order conditions determine the optimal demand for efficient low and high-skilled workers in firm k:

$$\bar{\ell}_i^h(k) = \frac{y_i(k)}{A_i} \left(\frac{\theta_i^S W_i}{W_i^h} \right)^{\sigma_S} \qquad \text{and} \qquad \bar{\ell}_i^l(k) = \frac{y_i(k)}{A_i} \left(\frac{(1-\theta_i^S) W_i}{W_i^l} \right)^{\sigma_S}, \tag{2.B9}$$

where W_i is the aggregate wage index and is defined as:

$$W_i = \left[(\theta_i^S)^{\sigma_S} \left(W_i^h \right)^{1-\sigma_S} + (1-\theta_i^S)^{\sigma_S} \left(W_i^l \right)^{1-\sigma_S} \right]^{\frac{1}{1-\sigma_S}}. \tag{2.B10}$$

Secondly, each firm chooses the optimal combination of native and foreign workers within each education category, taking the total supply of efficient high and low-skilled labor as given. Firms solve the following cost minimization for high-skilled workers:

$$\min_{\ell_i^h(k),\ell_{-i}^h(k)} w_i^h \ell_i^h(k) + w_{-i}^h \ell_{-i}^h(k)$$

subject to:

$$s.t.\ \left(\theta_i^N \left(\ell_i^h(k) \right)^{\frac{\sigma_N - 1}{\sigma_N}} + \left(1-\theta_i^N\right) \left(\ell_{-i}^h(k) \right)^{\frac{\sigma_N - 1}{\sigma_N}} \right)^{\frac{\sigma_N}{\sigma_N - 1}} \geq \bar{\ell}_i^h(k).$$

The optimal labor demands for skilled natives and migrants are then equal to:

$$\ell_i^h(k) \;=\; \bar{\ell}_i^h(k) \left(\frac{\theta_i^N W_i^h}{w_i^h} \right)^{\sigma_N} = \frac{y_i(k)}{A_i} \left(\frac{\theta_i^S W_i}{W_i^h} \right)^{\sigma_S} \left(\frac{\theta_i^N W_i^h}{w_i^h} \right)^{\sigma_N} \tag{2.B11}$$

and

$$\ell_{-i}^h(k) \;=\; \bar{\ell}_i^h(k) \left(\frac{(1-\theta_i^N) W_i^h}{w_{-i}^h} \right)^{\sigma_N} = \frac{y_i(k)}{A_i} \left(\frac{\theta_i^S W_i}{W_i^h} \right)^{\sigma_S} \left(\frac{(1-\theta_i^N) W_i^h}{w_{-i}^h} \right)^{\sigma_N}$$

where W_i^h is the remuneration of the efficient high-skilled labor composite:

$$W_i^h = \left[(\theta_i^N)^{\sigma_N} \left(w_i^h \right)^{1-\sigma_N} + \left(1-\theta_i^N\right)^{\sigma_N} (w_{-i}^h)^{1-\sigma_N} \right]^{\frac{1}{1-\sigma_N}}. \tag{2.B12}$$

Labor demand and wage index for the low-skilled natives and migrants are derived in a symmetric way. The homogeneity of firms induces that the firm-specific indicators, k, may be dropped. The above described cost minimization problem determines the optimal unit cost of production for each firm:

$$c_i = \frac{w_i^h \ell_i^h + w_{-i}^h \ell_{-i}^h + w_i^l \ell_i^l + w_{-i}^l \ell_{-i}^l}{y_i} = \frac{W_i}{A_i}. \tag{2.B13}$$

The firm's profit maximization determines the price and quantity produced per firm. Each firm faces a residual demand curve with a constant elasticity of substitution equal to ϵ and then chooses the same markup $\epsilon/(\epsilon-1)$ which yields the following pricing rule:

$$p_i = \frac{\epsilon}{\epsilon-1} c_i = \frac{\epsilon}{\epsilon-1} \frac{W_i}{A_i}. \tag{2.B14}$$

The output per firm, y_i, is determined by the profit maximization and the free entry condition. Indeed, as long as the profits are positive, new firms will enter the market causing profits to fall, until they are driven to zero:

$$\pi = (p_i - c_i)\, y_i - W_i f_i = 0, \tag{2.B15}$$

so that:

$$y_i = (\epsilon - 1) A_i f_i. \tag{2.B16}$$

The mass of varieties B_i produced in economy i is a function of country size. Notice that the total production in economy i is $B_i y_i$, therefore:

$$B_i y_i = B_i A_i \bar{\ell}_i^T = \tfrac{\epsilon-1}{\epsilon} A_i \bar{L}_i^T = B_i(\epsilon-1) A_i f_i,$$

because only the share $(\epsilon-1)/\epsilon$ of total labor $\bar{L}_i^T$ is devoted to the production purposes (that is: $\bar{\ell}_i^T$), the rest is employed to cover the fixed costs. The mass of varieties produced in a given country is then equal to:

$$B_i = \frac{\bar{L}_i^T}{\epsilon f_i}. \tag{2.B17}$$

Aggregating the country-pair-specific flows of goods one obtains a simple representation of export from country j to country i, as a share of the domestic GDP:

$$\frac{X_{ij}}{X_j} = \frac{X_i \,(P_i/\tau_{ij})^{\epsilon-1}}{\sum_{h=1}^N X_h \,(P_h/\tau_{hj})^{\epsilon-1}}. \tag{2.B18}$$

Migration

Using the explicit form of the utility:

$$U_{ij}^s = \ln\left[\left(1 - c_{ij}^s\right) \frac{w_{ij}^s}{P_i}\right] + \xi_{ij}, \tag{2.B19}$$

and assuming that $\xi_{ij} \sim G(0, 1/\mu)$, one can apply the McFadden's theorem (see McFadden, 1984) to calculate the probability that an agent of type s will emigrate from j to i:

$$\pi_{ij}^s = \Pr[U_{ij}^s = \max_{n\in N}\left(U_{nj}^s\right)] = \frac{\exp\left(U_{ij}^s\right)}{\sum_{n=1}^N \exp\left(U_{nj}^s\right)}$$

$$= \frac{\Big((1-c_{ij}^s)w_{ij}^s/P_i\Big)^{\mu}}{\sum_{n=1}^{N}\Big((1-c_{nj}^s)w_{nj}^s/P_n\Big)^{\mu}}. \tag{2.B20}$$

Knowing that for $j \neq i$:

$$\pi_{ij}^s = \frac{M_{ij}^s}{L_j^T} = \frac{\Big((1-c_{ij}^s)w_{-i}^s/P_i\Big)^{\mu}}{\sum_{n=1}^{N}\Big((1-c_{nj}^s)w_{nj}^s/P_n\Big)^{\mu}}, \tag{2.B21}$$

and for $i = j$:

$$\pi_{jj}^s = \frac{M_{jj}^s}{L_j^T} = \frac{\Big(w_j^s/P_j\Big)^{\mu}}{\sum_{n=1}^{N}\Big((1-c_{nj}^s)w_{nj}^s/P_n\Big)^{\mu}}, \tag{2.B22}$$

I obtain the random utility model equations, which define the endogenous flows of people:

$$\frac{M_{ij}^s}{M_{jj}^s} = \frac{\pi_{ij}^s}{\pi_{jj}^s} = \left(\frac{w_{-i}^s/P_i}{w_j^s/P_j}\left(1-c_{ij}^s\right)\right)^{\mu}. \tag{2.B23}$$

Competitive equilibrium

The competitive equilibrium is a set $\{w_i^s, w_{-i}^s, W_i, W_i^h, W_i^l, c_i, p_i, P_i, B_i, [X_{ij}]_{i,j\in N}, [M_{ij}^s]_{i,j\in N}\}_{i\in N}$ such that for a set of common parameters $\{\epsilon, \sigma_S, \sigma_N, \mu\}$, a set of country-specific parameters $\{\theta_i^S, \theta_i^N, L_i^s, f_i, A_i\}_{i\in N}$ and the matrices of country-pair trade costs $[\tau_{ij}]_{i,j\in N}$ and migration costs $[c_{ij}^s]_{i,j\in N}$, $s \in \{l, h\}$:

1. Each vector of nominal wages in $i \in N$: $w_i^l, w_i^h, w_{-i}^l, w_{-i}^h$ is determined by four labor market clearing conditions:
$$\begin{aligned} L_i^l &= \bar{L}_i^T(1-\theta_i^S)^{\sigma_S}\left(\theta_i^M\right)^{\sigma_M}(W_i)^{\sigma_S}\left(W_i^l\right)^{\sigma_M-\sigma_S}(w_i^l)^{-\sigma_M},\\ L_i^h &= \bar{L}_i^T\left(\theta_i^S\right)^{\sigma_S}\left(\theta_i^M\right)^{\sigma_M}(W_i)^{\sigma_S}\left(W_i^h\right)^{\sigma_M-\sigma_S}\left(w_i^h\right)^{-\sigma_M},\\ L_{-i}^l &= \bar{L}_i^T(1-\theta_i^S)^{\sigma_S}(1-\theta_i^M)^{\sigma_M}(W_i)^{\sigma_S}\left(W_i^l\right)^{\sigma_M-\sigma_S}(w_{-i}^l)^{-\sigma_M},\\ L_{-i}^h &= \bar{L}_i^T\left(\theta_i^S\right)^{\sigma_S}(1-\theta_i^M)^{\sigma_M}(W_i)^{\sigma_S}\left(W_i^h\right)^{\sigma_M-\sigma_S}(w_{-i}^h)^{-\sigma_M}, \end{aligned} \tag{2.B24}$$
where $L_i^l, L_i^h, L_{-i}^l, L_{-i}^h$ are the exogenous quantities of labor in country i.
2. The zero profit condition pins down the wage index: W_i for $i \in N$.
3. The equilibrium wages and the wage indexes determine: $\{W_i^h, W_i^l, c_i, p_i\}$.
4. The mass of varieties is determined by the market size equation.
5. The mass of varieties, the wage indexes and the bilateral trade costs $[\tau_{ij}]_{i,j\in N}$, determine P_i.
6. The trade matrix $[X_{ij}]_{i,j\in N}$ is determined by the trade gravity equation.
7. The migration matrices $[M_{ij}]_{i,j\in N}$ are determined by the bilateral migration costs $[c_{ij}]_{i,j\in N}$ and the random utility model equations.

Relations between migration and trade

Proof. (*Proposition 2.1*) In the proof, I will make use of the logarithms of relative migration and trade flows (2.6 and 2.4 respectively):

$$\begin{aligned} \ln \frac{M_{ij}^s}{M_{jj}^s} &= \mu \ln \left(\frac{w_{-i}^s/P_i}{w_j^s/P_j} \right) + \mu \ln \left(1 - c_{ij}^s\right), \\ \ln \frac{X_{ij}}{X_{jj}} &= \ln \frac{X_i}{X_j} + (\epsilon - 1) \ln \left(\frac{P_i}{P_j} \right) + (1-\epsilon)\tau_{ij}. \end{aligned} \tag{2.B25}$$

(a) Consider a liberalization of migration from country j to country i. Let the bilateral migration cost c_{ij}^s decrease. Using the logarithm of the migration flow equation (first in 2.B25), it is straightforward to see that:

$$\frac{\partial \ln \frac{M_{ij}^s}{M_{jj}^s}}{\partial \ln c_{ij}^s} = \underbrace{\frac{-\mu c_{ij}^s}{1 - c_{ij}^s}}_{-} + \mu \underbrace{\frac{\partial \ln w_{-i}^s / w_j^s}{\partial \ln c_{ij}^s}}_{+} + \mu \underbrace{\frac{\partial \ln P_j / P_i}{\partial \ln c_{ij}^s}}_{-} < 0, \tag{2.B26}$$

where the first element always dominates. An inflow of immigrants (to country i) increases internal demand, which triggers the GDP level, dampens wages and decreases the price index. For country j the effects are opposite. Therefore, the first round effect of decreasing migration cost to country i is an increase in a relative flow of migrants towards country i.

Consider now the logarithm of the equation describing relative flows of trade (the second in 2.B25). Taking the derivative of this expression with respect to c_{ij}^s one gets:

$$\frac{\partial \ln \frac{X_{ij}}{X_{jj}}}{\partial \ln c_{ij}^s} = \underbrace{\frac{\partial \ln X_i / X_j}{\partial \ln c_{ij}^s}}_{-} + (\epsilon - 1) \underbrace{\frac{\partial \ln P_i / P_j}{\partial \ln c_{ij}^s}}_{+} \gtrless 0. \tag{2.B27}$$

The positive market size effect related to an inflow of immigrants to country i causes the GDP to increase and the price index to fall. Depending on the magnitude of both forces, bilateral trade may be higher or lower. When the general equilibrium effects on wages and labor flows dominate the price effects, then trade and migration act as **complements**, if one imposes a migration shock.

(b) Consider a liberalization of trade from country j to country i. Let the bilateral trade cost τ_{ij} decrease. With the equation describing aggregated trade flows, one can show that:

$$\frac{\partial \ln \frac{X_{ij}}{X_{jj}}}{\partial \ln \tau_{ij}} = \underbrace{(1 - \epsilon)}_{-} + (\epsilon - 1) \underbrace{\frac{\partial \ln P_i / P_j}{\partial \ln \tau_{ij}}}_{+} + \underbrace{\frac{\partial \ln X_i / X_j}{\partial \ln \tau_{ij}}}_{+} < 0. \tag{2.B28}$$

The direct effects of liberalizing trade (first element) always dominate, so that the bilateral trade flow increases.

In the same vein, consider the impact of trade liberalization on bilateral migration flow from j to i:

$$\frac{\partial \ln \frac{M_{ij}^s}{M_{jj}^s}}{\partial \ln \tau_{ij}} = \mu \underbrace{\frac{\partial \ln w_{-i}^s / w_j}{\partial \ln \tau_{ij}}}_{+} \underbrace{-\mu \frac{\partial \ln P_j / P_i}{\partial \ln \tau_{ij}}}_{+} > 0. \tag{2.B29}$$

A decrease in trade cost decreases the GDP level in the receiving country i, which diminishes wages. Simultaneously, a smaller cost of imports lowers the price index P_i. In country j the effects are opposite. Therefore, a decrease in bilateral trade cost results in a drop in bilateral migration, and consequently, migration and trade act as **substitutes**, if one imposes a trade shock. □

2.C Calibration algorithm and model fit

Considering the fact that the proposed model assumes some multidimensional nonlinear relations between the key endogenous variables, I choose to analyze its outcomes through the numerical simulations of the properties of the general equilibrium. Therefore, both the calibration and simulation procedures are conducted iteratively, to restore all the equilibrium conditions in the system of $N = 35$ OECD and rest of world economies.

For the calibration, I propose the following algorithm of proceedings. The first step consists in setting the values of all the exogenously given parameters of the model (described in detail in the previous section). The full set of parameters contains the country specific shares of high-skilled / migrants in producing the value added, the elasticities (these are: ϵ - elasticity of substitution between varieties, σ_S - elasticity of substitution between low and high-skilled, σ_N - elasticity of substitution between natives and migrants) and the dispersion of EVD distribution μ.

Secondly, using the macroeconomic data, I define the vectors of the exogenous macroeconomic variables. Actual levels of GDPs are taken from the World Bank's World Development Indicators. The bilateral migration matrices of different skill levels are computed using the DIOC database provided by the OECD, extended with the UN database and the dataset by Artuc et al. (2015). The data on bilateral trade values originate from the World Bank's WITS database. Then the fixed cost of entry is constructed by using the data from Doing Business Indicators by the World Bank.[32] With these, one is able to determine the wage indexes W_i and the masses of varieties B_i from the equilibrium conditions.

The next step is the iterative procedure of fitting the TFP residuals A_i and the bilateral trade costs matrix $[\tau_{ij}]$ taking into consideration two criteria. Not only does the general equilibrium of the model have to be ensured (all the equilibrium conditions reduce to a system of N zero-profit equations which then are solved for the TFP residual), but also the model aspires to have a close fit to the real trade data. The latter is controlled by the trade cost matrix. What is proposed is the following loop. First, the solution to the system of $N(N-1)$ gravity trade equations is calculated.[33] This partial solution is then used to restore the general equilibrium of the model by iteratively solving N zero-profit equations and fitting the TFP residuals. After computing

[32] In detail, I calculate the fixed cost vector as an unweighted synthetic indicator of three standardized variables: the number of days needed to start a business, the cost of starting a business (as a share of GNP p.c.) and the survival rate of firms, normalized to the minimal value of 1.

[33] I do the computations with the help of *nleqslv* package in R. The solver of systems of nonlinear equations in *nleqslv* is based on Dennis and Schnabel (1996). I use the Broyden method which is an extension of the Newton method of solving systems of nonlinear equations.

the endogenous bilateral trade flows, the model trade matrix is compared to the actual trade matrix and the distance between the two is calculated (which is the sum of squares of differences between particular entries). The iteration on $[\tau_{ij}]$ and A_i ceases when this distance is minimized. Furthermore, using the labor market equilibrium conditions, the skill and origin-specific wages are calculated for every country. Finally, the bilateral migration cost matrices (for low and high-skilled workers) $\left[c_{ij}^{l}\right]$ and $\left[c_{ij}^{h}\right]$ are determined by the random utility model specification, which completes the calibration.

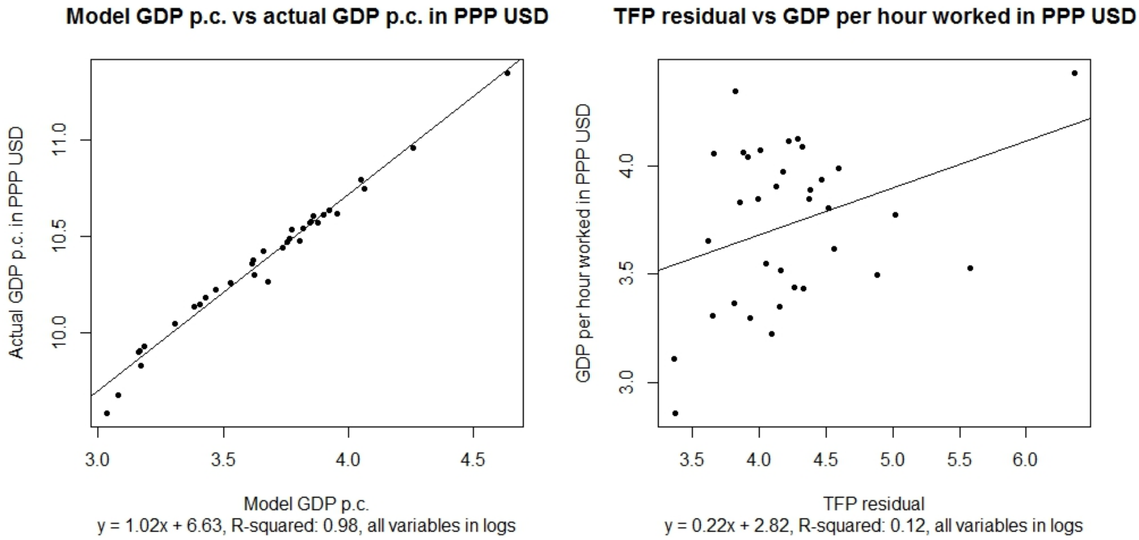

FIGURE 2.C1: The match of (log) of model variables with (log) of actual variables.
Source: own calculations.

The calibration concentrates on fitting the matrices of global migration and international trade, allowing wages, prices and masses of varieties to float freely. Therefore, the only restrictions imposed on these endogenous variables are defined by the random utility migration equations, gravity trade equations, and the equilibrium conditions which reduce to the system of zero-profit conditions (taking the exogenous macroeconomic variables and parameters values as given).

In terms of the GDP per capita, the model provides a close matching with actual data (see Figure 2.C1). The R^2 of the regression is equal to 0.98 and the slope is 1.02. Then, the TFP residuals are weakly, positively correlated with the productivity indicator (which in this case is the GDP per hour worked in PPP USD). As the TFP residual is computed in a way that the general equilibrium is obtained in the multi-country system, it may capture various characteristics of the analyzed economies.

Consider the comparison of model trade matrix and actual bilateral trade values. This exercise allows us to evaluate both the market equilibrium price indexes and the bilateral iceberg trade costs which are numerically fitted to maximize the Euclidean distance between both trade matrices. The correlation between real and model trade values equals 98.92 percent and is not perfect due to the fact that I impose the iceberg cost of producing for the home market to be equal to 1, whereas any bilateral cost cannot be smaller than this value (see Figure 2.C2). Thus, I lose N degrees of freedom in calibrating the trade cost matrix. The regression line that relates both matrices is: $X_{ij}^{REAL} = 1.0006 \cdot X_{ij}^{MODEL} - 0.02$ $R^2 = 0.9892$. This means that only 1.08 percent of the real bilateral trade flows is not explained in the calibrated model. This result seems to be very promising in terms of analyzing the general equilibrium effects of liberalizing both migration and trade.

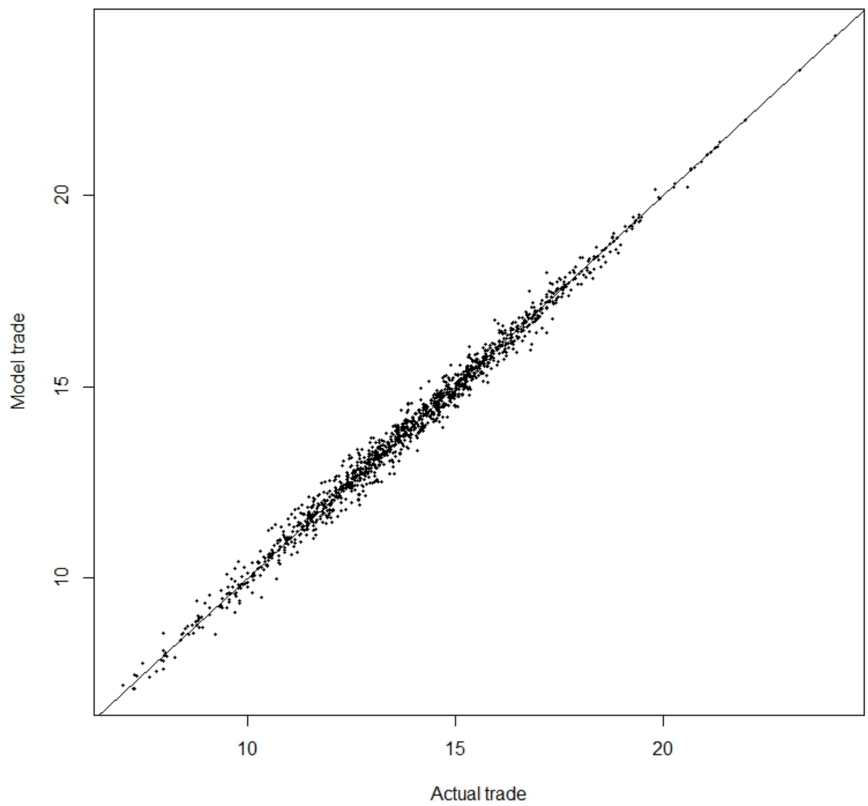

FIGURE 2.C2: The match of (log) of model trade with (log) of actual trade.
Source: own calculations.

2.D Aggregated gains as values

TABLE 2.D1: Aggregated gains from liberalizing migration (changes in variables)

	EU							OECD						
	Real GDP	L_i^l	L_i^h	L_{-i}^l	L_{-i}^h	Imp	Exp	Real GDP	L_i^l	L_i^h	L_{-i}^l	L_{-i}^h	Imp	Exp
MIN	-9,388	-4,412	-3,258	1,939	912	-70	-68	19,229	-15,738	-7,928	15,560	8,050	-57	-57
MID	-10,885	-5,093	-3,787	2,219	1,067	-80	-77	22,144	-18,054	-9,244	17,856	9,385	-64	-64
MAX	-28,259	-21,318	-5,468	9,547	1,170	-179	-170	64,428	-68,252	-13,309	67,582	13,981	-133	-133

TABLE 2.D2: Aggregated gains from liberalizing trade (changes in variables)

	EU							OECD						
	Real GDP	L_i^l	L_i^h	L_{-i}^l	L_{-i}^h	Imp	Exp	Real GDP	L_i^l	L_i^h	L_{-i}^l	L_{-i}^h	Imp	Exp
MIN	1.202	-43	-19	55	10	73	83	7.684	104	8	170	123	539	539
MID	2.281	-82	-37	104	18	146	163	14.805	211	16	314	235	1.036	1.036
MAX	4.643	-169	-76	210	36	302	337	31.028	484	37	603	481	2.117	2.117

Note: The tables provide the changes in the values of real GDP (in millions of USD PPP), population of natives (low-skilled and high-skilled, in thousands of people), population of residents (low-skilled and high-skilled, in thousands of people), value of imports and exports (in millions of $) in the EU and the OECD after liberalizing migration, trade and migration and trade among all the OECD countries, in 3 scenarios: MIN, MID and MAX. Source: own calculations.

2.E Robustness checks

Robustness to elasticities

Let us start with different values for the elasticity of substitution between the low-skilled and the high-skilled workers. In the reference scenario, I assume that $\sigma_S = 1.75$. Consider two border cases of $\sigma_S^{LOW} = 0.9$ and $\sigma_S^{HIGH} = 2.6$, which are close to +/- 50 percent changes in the starting value of the parameter. In columns three and four of Table 2.E2, the economic effects on the natives living in all the OECD countries after a standard MID shock to migration and trade are reported. A smaller value of σ_S signifies that the non-college-educated and college-educated are stronger complements, so that the gains from having a diversified labor force are larger. One can observe stronger effects on the real wages of migration shocks for those countries, which experience a net inflow of immigrants. Consequently, countries which encounter a reduction in population are characterized by an even higher losses. The reverse effect (that is, a less dispersed distribution of gains) may be observed with an assumption of higher substitutability between both types of workforce. However, even though the value of σ_S changes drastically, the quantitative outcomes do not move more than by +/- 10 percent (with an exception for New Zealand). Since the value of the elasticity of substitution is consensually estimated at the level of $1.75 - 2$ in the literature, this parameter is certainly not a cause of any confounding misspecification.

The value of the elasticity between natives and immigrant is far less consensual than the previous one. Ottaviano and Peri (2012) estimate it at the level of $\sigma_N = 20$, but Borjas (2013) argues that native and foreign workers are close to perfect substitutes. Therefore, I take the +/-50 percent deviations in this parameter as a robustness check. Lower values of σ_N increase the gains from diversity and magnify the positive effects of higher migration flows. On the contrary, while forcing substitutability between natives and foreigners, the beneficial impact of larger migration vanishes. Once again, the quantitative deviations are rather small.

The two former robustness checks were concerned with the structure of production and the labor market. Their direct impact on the results is working only through migration channels and does not appear to be severe. Some significant differences in the real wage impact of liberalizing migration and trade may be found after manipulating the elasticity of substitution between any two varieties consumed. In the reference scenario I considered $\epsilon = 4$, which is in line with the empirical findings (both the old and the recently published ones). This element of the model strongly relates to the gains from trade and the extent to which its value is vulnerable to bilateral costs of international exchange of goods. This debate is far from over, but as the empirical evidence suggest, that ϵ for aggregated product structure is probably closer to the lower bound of its confidence interval. In fact, what I check are both lower and higher values of this figure, taking +/-50 percent of its value. As expected, lower elasticity, $\epsilon = 2$, means higher gains from having liberalized trade, which changes the results drastically. The impact of trade makes the natives in the less integrated economies (such as Mexico, Turkey or Chile) strongly better off by comparison to the reference scenario. None of the OECD countries loses, and all the changes in real wages are above 2 percent. Taking $\epsilon = 6$ reduces the positive effects of liberalizing trade, and makes the natives in the majority of OECD states worse off.

Alternative parametrization of agents' utility

The paper by Bertoli et al. (2013) provides some insights about the estimation of the elasticity of utility with respect to real wage in the random utility model. The authors analyze a simple Roy model in which agents decide about locating, considering the deterministic (objective) real wage and stochastic (subjective) taste for migration. This representation leads to a logit probability of migration, which is then a function of the wage rate. They estimate the core parameter (denoted by μ in the model) using a nested logit model in logarithms. They find that the elasticity of utility in respect of wage ranges from 0.501 to 0.756 (depending on the estimation procedure, the reference value is 0.655).

According to the results by Bertoli et al. (2013) and my own estimations of μ (see Tables 2.1 and 2.2), I run an additional set of simulations assuming a lower value of the elasticity of utility in respect of the real wage. In line with those findings, I take $\mu = 0.7$. The main country-specific results are gathered in the eight column of Table 2.E2. Clearly, the qualitative properties are identical to the benchmark results with $\mu = 1$. However, the magnitudes of the effects are now somewhat different, and are characterized by lower dispersion. Indeed, the agents are now less responsive to changes in migration costs, thus fewer people migrate, and so both the benefits for the winners and the costs for the losers are now reduced.

Similarly, I investigate the other possibility of a higher elasticity of migration with respect to the real wage ratio. Taking $\mu = 1.3$, one can observe that the spread between the winners and the losers is now wider; however the quantitative difference in the effect on wages for the majority of countries is limited to several percentage points.

TFP effects of net migration

Net migration may affect the productivity through a change in the number of highly skilled professionals. Some recent findings by Peri et al. (2013) provide evidence that the immigration of scientists, engineers and mathematicians has a strong positive influence on the remuneration of high-skilled non-migrants in the US, and a slight effect on the less educated. Aubry et al. (2014) show that the TFP effect plays an important role in the overall impact of net migration for the natives in OECD countries.

However, there are some confusing arguments about the impact of the high-skilled workers on the technological progress and productivity. On the one hand, Acemoglu and Angrist (2000) do not find any relations between the share of tertiary educated workers and the economy-wide productivity. On the other hand, Moretti (2004a) estimates robust social returns attributed to high-skilled workers. Therefore, I would like to account for these potential spillovers and endogenize the level of TFP in each economy. In doing so I follow Lucas (1988) and write the TFP function as a product of an exogenously given TFP residual, $\bar{A}_i$, and a concave function of the high-skilled share in population: $A_i = \bar{A}_i g_i^{\lambda}$, $g_i \equiv \frac{L_i^h + L_{-i}^h}{L_i^T}$. I arbitrarily fix the elasticity of TFP in respect of the high-skilled share at the level of $\lambda = 0.3$.

The results of the robustness check including endogenous TFP levels are presented in column ten in Table 2.E2. The main difference with the reference results is a larger dispersion of the quantitative effects. Indeed, the countries which win are the ones that attract relatively more high-skilled workers. This improves the productivity of all the employed and causes the nominal wages to rise. On the contrary, the losing countries are generally the ones drained of their high-skilled potential. Therefore, the losses for the natives in these economies are even more pronounced after accounting for endogenous TFP.

The more selective the migration flow is, the greater the differences from the benchmark are. Therefore, New Zealand, Canada and Switzerland are the main winners. By contrast, the rest of the countries, (not only the previously losing, but also those which experienced a slight gain in real wages comparing to the reference scenario) are now encountering significant drops in real wages, even though the total population rises (consider for example Austria, Germany or the Netherlands, which are the destinations for many low-skilled immigrants). Therefore, accounting for any TFP effects of migration results in a more pessimistic evaluation of the gains from reducing migration barriers.

Congestion effects of immigration

In this section, I take into consideration the potential negative externalities of higher immigration inflows. Following Docquier et al. (2015), I assume that the crowding effect (an increase in population) deteriorates the countries TFP with an elasticity $\phi = 0.03$. This value is equal to the share of the value added due to land in the production of the developed countries (following Ciccone and Hall (1996)). In this scenario, the destination countries are penalized, whereas the sources gain additional productivity effect. Taking the previously reported magnitude of the congestion effects, the results are not dramatically different (the changes in effects are less than 10 percent in comparison to the benchmark).

Network effects of migration on trade

The literature dealing with the relation between trade and migration provides empirical evidence that migrants may reduce the bilateral trade costs between the destination and home countries through two channels. Preference and information channels, which are commonly aggregated as a single network effect, are the important determinants of the complementary co-movement of migration and trade. An inflow of immigrants, which increases the probability of recruiting a foreigner in an exporting firm, reduces the cost of gathering the information about local markets, affords insights into cultural requirements when doing business, and helps to establish direct business links. Simultaneously, an immigrant demands more of the products that originate from his motherland, which spurs the bilateral flow of goods. These two factors cause that, apart from the earlier investigated market size effects, there is a specific relation between migration and trade. In this section I would like to account for this.

To begin, I calculate the elasticity of bilateral trade cost with respect to the number of immigrants to and emigrants from a particular country. I modify the regressions which decompose the numerically calibrated values of τ_{ij}'s by introducing the logs of in- and out- migrants between two particular countries. In Table 2.E1, I summarize the outcomes of estimations.

The results are close to what has been obtained in the previous versions (see Table 2.4). Both immigrants and emigrants reduce bilateral trade costs, although the effects are limited. All the estimates suggest that the effect of immigrants is stronger, which is in line with what was obtained by Parsons (2012). This confirms the conclusions by Gould (1994), who states that the information channel is more pronounced than the preference channel.

Using these parameters, I run a full liberalization simulation, assuming that bilateral trade costs decrease with the stock of bilateral immigrants and emigrants (as in Docquier et al., 2015)). The

TABLE 2.E1: Estimation of legal bilateral trade costs with network effects of migration

	Dependent variable: $\ln \tau_{ij}$				*Dependent variable:* τ_{ij}			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	OLS	OLS	OLS	OLS	PPML	PPML	PPML	PPML
Tariff and	0.456***	-0.107	1.047***	0.676***	0.160	0.410**	0.819***	0.893***
non-tariff barriers	(0.175)	(0.125)	(0.163)	(0.114)	(0.249)	(0.184)	(0.211)	(0.147)
Log emigrants	-0.037***	-0.021***	-0.017***	-0.018***	-0.051***	-0.011*	-0.029***	-0.019***
	(0.006)	(0.004)	(0.006)	(0.004)	(0.008)	(0.006)	(0.008)	(0.005)
Log immigrants	-0.062***	-0.052***	-0.048***	-0.053***	-0.060***	-0.062***	-0.046***	-0.057***
	(0.006)	(0.004)	(0.005)	(0.004)	(0.006)	(0.006)	(0.005)	(0.005)
Log distance	0.215***	0.290***	0.164***	0.243***	0.217***	0.346***	0.154***	0.249***
	(0.016)	(0.012)	(0.015)	(0.011)	(0.021)	(0.016)	(0.019)	(0.015)
Border	-0.068	-0.021	-0.059	-0.005	-0.128	0.098	-0.107	0.098
	(0.064)	(0.030)	(0.061)	(0.028)	(0.086)	(0.075)	(0.083)	(0.072)
Language	-0.050	-0.103***	-0.059	-0.079***	-0.070	-0.104**	-0.072	-0.084**
	(0.054)	(0.026)	(0.051)	(0.024)	(0.060)	(0.042)	(0.058)	(0.039)
Year2000	-0.171***	-0.098***			-0.215***	-0.175***		
	(0.030)	(0.016)			(0.042)	(0.024)		
Log trade			-0.062***	-0.041***			-0.074***	-0.055***
			(0.004)	(0.002)			(0.005)	(0.003)
Constant	0.949***	0.180	2.006***	1.133***	1.299***	-0.456***	2.566***	1.413***
	(0.131)	(0.128)	(0.140)	(0.130)	(0.165)	(0.160)	(0.176)	(0.171)
Origin FE	NO	YES	NO	YES	NO	YES	NO	YES
Destination FE	NO	YES	NO	YES	NO	YES	NO	YES
Observations	2,244	2,244	2,244	2,244	2,244	2,244	2,244	2,244
R-squared	0.315	0.873	0.382	0.890	0.190	0.839	0.267	0.877

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$, standard errors in parenthesis. Source: own calculations.

results show that the network effects of migration on trade costs may bring some important gains for both receiving and, more importantly, sending countries (see Table 2.E2, column 12). Canada and Switzerland are the best examples of the former states. Considering, for example, the cases of Turkey, Ireland or Korea shows that the latter instance is also possible. Quantitatively, the network effects may increase the effects of the liberalization of migration and trade by more that 50 percent.

Network effects of migration on migration

Beine et al. (2011) gives evidence that migration networks have a strong impact on the value of migration costs. In this robustness check, an additional mechanism is considered, namely that the bilateral migration costs are functions of the actual numbers of migrants. Therefore, an inflow of new immigrants has a decreasing effect on the value of migration costs (according to Beine et al. (2011), the values of semi-elasticities of migration costs with respect to the number of immigrants are: 0.2 for the low-skilled and 0.05 for the high-skilled). A similar strategy was implemented by Docquier et al. (2015), who find that network effects on migration costs visibly increase the gains from liberalizing migration. In the case of current model, the implication of including migration networks are positive for all countries, for some of them the gains increase by more than 100 percent. This modification solves one possible source of Lucas critic, the fact that migration costs are (at least partly) endogenous.

Brains waste

Many of the high-skilled emigrants take low-skilled occupations in the host countries. This is more the case with non-OECD immigrants, however one cannot rule out this phenomenon concerning the intra-OECD migration. Therefore, in the last robustness check, it is assumed that 10 percent of high-skilled migrants works as low-skilled laborers. The results are negative for all destinations, however the magnitude of the effect of brain waste on natives' welfare is rather small.

TABLE 2.E2: Robustness checks

Code	Ref.	σ_S 0.9	σ_S 2.6	σ_M 10	σ_M 30	ϵ 2	ϵ 6	μ 0.7	μ 1.3	λ 0.3	ϕ 0.03	Net. Tr.	Net. Mig.	Brain waste
AUS	6.15%	6.43%	6.06%	6.86%	5.91%	10.85%	3.10%	4.52%	8.22%	6.82%	5.78%	7.87%	7.04%	5.55%
AUT	0.57%	0.10%	0.67%	0.74%	0.51%	3.22%	0.10%	0.56%	0.58%	-1.11%	0.56%	1.44%	0.63%	0.37%
BEL	1.33%	1.16%	1.38%	1.44%	1.30%	3.74%	0.18%	1.36%	1.28%	0.48%	1.33%	3.42%	1.33%	1.22%
CAN	6.83%	7.44%	6.64%	7.49%	6.62%	12.37%	2.71%	5.66%	8.28%	8.46%	6.62%	10.89%	7.30%	5.66%
CHE	6.71%	7.39%	6.49%	7.66%	6.39%	6.69%	3.48%	5.61%	8.03%	9.49%	6.42%	13.03%	7.21%	5.90%
CHL	1.62%	1.16%	1.71%	1.68%	1.61%	11.69%	-0.34%	1.84%	1.37%	-0.53%	1.68%	3.41%	1.50%	1.50%
CZE	0.00%	-0.38%	0.08%	0.04%	-0.01%	2.45%	-0.22%	0.15%	-0.18%	-1.37%	0.03%	0.69%	-0.05%	-0.25%
DEU	0.51%	0.18%	0.60%	0.67%	0.46%	3.14%	-0.06%	0.61%	0.40%	-1.02%	0.53%	1.57%	0.51%	0.35%
DNK	0.28%	0.09%	0.34%	0.38%	0.26%	3.28%	-0.10%	0.38%	0.16%	-0.60%	0.30%	1.16%	0.26%	0.22%
ESP	0.19%	0.15%	0.20%	0.24%	0.17%	2.71%	0.00%	0.22%	0.14%	0.04%	0.20%	0.52%	0.17%	-0.06%
EST	0.13%	-0.06%	0.19%	0.18%	0.11%	3.18%	-0.34%	0.30%	-0.09%	-0.52%	0.18%	0.86%	0.06%	-0.31%
FIN	0.26%	0.06%	0.30%	0.30%	0.24%	3.25%	-0.15%	0.35%	0.13%	-0.63%	0.28%	0.95%	0.22%	0.14%
FRA	0.23%	-0.08%	0.29%	0.29%	0.20%	3.11%	-0.10%	0.30%	0.13%	-0.70%	0.24%	0.84%	0.20%	0.00%
GBR	-0.85%	-1.34%	-0.72%	-0.68%	-0.91%	3.12%	-0.88%	-0.33%	-1.50%	-2.27%	-0.71%	-0.24%	-1.11%	-1.45%
GRC	-0.64%	-0.65%	-0.63%	-0.51%	-0.68%	2.49%	-0.45%	-0.30%	-1.10%	-0.73%	-0.54%	-0.49%	-0.83%	-0.90%
HUN	-0.26%	-0.54%	-0.19%	-0.22%	-0.28%	2.44%	-0.45%	0.00%	-0.59%	-1.34%	-0.20%	0.35%	-0.38%	-0.59%
IRL	1.73%	1.56%	1.78%	1.93%	1.66%	4.77%	-0.67%	1.98%	1.41%	0.73%	1.87%	4.35%	1.61%	1.32%
ISL	-0.06%	-0.42%	0.03%	0.05%	-0.10%	5.65%	-0.74%	0.28%	-0.51%	-1.62%	0.04%	0.86%	-0.23%	-0.25%
ISR	2.99%	3.18%	2.94%	3.42%	2.85%	8.37%	0.85%	2.55%	3.55%	3.48%	2.93%	5.36%	3.16%	1.80%
ITA	-0.09%	-0.34%	-0.04%	-0.01%	-0.11%	2.65%	-0.26%	0.10%	-0.33%	-1.10%	-0.03%	0.35%	-0.20%	-0.18%
JPN	0.84%	0.74%	0.86%	0.90%	0.82%	6.19%	-0.01%	0.88%	0.78%	0.42%	0.84%	1.79%	0.83%	0.44%
KOR	0.92%	0.84%	0.95%	1.01%	0.89%	8.45%	-0.78%	1.38%	0.35%	0.17%	1.05%	2.99%	0.74%	0.37%
LUX	-0.45%	-0.67%	-0.37%	-0.36%	-0.48%	2.64%	-0.41%	-0.24%	-0.77%	-1.29%	-0.37%	-0.05%	-0.62%	-0.96%
MEX	0.55%	0.60%	0.53%	0.70%	0.50%	14.39%	-1.64%	1.60%	-0.76%	0.69%	0.88%	2.93%	-0.07%	0.42%
NLD	0.84%	0.61%	0.90%	0.99%	0.79%	3.50%	-0.06%	0.93%	0.72%	-0.20%	0.87%	2.30%	0.82%	0.57%
NOR	0.36%	0.18%	0.40%	0.45%	0.33%	2.61%	-0.03%	0.42%	0.28%	-0.15%	0.36%	1.28%	0.34%	0.14%
NZL	8.36%	10.90%	7.71%	8.93%	8.17%	17.35%	3.61%	6.53%	10.56%	13.38%	8.00%	10.07%	9.13%	7.49%
POL	-0.69%	-1.11%	-0.59%	-0.65%	-0.70%	2.07%	-0.53%	-0.36%	-1.09%	-2.37%	-0.62%	-0.46%	-0.83%	-0.93%
PRT	-1.26%	-2.06%	-1.17%	-1.16%	-1.30%	2.32%	-0.89%	-0.72%	-1.95%	-2.87%	-1.11%	-1.08%	-1.61%	-1.41%
SVK	0.08%	-0.30%	0.16%	0.10%	0.07%	2.16%	-0.24%	0.25%	-0.13%	-1.43%	0.11%	0.81%	0.01%	-0.16%
SVN	-0.09%	-0.28%	-0.04%	-0.04%	-0.10%	2.58%	-0.32%	0.10%	-0.33%	-0.85%	-0.04%	0.53%	-0.18%	-0.30%
SWE	0.45%	0.26%	0.50%	0.55%	0.42%	3.25%	0.01%	0.49%	0.39%	-0.20%	0.45%	1.38%	0.45%	0.26%
TUR	-0.16%	-0.37%	-0.12%	-0.06%	-0.19%	8.38%	-0.75%	0.32%	-0.74%	-1.03%	-0.03%	0.74%	-0.48%	-0.35%
USA	2.52%	2.49%	2.54%	2.85%	2.42%	5.85%	1.27%	1.93%	3.22%	2.34%	2.34%	3.32%	2.82%	1.94%
ROW	-0.04%	-0.06%	-0.04%	-0.03%	-0.05%	-0.54%	0.00%	-0.04%	-0.04%	-0.09%	-0.04%	-0.09%	-0.04%	-0.58%

Note: The table provides the percent changes in the real wages of natives in the benchmark scenario and after taking various values of key parameters, assuming a full liberalization in MID scenario. Source: own calculations.

Chapter 3

Time, Space and Skills in Designing Migration Policy

Abstract

The chapter proposes a multi-country model of international migration, in which prospective high-skilled emigrants choose their destination country, preferred type of visa, and the optimal duration of stay. Combining these elements into a unified theoretical framework provides a micro-foundation for multilateral resistance to migration. The application of the proposed theory consists in investigating global demographic implications of decreasing the costs of 6-year visas for the high-skilled professionals in the EU, calibrated as an introduction of H1B visas. This is compared with a policy of providing fiscal incentives (reduction of income tax rate) for medium-term, college-educated foreign workers. The two counterfactuals indicate a significant increase in the yearly inflows and total stocks of high-skilled immigrants in the EU. The outcomes of the former policy are driven by "visa-substitution" effect within the group of current emigrants, while the latter scenario provokes new entries of the previous never-migrants. Both policies induce the "talent-stealing" effect - losses of skilled migrants by the non-EU states, which is significantly reinforced by the multilateral resistance to migration.

Keywords: migration policy, temporary migration, discrete choice models, H1B visas.

JEL: F22, J61.

3.1 Introduction

The quality of immigrants emerges as a key objective in determining migration policy in many destination countries. In the US, the Immigration Act of 1990 established the H1B visa, which is aimed at attracting well-educated professionals from all over the world for a temporary working period. Selectivity of immigrants has become one of the most recognizable features of national migration policies in Australia, Canada or New Zealand. These countries impose immigration quotas and evaluate the candidates using a point-based system. Despite these restrictions, they still attract large waves of highly skilled individuals, which enables them to shape the size and the structure of incoming workforce.[1]

Until recently, in contrast, the EU proposed less restrictive regulations, and did not attach great importance to the quality of immigrants. Such a migration policy often did not meet the needs of internal labor market and the expectations of potential immigrants. In 2009 the European Parliament passed a union-wide solution to the problem of Europe's attractiveness for the educated immigrants. The European Blue Card (EBC) program is constructed for those high-skilled non-EU workers, who wish to spend between one and four years in the EU as a professional employee. This initiative resembles the H1B visa, however, the popularity of both proves to be drastically different. In 2014, the US issued 316,000 H1B visas (124,000 new issues and 192,000 prolongations), while the efficacy of EBC seems to be disappointing with only 13,000 issues in 2014. One might ask about the causes of this discrepancy. Is it due to the fact that EBC is a relatively new policy (launched in 2013), and potential candidates are not well informed about a novel emigration option? Or, conversely, is the EU immanently less attractive than other rich destinations, and any liberalization of migration policy would never improve it? Finally, how does the effect of visa liberalization compares to a pecuniary incentive for new high-skilled immigrants: a tax concession program?[2]

The observed discrepancy in migration policies in the EU and other rich destinations is the core motivation for this research. The chapter tries to identify the consequences of reducing this difference for the global flows of high-skilled migrants. I give quantitative evidence about the efficacy of two migration policies in the EU: an implementation of H1B visa, and an alternative tax reduction scheme for the college-educated immigrants. Taking the striking difference between the US and the EU in the effects of visa policies as the reference point, I run a counterfactual experiment of implementing American resolutions (H1B visas) in Europe, and I compare it to a fiscal incentive for the high-skilled immigrants. I propose a multi-country model with utility-maximizing heterogeneous agents, who endogenously decide about the destination of emigration, the visa to apply for, and the optimal duration of stay, in an environment of imperfect information. People differ in their subjective preferences towards living in all the possible destinations, and, independently of that, may experience different, unanticipated, random shocks after having emigrated. Heterogeneity in preferences results in individual-specific choices of destination country and visa, whereas the heterogeneity in unexpected migration costs differentiates the optimal duration of stay. In this framework, I quantify the new distribution of migrants across 35 richest destinations, resulting from counterfactual migration policy liberalizations for the high-skilled workers in the EU.

Along with the quantitative results, this study contributes to the theoretical literature on modeling international migration. This is the first approach towards enriching a classical discrete choice model (with many sending and receiving countries) in the vein of McFadden (1973), with agents' decisions about the duration of stay, inspired by Djajić (2014a). For a simplified version of this model I provide closed-form solutions for the probabilities of emigration and the distribution of duration of stay. Since the full model becomes relatively complex at some

[1] Recent literature documents that international migration brings a non-trivial impact on the welfare of natives in the sending and the receiving countries (Aubry et al., 2014, Docquier et al., 2015). An important role in this process is played by the selection of migrants regarding their education level (Grogger and Hanson, 2011).

[2] This particular immigration policy is motivated by the fact that some European countries actually provide a restricted tax concession program. For example, Belgium, Denmark, Italy, the Netherlands, and Sweden offer tax exemptions for foreign researchers and scientists (following the CES IFO report on: Tax concessions for brainpower - Tax policy as a measure in the competition for brainpower, and the OECD (2011)). In my counterfactual simulations I propose a more liberal approach, that is a reduction in income taxation for all college-educated immigrants, not only the tertiary-educated ones.

level, I solve it numerically. Furthermore, following Bertoli and Moraga (2013), the proposed theoretical framework gives a micro-foundation for multilateral resistance to migration (MRM), by relaxing the independence of irrelevant alternatives (IIA) axiom (as a consequence of a non-trivial correlation structure between discrete choice options).[3] In this framework, I experiment with alternative visa policies in the EU.[4] I focus on the way the migration policy affects the destination choices of migrants (*geographical dimension*), the duration of stay (*time dimension*), and the selection of migrants with respect to their education levels (*skill dimension*). The theoretical and numerical outcomes show that a simultaneous consideration of these three factors enables to single previously overlooked economic effects out. Moreover, neglecting MRM due to disregarding some of those dimensions may bring a significant bias in the quantitative evaluation of counterfactual migration policies.

Considering the numerical outcomes of the simulations, I give evidence that the proposed modifications of the EU's migration policy may have a visible impact on the supply of skilled labor. Implementing an H1B visa in the EU increases the yearly flows of college-educated workers by 3 percent, and the total stocks 6.1 percent. This policy improves the relative attractiveness of medium-term visas in Europe, therefore, it induces the "visa-substitution" effect: the current migrants with short-term and long-term visas are now more prone to substitute them for cheaper medium-term visas within the same destination. However, the H1B policy has no impact on the absolute attractiveness of Europe: no new never-migrants are invited. Additional flows are procured by the "talent-stealing" effect: some of the current migrants in non-EU countries decide to migrate to the EU. In terms of the tax concession policy, the aggregated flows of high-skilled immigrants in Europe increase by 10.6 percent, while total stocks change by 5.6 percent. In this case, the "visa-substitution" effect is quantitatively less important, while the "talent-stealing" effect remains sizable. The main economic force that determines the high raise in inflows, is the augmentation of the absolute attractiveness of Europe, which induces a strong "new-entry" effect of previous never-migrants.

The rest of the chapter is organized as follows. In the next Section I briefly summarize the reference literature. The third Section presents a general overview of the model, and the analytical solution to its simplified version with one visa. This is followed by a description of multi-visa models, in Section 4. Section 5 discusses data used, as well as numerical procedures of calibration and simulations. Section 6 analyzes the results of counterfactual simulations and Section 7 concludes.

3.2 Related literature

The proposed theoretical approach contributes to three important strands of literature on international migration. First, the study relates to the literature on migrants' location choice in multi-country systems. Then, since I explicitly model decisions about the duration of stay, I refer to the literature on temporary and return migration. Finally, since the core of the model is the computation of the effects of redesigning visa portfolios and implementing fiscal incentives, I refer to the broad literature on migration policy.

[3] Multilateral resistance to migration allows for complex interdependencies among the choice options. In particular, with MRM, a change in the attractiveness of a third country (caused by an increase in net income, or a reduction in bilateral migration costs), can have an indirect impact on the relative ordering of preference towards emigrating to any two distinct destinations.

[4] The model considers 178 sending countries and 35 developed destinations: 28 EU members, Australia, Canada, Iceland, Norway, New Zealand, Switzerland, and the US.

A large body of research in international migration concentrates on explaining the motives for choosing particular destination countries. To describe the location decisions at the macro level, both theoretical and empirical papers exploit the random utility maximization (RUM) model proposed by McFadden (1973). Empirical contributions by Grogger and Hanson (2011), Beine et al. (2011) or Belot and Hatton (2012) give evidence on the main drivers of destination choice in the framework of logit model. Docquier and Machado (2015) and Docquier et al. (2015) make use of this model to quantify the consequences of reducing barriers to migration in a global context. All of these approaches consider only permanent immigration, and assume independence across the choice options. In a nutshell, the economic situation in a third country has no impact on the relative odds of emigrating to any two destinations. Evidence by Bertoli and Moraga (2013, 2015) suggests, however, the contrary. According to their findings, the interdependence across decisions is a substantial factor that determines the incentives to migrate, the overall size, and the composition of migration flows. This multilateral resistance to migration creates a challenge for both empirical and theoretical modelers. Considering the econometric models, following the seminal paper by Bertoli and Moraga (2013), the correlations across choice options are structured in individuals' preferences, following McFadden (1978). Depending on the model specification, these relations can be controlled using origin-time, destination-time, or origin-nest dummies (Beine et al., 2015, Beine and Parsons, 2015, Bertoli et al., 2013, Ortega and Peri, 2013). However, the theoretical literature lacks in a micro-based explanation to this phenomenon. In response, the model introduces the time dimension of migration decisions, which by definition, imposes correlations across the choice options, and provides a micro-foundation for multilateral resistance to migration.

The time dimension in people's decisions about international migration has been introduced to theoretical models of migration in the early works by Djajić and Milbourne (1988), Djajić (1989), Galor and Stark (1990), Dustmann (1993), and Borjas and Bratsberg (1996). These papers also treat the choice of the length of the period spent abroad as a solution to the utility maximization problem. A representative person cares about the life-cycle utility which depends on the level of wages or the total stock of financial, or human capital.[5] More recently, Dustmann and Weiss (2007), Adda et al. (2014), and Dustmann and Görlach (2015) mention four mechanisms that bring incentives for deciding to migrate temporarily.[6] Furthermore, Dustmann and Görlach (2015) provide a thorough analysis of hitherto state of literature on temporary migration and construct a theoretical model which incorporates these potential motives for earlier return. Dustmann et al. (2011) proposes a two-skill, two-country model to account for specific selection and return patterns. They conclude that people have more incentives to stay in a country that rewards more their main skill, so that in aggregated terms, temporary migration is a source of "brain circulation".[7] The fact that temporary migrants may bring significant positive

[5] Nakajima (2014) proposes an alternative theoretical setup assuming that each immigrant is characterized by a "homesickness" parameter - a disutility of living abroad. Using the data from Mexican Migration Project Survey, the author finds that people return earlier because the gains from staying longer in the US are not large enough to compensate for their homesickness.

[6] These factors are: (1) high preferences for consumption in home country when the wages are low, (2) high purchasing power of the currency of destination country in the home country, (3) a vanishing wage differential between host and source countries, when the immigrant accumulates human capital, and finally (4) an accelerated human capital accumulation in the destination country.

[7] A relatively new strand of literature emphasizes the "brain circulation" process which is a direct consequence of return migration. This approach is a complement rather than a substitute to the well-developed notions of "brain drain" and "brain gain". In the case of "brain drain", emigration necessarily causes impoverishment of the sending countries, because those who decide to leave the country of birth are the well-educated workers (Docquier and Rapoport, 2012). The positive selection of out-migration causes negative economic effects for the sources, since the benefits are transferred to the destinations along with the flow of human capital. An immediate response to this theory is the concept of "brain gain" which stresses the fact that in the poorer countries, rational economic agents would invest in their education in order to increase their chance to emigrate. This process, in the long run,

spillovers for the sending countries is highlighted, among others, by Dustmann and Görlach (2015). Bijwaard and Wahba (2014) empirically confirm that such a process takes place, and the high-earners are more likely to return home.

In support for distinguishing between temporary and permanent migrants, some studies give evidence about differences in characteristics and economic behaviors between the two groups. Considering, for example, the accumulation of financial resources, various strategies (conditional on migrant's duration of stay) are reported by Djajić and Vinogradova (2015), Dustmann and Mestres (2010a,b), Kırdar (2009). Thanks to the availability of micro-level data, some authors managed to quantify the properties of the actual distribution of the length of stay, and the factors which make people migrate temporarily (Aydemir and Robinson, 2008, Bijwaard, 2010, Bijwaard et al., 2014, Bijwaard and Wahba, 2014, Dustmann, 2003, Pinger, 2010). In terms of theoretical modeling, the works by Djajić (2014a,b) propose two-countries, continuous-time models in which the decisions about the duration of stay are endogenized. In fact, the majority of papers that consider the time dimension in migration decisions disregard the choice of locations, and analyze a dyad of a sending and a receiving country. This chapter differs from the previous ones by developing a theoretical model in which people select both location and the time period spent abroad.

The question of designing an efficient migration policy in the developed regions still remains opened (Czaika and De Haas, 2013). Countries, which experience a sizable inflow of new immigrants (Canada, Australia, New Zealand), proposed a selective visa policy that depends on a point system of evaluating the candidates for visas. However, recently they turn to the US pattern of employer-sponsored visas for the high-skilled (Koslowski, 2014), which proves to be a successful way of attracting highly productive talents (Peri et al., 2013). Martín and Venturini (2015) evaluate the current state of EU's visa policy. Noticing its simplicity and underdevelopment, they propose a unified and comprehensive modification at the EU level.

The relation between temporary flows of people and migration policy is analyzed by Thom (2010). By simulating a two-country model, the author concludes that more restrictions leads to a smaller gross flow of Mexicans to the US. However, the stock of immigrants may rise due to an increase in the average length of stay of those who decide to emigrate. Constant and Zimmermann (2011) point out that people decide to migrate temporarily (and circularly) when the barriers for mobility decline. In a multi-country context, Giordani and Ruta (2013) and De la Croix and Docquier (2012) suggest the possibility of coordination failures in terms of designing international migration policies which lead to a Pareto-dominated outcomes. In conclusion, they express the need for a global coordination in migration policy.[8]

3.3 Decisions about destination and the duration of stay

I start with introducing a general version of the model. The *ex ante* decision (which is reached before migrating), is analyzed below. At this stage agents know their individual preferences towards living in different countries $j \in \mathcal{N}$, represented by random components: ε_j, and the expected (or equivalently, anticipated) country-pair-specific cost of migration from i to j: x_{ji}.

would eventually provide strong positive effect for the developing economies. Finally, considering the fact that not all migrants are permanent, the returnees are expected to bring their human, social and entrepreneurial capital home. This process is broadly referred to as "brain circulation".

8 Works by Facchini and Mayda (2008), Facchini et al. (2011), Facchini and Willmann (2005) treat migration policy as endogenous and dependent on various factors. They try to determine the causes of different migration policies, and relate them to external interest groups, strategies of politicians, or lobbyists.

These variables includes legal (in particular: visa) and psychological, sociological, as well as cultural costs. The *ex post* decision (reached after migrating) is subject to additional information. The values of unforeseen costs of living abroad (denoted by ρ_{ji}) are revealed, and force individuals to modify their decisions about the duration of stay. The latter is analyzed in the next subsection.

Consider an economic agent, who currently lives in country i and considers moving to country $j \in \mathcal{N}$.[9] Each individual is economically active for one period which lasts 1 unit of time, equivalent to 50 years.[10] She can choose any of N destinations grouped in the choice set $\mathcal{N}$, including her homeland i. Receiving countries differ in the levels of net wages (denoted by v_j) and in the expected costs of migration, (labeled by $x_{ji}(\bar{d})$), dependent on the authorized maximal duration of stay $\bar{d} \in [0, 1]$.[11] Furthermore, each country $j \in \mathcal{N}$ provides an individual offer of visas for the prospective immigrants. Assume that there are D_j types of permissions of stay in a destination j, and each migrant selects her preferred option $\bar{d} \in \mathcal{D}_j$. Assuming her *ex ante* decision to be binding, an immigrant would spend time $\bar{d}$ abroad and return to her homeland for the remaining part of her life: $1 - \bar{d}$.

People have heterogeneous preferences towards living in each receiving country. Consequently, the utility component related to living in state $j \in \mathcal{N}$ is augmented with an agent-specific random term ε_j, which represents the taste for living in country j.[12] Assume that ε_j is an iid stochastic variable distributed according to the Gumbel's distribution. In this vein, this approach refers to the literature which uses the discrete choice random utility maximization (RUM) model.[13]

All the above-mentioned values are known to the agent *ex ante*, that is before the actual moving. What is not revealed to the individual, is the unanticipated migration cost, ρ_{ji}, which enters the utility function quadratically. This element represents the unforeseen cultural, social and institutional aspects of living abroad for a migrant from i to j, in contrast with the expected migration cost $x_{ji}(\bar{d})$, known *ex ante*.[14] Having no experience in being a part of a foreign society, an agent predicts that emigration may be either detrimental for his lifetime utility (positive value of ρ_{ji}), or beneficial ($\rho_{ji} < 0$), if the lifestyle in the destination country suits them better. Therefore, she forms an *ex ante* (before emigration) expectation of the value of this parameter. I consider

[9] This model describes only the behavior of high-skilled individuals. However, a model with many types of agents, differentiated with respect to their education level, is a straightforward extension. In fact, the previous versions of the model considered two education levels (low- and high-skilled), which boiled down to indexing all the variables with superscripts: $s \in \{L, H\}$, and considering the skill-specific environments separately, at the same time.

[10] Time in this model is assumed to be continuous, however I consider the states of the world in two discrete point: the reference point $t = 0$ and the terminal point: $t = 1$. The period is assumed to last for 50 years, normalized to unity.

[11] These costs are known to every potential emigrant, and are identical across all individuals, who move from i to j. They may relate to some objective discrepancies between the source and the destination country, i.e. distance, differences in culture, or social norms. Additionally, since this foreseen migration costs is specific to a particular type of visa, it incorporates all legal barriers to migrate.

[12] Individual heterogeneity may be linked to personal qualities of an agent, her ability to assimilate, specific qualifications (language skills), or simply reflect the preferences.

[13] The theoretical consequence of this assumption is the possibility to represent the choice probability as a logit. An alternative would be to use the Gaussian distribution, which would lead to choice probabilities defined as probits. The unquestioned advantage of the first solution is its simplicity when it comes to solving the model with many choice options. In practice, considering the further modifications of the reference model and their calibration strategies, ε_j could be distributed according to any continuous distribution defined on $\mathbb{R}$. However, I decide to keep the assumption about Gumble's distribution to directly compare the results with classical migration models.

[14] The concept of unforeseen migration cost may be illustrated with all random events that take place after emigrating, and cannot be *ex ante* internalized by individuals, i.e. satisfaction from a new job, social networks in the host country, or even nostalgia for the homeland. This additional migration cost is the second source of heterogeneity across agents.

a situation in which ρ_{ji} is distributed according to a probability density function $\bar{\rho}(\cdot)$ defined on $\mathbb{R}$. Since *ex ante* people have neutral expectations about the unforeseen circumstances after migration (all other foreseeable factors are captured by $x_{ji}(\bar{d})$), a necessary requirement is that $\mathbb{E}[\bar{\rho}_{ji}] = 0$. Thus, *ex ante* the expected value of the unforeseen migration cost does not influence the choice of destination and visa type. In this way, ρ_{ji} brings the second source of heterogeneity across agents. In brief, the model considers people having "bad" draws of unexpected migration costs, characterized by $\rho_{ji} > 0$ (where ρ_{ij} is the realization of a random variable $\bar{\rho}_{ij}$, independent of individual preferences towards different destinations, ε_j), and those who assimilate well in the host country, with: $\rho_{ji} < 0$.

After entering the labor market in country i, an individual compares the expected, *ex ante*, gains in each country j, represented by a linear, random utility function (considered, among others, by Grogger and Hanson, 2011)[15]:

$$\mathbb{E}[U_{ji}(\bar{d})] = \bar{d}\left(\alpha\left(v_j - x_{ji}(\bar{d})\right) + \varepsilon_j - \bar{d}\mathbb{E}[\bar{\rho}_{ji}]/2\right) + (1-\bar{d})\left(\alpha v_i + \varepsilon_i\right). \tag{3.1}$$

In order to reach their decisions about future location, individuals compare the levels of net wages across all destination $j \in \mathcal{N}$.[16] They also consider their individual tastes towards living in foreign countries and potential costs ascribed to moving (both tangible and non-tangible ones). In details, α is the marginal utility of income, and v_j is the net wage (gross wage in USD PPP reduced by mandatory income taxes in destination j). $x_{ji}(\bar{d})$ stands for expected, bilateral migration cost of moving from i to j, for a period of length $\bar{d}$, determined by the receiving country visa policy: $\bar{d} \in \mathcal{D}_j$. The legal part of this cost is the main policy instrument of the destination authority targeted at influencing the total flows of high-skilled immigrants. Additionally, as stated before, the utility depends on the individual preferences: ε's, and the expected value of the unforeseen migration cost equal, by assumption, to 0. Finally, the *ex ante* decision boils down to selecting the preferred destination country j^* and the duration of stay $\bar{d}^*$ defined by the visa portfolio $\mathcal{D}_{j^*}$. The agent chooses from $K = \sum_{j=1}^{N} D_j$ options, and takes the optimal *ex ante* decision:

$$(j^*, \bar{d}^*) = \underset{j\in\mathcal{N},\ \bar{d}\in\mathcal{D}_j}{\operatorname{argmax}}\ \mathbb{E}[U_{ji}(\bar{d})]. \tag{3.2}$$

After reaching a new destination country, agents discover the exact value of the unforeseen migration cost ρ_{ji}. Their *ex ante* measure of utility (3.1) is therefore modified by considering the actual realization ρ_{ji} of the random variable $\bar{\rho}_{ji}$. Given that the return cost is incorporated in the expected migration cost x_{ji}, the agent has to re-optimize the decision about the length of her stay by defining the time after which she would like to return to her homeland.[17]

Formally, the *ex post* utility for an immigrant from i to j, who acquired a visa of duration $\bar{d}^*$ is:

$$U_{j^*i}(\bar{d}^*, d) = d\left(\alpha\left(v_{j^*} - x_{j^*i}(\bar{d}^*)\right) + \varepsilon_{j^*} - d\rho_{j^*i}/2\right) + (1-d)\left(\alpha v_i + \varepsilon_i\right). \tag{3.3}$$

[15] Linear utility assumes constant marginal utility of income. At the other extreme, the log-utility would impose decreasing marginal utility of income, and might lead to different quantitative and qualitative results.

[16] I explicitly assume that prospective emigrants do not face credit constraints. This is credible for the high-skilled individuals, following Djajić et al. (2013), who give evidence that credit constraint are vital for migration decisions of the low-skilled, low-earning agents.

[17] The model assumes that people have no incentives to move to any other foreign country. Additionally, there is no option to overstay temporary visas. The second limitation may be implemented with an additional (monetary and psychological) utility cost connected with becoming an illegal resident. Therefore, only those who have strong preferences towards the host country (but not strong enough to apply for a visa with longer duration) would prolong the duration of temporary visa. Since the problem of overstaying is mainly related with low-skilled migrants, overstaying is not explicitly modeled in this chapter.

Notice that this utility function is defined for a given destination j^* and a given visa type $\bar{d}^*$ determined in the *ex ante* decision problem (3.2). Eventually, each individual reconsiders her emigration strategy by selecting the optimal duration of migration spell (expressed now by $d \in [0,1]$), through the maximization of her *ex post* (after emigration) utility:

$$d^* = \underset{d \in [0,1]}{\operatorname{argmax}} U_{j^* i}(\bar{d}^*, d) \tag{3.4}$$

The optimal, *ex post* duration is an interior solution, $d^* \in (0,1)$, if and only if at the moment d an individual is indifferent between staying abroad and returning home (possible only if $\rho_{ji} > 0$). In contrast, when $\rho_{ji} \leq 0$, an immigrant will certainly stay until the expiration date of visa: $d^* = \bar{d}^*$.

3.3.1 A model with one, permanent-stay visa

This subsection focuses on a simplified version of the general model. The aim is to obtain analytical solutions for the *ex post* aggregates which describe migrants' durations of stay across destinations. To start with, assume that only one type of visa is available in every receiving country. Suppose that this visa offers a permission to immigrate permanently. Therefore, a person may decide to stay at home (equivalent to setting $\bar{d}^* = 0$) or to emigrate to any country j (so that $\bar{d}^* = 1$ and $j^* = j$). Determining the *ex ante* duration of stay is, thus, a discrete choice from N available options:

$$\begin{aligned} &\exists j \in \mathcal{N}: \quad \alpha (v_j - x_{ji}) + \varepsilon_j > \alpha v_i + \varepsilon_i \quad \Rightarrow \quad \bar{d}^* = 1 \quad \& \quad j^* = j, \\ &\forall j \in \mathcal{N}: \quad \alpha (v_j - x_{ji}) + \varepsilon_j \leq \alpha v_i + \varepsilon_i \quad \Rightarrow \quad \bar{d}^* = 0 \quad \& \quad j^* = i. \end{aligned} \tag{3.5}$$

All in all, individuals select destinations with the highest expected utility, and immediately move there (or stay in their country of birth). Therefore, each of them faces a standard discrete choice problem analyzed by McFadden (1984), so that the probability to choose a destination j by an agent born in country i is equal to:

$$\pi_{ji} = \frac{\exp\left[\alpha (v_j - x_{ji})\right]}{\sum_{k=1}^{N} \exp\left[\alpha (v_k - x_{ki})\right]}. \tag{3.6}$$

Notice that the result (3.6) implies that the ratio of probabilities to emigrate to any two distinct destinations $j, k \in \mathcal{N}$ fulfills the Independence of Irrelevant Alternatives (IIA) axiom:

$$\frac{\pi_{ji}}{\pi_{ki}} = \exp\left[\alpha (v_j - x_{ji} - v_k + x_{ki})\right]. \tag{3.7}$$

IIA imposes that the relative odds of emigrating to countries j and k are solely functions of the characteristics of these two destination. Equivalently, adding another destination would influence all the other choice probabilities in the same way, so that the relation between any two of them would remain unchanged. In this setup, there is no correlation between two particular options, as the axiom states: the relative chances of selecting any two possibilities are independent of other (irrelevant) ones.

The second key simplification of the model concerns the distribution of unforeseen costs of living abroad: $\bar{\rho}_{ji}$. Consider the simplest density function that fulfills the demanded requirement (zero expected value): a symmetric two-point distribution. Assume that $\bar{\rho}_{ji}$ can take two possible values: $-\rho_{ji}$ or ρ_{ji}, with equal probabilities. Now, the *ex post* decision reached by a permanent migrant determines the optimal duration of stay. Being granted a visa, a person may stay in the receiving country as long as she wants. By solving the maximization problem (3.4), one gets:

Proposition 3.1. The optimal, ex post duration of migration is given by:

$$d^* = \begin{cases} \min\left\{\rho_{j^*i}^{-1}\left(V_{j^*i} + \varepsilon_{j^*} - \varepsilon_i\right); 1\right\}, & \text{if} \quad \rho_{j^*i} > 0, \\ 1, \quad \text{if} \quad \rho_{j^*i} < 0, \end{cases} \tag{3.8}$$

where $V_{j^*i} \equiv \alpha(v_{j^*} - x_{j^*i} - v_i)$ is the net value of migration.

Proof. See Appendix 3.A. □

A temporary migrant is characterized by $0 < d^* < 1$, whereas a permanent migrant sets $d^* = 1$. This division depends only on the comparison of objective amenities between two destinations and on the subjective preferences towards living in home and foreign country. In fact, when $\rho_{ji} > 0$, d^* is a random variable with tractable statistical characteristics. Consider the probability that a person characterized by $\rho_{ji} > 0$ moves abroad for a period shorter than a given $\delta \leq 1$.

$$\Pr[d < \delta] = \Pr\left[\rho_{ji}^{-1}\left(V_{ji} + \varepsilon_j - \varepsilon_i\right) < \delta\right] = \Pr\left[\rho_{ji}\delta + \varepsilon_i > V_{ji} + \varepsilon_j\right] = \frac{e^{\rho_{ji}\delta}}{e^{\rho_{ji}\delta} + e^{V_{ji}}}. \tag{3.9}$$

This probability increases in ρ_{ji}, because the higher the realization of unforeseen migration cost, the lower the propensity to stay in a foreign country. On the contrary, greater discrepancy between remunerations in destination and source, V_{ji}, decreases the chance that a randomly chosen individual returns to the homeland. What one obtains is a well-defined CDF of the random variable d^*, with a support on $\mathbb{R}$. Let it be labeled by $F(\cdot)$, while the associated PDF be represented by $f(\cdot)$.

Corollary 3.2. When $\rho_{ji} > 0$, for a given $\delta \leq 1$, the probability of staying for a period shorter than δ (the CDF of the duration of stay) is:

$$F(\delta) = \frac{e^{\rho_{ji}\delta}}{e^{\rho_{ji}\delta} + e^{V_{ji}}}. \tag{3.10}$$

The PDF of the duration stay, defined $\forall\, d \in \mathbb{R}$, is:

$$f(d) = \frac{\rho_{ji} e^{\rho_{ji}d + V_{ji}}}{\left(e^{\rho_{ji}d} + e^{V_{ji}}\right)^2}. \tag{3.11}$$

Proof. The CDF is derived in equation (3.9). The PDF is the first derivative of the CDF. □

However, in what follows, I focus only on those individuals who decide to migrate, so that necessarily $d > 0$. The probability of such an event is given by:

$$\Pr\left[V_{ji} + \varepsilon_j > \varepsilon_i\right] = \frac{e^{V_{ji}}}{1 + e^{V_{ji}}}. \tag{3.12}$$

The positive sign of d is guaranteed by agent's *ex ante* decision about emigration to country j (if it had not been the case, then country j would have never been considered as a potential destination for emigration). Therefore, I restrict the analysis to conditional probabilities, densities and moments, knowing that for sure: $d > 0$. Consequently, for a given $\delta \in [0, 1]$ the probability that a person stays in the destination country for a period shorter than δ (conditional on emigrating), is given by:

$$\Pr\left[d < \delta | d > 0\right] = \frac{1 + e^{V_{ji}}}{e^{V_{ji}}} \int_0^{\delta} \frac{\rho_{ji} e^{\rho_{ji} t + V_{ji}}}{\left(e^{\rho_{ji} t} + e^{V_{ji}}\right)^2} dt = \frac{e^{\rho_{ji}\delta} - 1}{e^{\rho_{ji}\delta} + e^{V_{ji}}}. \tag{3.13}$$

This function defines the conditional CDF of migration duration, defined on $\mathbb{R}_{++}$. I will refer to this distribution as $F_{d>0}(\cdot)$. The associated PDF is expressed by $f_{d>0}(\cdot)$.

Corollary 3.3. When $\rho_{ji} > 0$, for a given $\delta \leq 1$, the probability of staying for a period shorter than δ conditional on emigrating (the CDF of the positive duration of stay) is:

$$F_{d>0}(\delta) = \frac{e^{\rho_{ji}\delta} - 1}{e^{\rho_{ji}\delta} + e^{V_{ji}}}. \tag{3.14}$$

The PDF of the duration stay, conditional on emigrating, defined $\forall\, d \in\ (0; \infty)$, is:

$$f_{d>0}(d) = \frac{\rho_{ji} e^{\rho_{ji} d}(1 + e^{V_{ji}})}{(e^{\rho_{ji} d} + e^{V_{ji}})^2}. \tag{3.15}$$

Proof. See Appendix 3.A. □

According to equations (3.14) and (3.15), a higher unforeseen cost leads to shorter durations of stay (the mass of probability is concentrated on the left hand side, see Figure 3.1, Panel A and C). Conversely, if the net value of migration V_{ij} rises, then the length of a period spent abroad increases, which is depicted by a shift of probability density towards the right hand side, see Figure 3.1, Panel B and D.

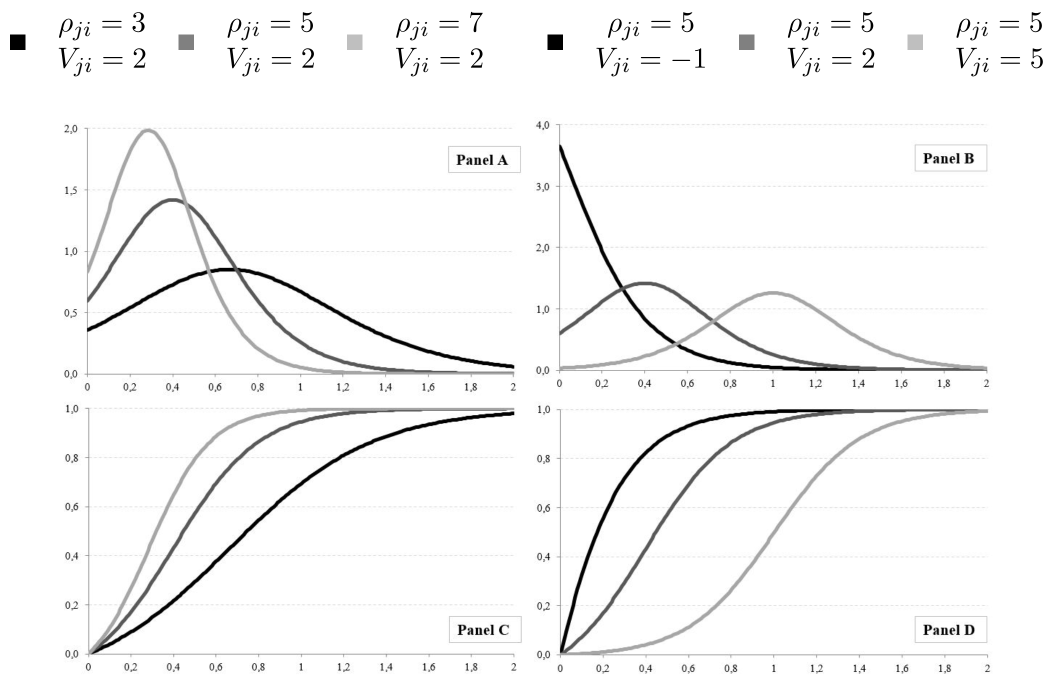

FIGURE 3.1: Comparative statics of conditional distributions of durations of stay, with respect to unforeseen migration costs ρ and net value of migration V.
Source: own calculations.

The group of individuals with $\rho_{ji} > 0$, is divided into a sub-group of temporary immigrants, and a sub-group of permanent residents. Using the defined conditional density, the probabilities that a random migrant falls into either of two sub-groups are given by:

Proposition 3.4. The probability of being a temporary migrant is given by:

$$\Pr\left[d < 1 | d > 0\right] = F_{d>0}(1) = \frac{e^{\rho_{ji}} - 1}{e^{\rho_{ji}} + e^{V_{ji}}}. \tag{3.16}$$

The probability of being a permanent migrant is given by:

$$\Pr\left[d \geq 1 | d > 0\right] = 1 - F_{d>0}(1) = \frac{1 + e^{V_{ji}}}{e^{\rho_{ji}} + e^{V_{ji}}}. \tag{3.17}$$

Proof. The consequence of the definition of conditional CDF of duration. □

Finally, let us aggregate the total number of foreign workers for different origins, destinations and status. Consider a single wave of immigrants flowing from country i to country $j \neq i$ in the beginning of a period (call it wave $t = 0$, the subscript is omitted). In time $\tau \in (0, 1)$ the total stock of workers originating from this wave is denoted by: $N_{ji}(\tau)$. A temporary migrant is a person who returns to her home country earlier than after 50 years (his duration of migration spell is $d^* < 1$). A permanent migrant stays in the destination country for all her life. Let the stock of individuals from the first group be labeled by: $\tilde{N}_{ji}(0)$, whereas the second: $\hat{N}_{ji}(0)$. Therefore, right after emigrating, when $\tau \to 0$, the total stock of foreign workers originating from i and residing in j is: $N_{ji}(\tau) = \tilde{N}_{ji}(\tau) + \hat{N}_{ji}(\tau)$. Notice that when $\tau \to 1$ all the temporary workers return home, and the only foreign labor force left are the permanent immigrants. Consequently, the number of non-native citizens from the analyzed wave is equal to: $\hat{N}_{ji}(\tau)$. In aggregated terms, the total stock of employees from a particular wave $t = 0$, living in country j at period τ is equal to the sum of natives and foreigners, who decided to immigrate:

$$L_j(\tau) = \sum_{i=1}^{N} N_{ji}(\tau). \tag{3.18}$$

The share of permanent migrants goes to one if the ratio of wages between destination and source country tends to infinity. Similarly, if the unforeseen costs are growing, then all the potential migrants stay for a short period of time and the fraction of permanent stayers diminishes completely. According to the previous notations:

$$\tilde{N}_{ji} = \frac{e^{\rho_{ji}} - 1}{e^{\rho_{ji}} + e^{V_{ji}}} \frac{N_{ji}}{2}, \qquad \hat{N}_{ji} = \left(\frac{1 + e^{V_{ji}}}{e^{\rho_{ji}} + e^{V_{ji}}} + 1\right) \frac{N_{ji}}{2}. \tag{3.19}$$

The key question from the point of view of the destination country is the actual labor force that is attracted during a period of one generation. One can calculate this number using the density of the average duration of stay of all migrants. Of course, permanent migrants fully contribute to the host country's labor supply, so their weight in the aggregate is 1 (taking the units of the generation period, 50 years). Therefore they provide exactly: $\hat{N}_{ji}$ units of labor. More computation is required to determine the labor force of temporary migrants, since everyone stays in the destination country according to her individual optimal decision about d^*. In consequence, a temporary migrant does not participate in the foreign labor market for the whole period, but individually decides about her optimal duration of stay. Knowing the country-pair-specific, conditional distributions of durations of stay (derived in Proposition 3.4), it suffices to compute the following conditional expectation: $\mathbb{E}_{d>0}[d^*|d^* < 1]$. After summing up temporary and permanent migrants, one arrives at an expression that (multiplied by the total, gross migration flow: N_{ji}) represents the effective labor supply in country j originating from country i during one period of time.

Proposition 3.5. The total labor force in country j immigrating from country i (expressed in the number of foreigners available for the period of one generation, 50 years) is equal to:

$$L_{ji}(V_{ji}, \rho_{ji}) = \frac{N_{ji}}{2}\left(\frac{1+e^{V_{ji}}}{\rho_{ji}e^{V_{ji}}}\ln\left(\frac{1+e^{V_{ji}}}{1+e^{V_{ji}-\rho_{ji}}}\right)+1\right). \tag{3.20}$$

Proof. See Appendix 3.A. □

Some asymptotic properties of L_{ji} function with respect to its arguments are depicted in the following:

Corollary 3.6.

$$\begin{aligned}
\lim_{\rho_{ji}\to 0} L_{ji}(V_{ji}, \rho_{ij}) &= N_{ji}, & \lim_{V_{ji}\to\infty} L_{ji}(V_{ji}, \rho_{ji}) &= N_{ji}, \\
\lim_{\rho_{ji}\to \infty} L_{ji}(V_{ji}, \rho_{ji}) &= N_{ji}/2, & \lim_{V_{ji,t}\to-\infty} L_{ji}(V_{ji}, \rho_{ji}) &= N_{ji}\frac{(1-e^{-\rho_{ji}})}{\rho_{ji}}, \\
\lim_{\rho_{ji}\to 0} L_{ji}(-\infty, \rho_{ji}) &= N_{ji}, & \lim_{\rho_{ji}\to\infty} L_{ji}(-\infty, \rho_{ji}) &= N_{ji}/2.
\end{aligned} \tag{3.21}$$

Proof. See Appendix 3.A. □

When the unforeseen cost goes to zero, or the ratio between remunerations in destination and source is infinitely large, then all the migrants become permanent residents. On the contrary, when ρ_{ji} goes to infinity, all the temporary migrants leave immediately from the hosting country. Infinitely small value of V_{ji} implies that the overall labor supply of migrants becomes a function of ρ_{ji} only, in such a way that the previously stated properties are preserved.

3.4 Multi-destination and multi-visas model

In this Section, I solve a multi-country model of migration in which each destination offers several visa options. Considering a version with two visas (a permit for a temporary and a permanent stay), I show that the model violates the IIA axiom and provides a micro-foundation for multilateral resistance to migration. Additional assumptions concerning countries' visa policy allow to solve this model analytically. Then, I describe the multi-destination three-visas model. Due to computational complexities, there is no closed-form solution of this extension. However, in the next Section, this version of the model is going to be calibrated and simulated using numerical methods, so that I will be able to verify that the properties of reduced form models can still be observed.

3.4.1 Model with two types of visas

Consider a system of N countries: state i, from which people emigrate, and states $1, ..., N$ which, along with country i, that are the potential destinations. Each state is characterized by a certain level of net wage labeled by v_j. Workers may choose to apply for a temporary visa, which allows to stay for a period $\left[0, \bar{d}^t\right], \bar{d}^t < 1$ or a permanent visa with $\bar{d}^p = 1$. The costs of living with these permissions are respectively: $x_{ji}(\bar{d}^t)$ and $x_{ji}(\bar{d}^p)$, if one wants to emigrate from country i to country $j \in \{1, ..., N\}$. I explicitly assume that $x_{ji}(\bar{d}^p) > x_{ji}(\bar{d}^t)$ for $j \neq i$. Otherwise, nobody would acquire a temporary visa. When an agent decides to stay in state i, she pays no migration costs, so that: $x_{ii}(\bar{d}^t) = x_{ii}(\bar{d}^p) = 0$. Consequently, the *ex ante* expected utilities ascribed to every possible decision are as follows:

$$\begin{aligned}
&\mathbb{E}[U_{ii}] = \alpha v_i + \varepsilon_i, \\
&\mathbb{E}[U_{ji}(\bar{d}^t)] = \bar{d}^t \left(\alpha \left(v_j - x_{ji}(\bar{d}^t)\right) - \bar{d}^t \mathbb{E}[\bar{\rho}_{ji}]/2 + \varepsilon_j\right) + (1 - \bar{d}^t) \left(\alpha v_i + \varepsilon_i\right), \\
&\mathbb{E}[U_{ji}(\bar{d}^p)] = \alpha \left(v_j - x_{ji}(\bar{d}^p)\right) - \mathbb{E}[\bar{\rho}_{ji}]/2 + \varepsilon_j.
\end{aligned} \tag{3.22}$$

As before, *ex ante* $\mathbb{E}[\bar{\rho}_{ji}] = 0 \, \forall j, i \in \mathcal{N}$. According to the former definition, utilities are no longer independent, and, in general, do not fulfill the standard IIA axiom. These correlations result from the fact that temporary migrants consider wages in the source and the host economies as the determinants of lifetime migration choices. Thus, one cannot use the theorem by McFadden (1984) in calculating the choice probabilities. To make the solution of these computations as simple as possible, without losing the main result, some additional assumption have to be imposed:

Proposition 3.7. If all N destination countries offer the same duration of temporary visas (equal to $\bar{d}^t$) and the differences in permanent and temporary migration costs are identical across destinations: $\Delta = x_{ji}(\bar{d}^p) - x_{ji}(\bar{d}^t) = x_{ki}(\bar{d}^p) - x_{ki}(\bar{d}^t)$ for $j \neq k$, $i, j, k \in \{1, ..., N\}$, then the unconditional probabilities of emigrating to a particular country $j \neq i$ are equal to:

$$\begin{aligned}
P[\mathbb{E}[U_{ii}] = \max] &= \frac{e^{\alpha v_i}}{\sum_{k=1}^{N} e^{\alpha(v_k - x_{ki}(\bar{d}^t))}}, \\
P[\mathbb{E}[U_{ji}(\bar{d}^t)] = \max] &= \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^t))}}{\sum_{k=1}^{N} e^{\alpha(v_k - x_{ki}(\bar{d}^t))}} - \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^t))}}{\sum_{k \neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))} + e^{\alpha\left(v_i + \frac{\Delta}{1 - \bar{d}^t}\right)}}, \\
P[\mathbb{E}[U_{ji}(\bar{d}^p)] = \max] &= \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^t))}}{\sum_{k \neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))} + e^{\alpha\left(v_i + \frac{\Delta}{1 - \bar{d}^t}\right)}}.
\end{aligned} \tag{3.23}$$

Proof. See Appendix 3.A. □

In order to make those probabilities comparable with a standard case that fulfills IIA, consider the following ratios:

Corollary 3.8. For any destination $j \neq i$ the ratios of probabilities of emigrating and staying are:

$$\frac{P[\mathbb{E}[U_{ji}(\bar{d}^t)] = \max]}{P[\mathbb{E}[U_{ii}] = \max]} = \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^t))}\left(e^{\frac{\alpha\Delta}{1-\bar{d}^t}} - 1\right)}{\sum_{k\neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))} + e^{\alpha\left(v_i + \frac{\Delta}{1-\bar{d}^t}\right)}},$$
$$\frac{P[\mathbb{E}[U_{ji}(\bar{d}^p)] = \max]}{P[\mathbb{E}[U_{ii}] = \max]} = \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^p) - v_1)}\left(\sum_{k\neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))}\right)}{\sum_{k\neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))} + e^{\alpha\left(v_i + \frac{\Delta}{1-\bar{d}^t}\right)}}. \tag{3.24}$$

Proof. The result is obtained by dividing second and third equations by first equation in (3.23). □

The ratios of probabilities of moving to j (either temporarily or permanently) and staying in i are dependent not only on the economic and policy variables describing those two countries, but also on the characteristics of all the other $N-2$ options. Clearly, the IIA property is not maintained, and adding further choice options would alter the relative odds of selecting one of N destinations. Introducing a second dimension of individuals' choice (not only the destination but also different durations of stays) automatically results in implicit relations with temporary options. Indeed, computing the coefficient of correlation between the utility of staying and the utility ascribed to temporary emigration to j, one observes that:

$$cor(\mathbb{E}[U_{ii}], \mathbb{E}[U_{ji}(\bar{d}^t)]) = cor(\varepsilon_i, \bar{d}^t\varepsilon_j + (1-\bar{d}^t)\varepsilon_i) = 1 - \bar{d}^t, \tag{3.25}$$

since period $1-\bar{d}^t$ is spent in home country. In consequence, an agent who has a strongly negative attitude towards living in her country of birth (a low value of ε_i) would be more inclined to emigrate rather than to stay. Similarly, a person with a strong preference towards a particular foreign destination, would like to emigrate permanently rather than temporarily.

Consider a situation in which the value of $x_{ji}(\bar{d}^p) - x_{ji}(\bar{d}^t) = \Delta = const$ for $i \neq 1$. Assuming $\Delta = 0$ is equivalent to reducing the model to a version with a permanent visa only. Consequently, the choice probabilities are identical to the classical ones which satisfy the IIA property:

$$P[\mathbb{E}[U_{ii}] = \max] = \frac{e^{\alpha v_i}}{\sum_{k=1}^{N} e^{\alpha(v_k - x_{ki}^t(\bar{d}^t))}},$$
$$P[\mathbb{E}[U_{ji}(\bar{d}^t)] = \max] = \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^t))}}{\sum_{k=1}^{N} e^{\alpha(v_k - x_{ki}(\bar{d}^t))}} - \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^t))}}{\sum_{k\neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))} + e^{\alpha v_i}} = 0,$$
$$P[\mathbb{E}[U_{ji}(\bar{d}^p)] = \max] = \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^t))}}{\sum_{k\neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))}},$$

and finally:

$$\frac{P[\mathbb{E}[U_{ji}(\bar{d}^p)] = \max]}{P[\mathbb{E}[U_{ii}] = \max]} = e^{\alpha(v_j - x_{ji}(\bar{d}^p) - v_i)}.$$

As long as $\Delta > 0$ (the policy makers offer temporary and permanent visas), the multilateral resistance term remains in the ratio of probabilities, and the model violates the IIA axiom. The magnitude of dependencies between options is explicitly computable through the elasticities of choice probabilities with respect to country's characteristics. Consider the choice probabilities when $\Delta = 0$:

$$\pi_{ji} \equiv P[\mathbb{E}[U_{ji}] = \max] = e^{V_{ji}} / \sum_{k=1}^{N} e^{V_{ki}},$$

where, for simplicity I take: $V_{ki} \equiv \alpha\left(v_k - x_{ki}(\bar{d}^t)\right)$. Similarly, assume a simplifying notation concerning the odds of selecting a temporary visa when $\Delta > 0$:

$$\mathbb{P}_{ji} \equiv P[\mathbb{E}[U_{ji}(\bar{d}^t)] = \max] = \underbrace{e^{V_{ji}} / \sum_{k=1}^{N} e^{V_{ki}}}_{\equiv \pi_{ji}} - \underbrace{e^{V_{ji}} / \left(\sum_{k \neq i} e^{V_{ji}} + e^{V_{ii}} C(\Delta) \right)}_{\equiv p_{ji}} = \pi_{ji} - p_{ji},$$

where: $C(\Delta) \equiv e^{(\alpha\Delta)/(1-\bar{d}^t)}$. It is straightforward to show that:

Proposition 3.9. When a host country offers temporary, as well as permanent visas ($\Delta > 0$), then the model exhibits multilateral resistance to migration. The elasticities of choice probabilities with respect to any country-specific characteristic: y_i are:

$$\begin{aligned} E_j^{\mathbb{P}_{ji}} &\equiv \frac{\partial \mathbb{P}_{ji}}{\partial y_j}\frac{y_j}{\mathbb{P}_{ji}} = \frac{\partial V_{ji}}{\partial y_j} y_j \left(\frac{\pi_{ji}(1-\pi_{ji})}{\pi_{ji} - p_{ji}} - \frac{p_{ji}(1-p_{ji})}{\pi_{ji} - p_{ji}} \right) = \frac{\partial V_j}{\partial y_j} y_j \left(1 - \pi_{ji} - p_{ji}\right), \\ E_j^{\mathbb{P}_{li}} &\equiv \frac{\partial \mathbb{P}_{li}}{\partial y_j}\frac{y_j}{\mathbb{P}_{li}} = -\frac{\partial V_{ji}}{\partial y_j} y_j \left(\frac{\pi_{li}\pi_{ji} - p_{li}p_{ji}}{\pi_{li} - p_{li}} \right). \end{aligned} \tag{3.26}$$

Proof. See Appendix 3.A. □

In contrast to the classical case with IIA axiom, the cross elasticities are l-specific, so they take different values for all the options $l \in N$.[18] Since one observes an asymmetric change in choice probabilities after an external shock, the IIA property is not maintained.

Let us now move to the *ex post* decisions about the duration of stay. The solution to problem (3.4) has the following form:

Proposition 3.10. The optimal, ex post duration of migration is given by:

$$d^* = \begin{cases} \min\left\{ \rho_{j^*i}^{-1}\left(V_{j^*i}(\bar{d}) + \varepsilon_{j^*} - \varepsilon_i\right); \bar{d} \right\}, & \text{if} \quad \rho_{i^*} > 0, \\ \bar{d}, \quad \text{if} \quad \rho_{j^*i} < 0, \end{cases} \tag{3.27}$$

for the temporary (permanent) migrants, taking $\bar{d} = \bar{d}^t$ ($\bar{d} = \bar{d}^p$).
Notice that: $V_{j^*i}(\bar{d}) \equiv \alpha(v_{j^*} - x_{j^*i}(\bar{d}) - v_i)$.

Proof. See the proof of Proposition 3.1. □

Finally, one can explicitly represent the distributions of durations of stay (by visa type) in the same way as it was done in a model with one visa type. However, in contrast to what has been concluded before, the overall distribution of duration of stay (concerning the all types of high-skilled immigrants) will now be a combination of two distributions: of the temporary and

[18] Following Train (2009), the elasticities of choice probabilities in a model with IIA are equal to: $E_j^{\pi_{ji}} = \frac{\partial V_{ji}}{\partial y_j} y_j (1 - \pi_{ji})$ and $E_j^{\pi_{li}} = -\frac{\partial V_{ji}}{\partial y_j} y_j \pi_{ji}$. The cross elasticity for every l is constant, so that the choice probabilities change identically (symmetrically) after a shock. This proves the IIA property.

permanent immigrants. Therefore, this aggregated distribution of duration of stay may not be (and typically is not) unimodal.

3.4.2 A model with three visas

For the purpose of a better representation of visa policies in the analyzed host countries, the last modification of the model considers three types of visas: a short-term one, a medium-term residence permit and a permanent staying permission. This general classification of visas is very close to what is proposed by the main destination countries for immigrants.[19]

As it can be concluded from the summary of visa policies in Appendix 3.B, authorities prefer to classify immigrants into short (duration of stay of 1 years), medium (6 years) and long-term (permanent) category. Therefore, the final version of the model differentiates between three types of visas in each destination. The definitions, mechanisms and properties of such a model are in line with what has been presented in the case of two visas, except for the fact that now there are two temporary visas: a one with duration of $d^{t1} = 1/50$, and a one with duration that ranges: $d^{t2} = 6/50$. This brings a further complication to the correlation structure among all the emigration options.

Each of N countries issues two types of temporary visas and a permanent visa. For each $i, j \in \mathcal{N}$ their costs are equal to: $x_{ji}(\bar{d}^p) > x_{ji}(\bar{d}^{t2}) > x_{ji}(\bar{d}^{t1})$. The *ex ante* expected utilities of migration from country i to j are:

$$\begin{aligned}
&\mathbb{E}[U_{ii}] = \alpha v_i + \varepsilon_i, \\
&\mathbb{E}[U_{ji}(\bar{d}^{t1})] = \bar{d}^{t1}\left(\alpha\left(v_j - x_{ji}(\bar{d}^{t1})\right) - \bar{d}^{t1}\mathbb{E}[\bar{\rho}_{ji}]/2 + \varepsilon_j\right) + (1-\bar{d}^{t1})\left(\alpha v_i + \varepsilon_i\right), \\
&\mathbb{E}[U_{ji}(\bar{d}^{t2})] = \bar{d}^{t2}\left(\alpha\left(v_j - x_{ji}(\bar{d}^{t2})\right) - \bar{d}^{t2}\mathbb{E}[\bar{\rho}_{ji}]/2 + \varepsilon_j\right) + (1-\bar{d}^{t2})\left(\alpha v_i + \varepsilon_i\right), \\
&\mathbb{E}[U_{ji}(\bar{d}^{p})] = \alpha\left(v_j - x_{ji}(\bar{d}^{p})\right) - \mathbb{E}[\bar{\rho}_{ji}]/2 + \varepsilon_j .
\end{aligned} \tag{3.28}$$

As before, *ex ante* $\mathbb{E}[\bar{\rho}_{ji}] = 0\, \forall i, j \in \mathcal{N}$. For this version I restrain from presenting the analytical results due to their complexity and lack of additional insights in comparison to what was presented in the former subsections.

Consequently, the applied modeling strategy is designed as follows. I develop a multi-country model with 178 sending states and 35 destinations. Accounting for multidimensional correlations between the utilities ascribed to different target states (in line with the fact that the IIA axiom is not satisfied), I investigate the world-wide equilibrium outcome of altering migration policies in the group of European Union countries. The aim of the counterfactual exercise is to quantify the long-run consequences for the most developed regions of the world of different migration policies in the EU. The mechanisms of this model are identical to what has been presented in the previous sections, but now one has to frame these analytical results in the context of three visa types per destination. Therefore, each individual faces a choice set of: $1+3\cdot 35 = 106$ options (staying at home, or emigrating to one of 35 destinations with one of three visas). Then, each discrete option is characterized by its own continuous distribution of duration of stay, which then is aggregated at the country-pair level.

[19] In what follows, I will concentrate only on those host countries which will be considered in the calibration and simulation exercises: Australia, Canada, New Zealand, the US, Switzerland, Iceland, Norway and 28 EU states.

3.5 Numerical solution of the model

The purpose of calibration is to compute (expected and unforeseen) migration costs by fitting the moments observed in the data. After completing this step, I introduce alternative migration policies, and solve the model for the new equilibrium. The outcomes are: new flows and stocks of immigrants, and the distributions of durations of stay for country pairs.

3.5.1 Data

The calibration of the model is based on the data for 2013. Each country $j \in \mathcal{N}$ is characterized by a uniform, gross wage for the high-skilled workers. I compute them for 178 countries in the sample, using the data on skill premiums for 52 countries, the shares of tertiary educated for 144 countries from the Barro-Lee database (Barro and Lee, 2013), and several explanatory variables from the WDI by the World Bank.[20] With the estimated parameters, I compute the predicted skill premiums, and, using the data on GDP per capita in PPP, I calculate the wage rates for the whole sample of 178 states. Finally, taking the country-specific data on income taxation (originating from the yearly tax reports by Ernst & Young, KPMG, and Pricewaterhouse Coopers), I compute the net-of-income-tax wages, v_j. For the marginal utility of net income, α, I take the value of 0.05, following Grogger and Hanson (2011). The full sample of 178 countries is presented in Table 3.E1, whereas the data on net wages for high-skilled workers are gathered in Table 3.E2..

Another set of observables concerns the yearly flows of migrants from 178 sources to 35 destinations with a distinction between people who come with temporary (short and medium-term) visas and those who obtain permanent residence permits.[21] The gross flows of migrants aggregate individual, discrete-choice decisions about the destination country and the selected visa. Therefore, along with net wages, they determine the visa-specific, expected costs of migration, $x_{ji}(\bar{d})$.

In order to be able to estimate the parameters which define the distribution of durations of stay (that is the country-pair-specific unforeseen costs: ρ_{ji}), one needs empirical counterparts of the probabilities of staying, when migrating from any source i to any destination j. To this end, I calculate conditional and unconditional probabilities of staying for each pair of countries. I use the DIOC database provided by the OECD, and the data set published by Abel and Sander (2014) to compute these values. A detailed description of the computation procedure can be found in Appendix 3.D.

3.5.2 Calibration algorithm

Considering the complexity of interdependencies between the utilities ascribed to different destinations and durations of stay, I decided to calibrate the model using a Monte Carlo method. One needs to determine the values of country-pair-specific and visa-specific migration costs, labeled by x_{ji}^{w} for all the sources and destinations considered: $j, i \in \{1, ..., N\}$, and three types of visas: $w \in \{t_1, t_2, p\}$. Additionally, to be able to define the agents' aggregated behavior in

[20] In the extrapolating regression I consider indicators, which reflect the levels of development and education in the analyzed countries. For this purpose, I selected: the share of high-skilled, urban population rate, pupil-teacher ratio, and High tech exports a percent of GDP.

[21] For a detailed description of sources for the data on gross flows of migrants by visa type, please consult Appendix 3.C

terms of their preferred length of stay, I have to specify the country-pair-specific distribution of duration of stay which is dependent on the value of unforeseen migration cost: ρ_{ji}.

The initial step is the calculation of x^w_{ji}. From the data describing the yearly inflows of immigrants for different visa types, I firstly compute the probabilities of emigration from each source country to any destination. Then, for a given sending country $i \in \{1, ..., N\}$ I separately conduct a Monte Carlo experiment. I draw 250,000 realizations of vectors of random components ε_j from Gumbel distribution, for all the 35 potential hosts j. These 35-dimensional vectors represent 250,000 potential migrants who have random tastes towards each destination. Starting with the initial values for migration costs, I iteratively compute the utilities ascribed to each and every migration option (3.28), and the simulated probabilities of emigration to any state with a particular visa type. Finally, using a conservative updating rule, I modify the actual values of x^w_{ji}'s. The algorithm stops when the simulated probabilities of emigration are close to their empirical counterparts (the difference between each pair is less than 10^{-5}). With the values of migration costs in hand, one can predict the flows of migrants (by duration of visa) between any two country pairs. Figure 3.E1 presents the comparison of the aggregated skill-specific and visa-specific flows for 35 destinations (actual data versus model outcomes). Using the constructed average durations of stay, I compute total stocks of immigrants, as if the yearly flows of migrants were equal to the values from year 2013, over the whole 50-year period.

The second part of the calibration procedure tackles with the unforeseen migration costs. For each source i and each destination j I try to fit the conditional and unconditional probabilities of staying calculated using the DIOC and Abel and Sander (2014) databases (in fact I consider here only those country pairs, for which I have at least two data points). Initially, I draw 250,000 realizations of the difference between the random components: $\varepsilon_j - \varepsilon_i$ from the logistic distribution. These values represent 250,000 migrants from country i to country j. Then, I define the potential values of ρ_{ji} to be between 0.01 and 20, with step 0.01. For each of these steps, I calculate the simulated distribution of duration of stay of migrants from i to j. After sorting the immigrants with respect to their preferred visa type, I compute their actual durations of stay, after discovering the value of ρ_{ji}. In this way, the simulated distribution of lengths of stays is constructed, and the counterparts of empirical probabilities of staying can be calculated. At the end, the value of $\rho_{ji} \in [0.01; 20]$ which minimizes the Euclidean distance between the simulated and empirical probabilities is chosen as the best estimation. For those country pairs, for which the data on probabilities of stay are not sufficient, I extrapolate the values of ρ_{ji} using the estimations from a cross-section regression with gravity variables, and origin and destination fixed effects (see Table 3.E5). Figure 3.E2 depicts the distributions of estimated values of ρ_{ji}'s for 35 receiving countries. More attractive destinations (i.e. Canada or the US) are generally characterized by lower values of unforeseen migration costs, than the less popular ones (i.e. Bulgaria or Romania).

3.5.3 Simulation algorithm

Each of the simulations starts with defining a new migration policy (either modifying visa costs, or providing fiscal incentives for immigrants). In the first counterfactual scenario, I assume that in all the EU countries the costs of 6-year visas are reduced to the levels that are observable in the US (where H1B visa is a well-known, well established policy device).[22] In describing this

[22] Apart from the legal part, the expected migration costs comprise of non-reducible part related to geography, social cohesion of migrants or cultural and social differences. An identification of importance of the main determinant of these elements is proposed in Table 3.E4. From these estimates, I also compute the legal visa costs for all countries, by investigating the destination-visa specific fixed effects that capture all the formal burdens on immigrants.

procedure, let me concentrate on a particular destination country - Germany (see Figure 3.2). The black points represent the average visa costs in the US (considering the 1-year, 6-year and a permanent visa). The light gray points depict the very same values for Germany in the reference scenario. It is clearly visible, that the 6-year visa is relatively cheap in the US, and relatively expensive in Germany (which imposes a convex visa cost function for the US, and a concave one for Germany). The goal is to decrease the cost of a 6-year visa in Germany (point X) in a way that imposes the relative cost structure from the US. To achieve this, I reduce this cost (to point Y), such that the ratio of difference in the costs of 6-year and 1-year visas (A^{DEU}) to the difference in the costs of 50-year and 1-year visas (B^{DEU}) is the same as in the US (and equal to A^{USA}/B^{USA}). This procedure is followed for all the other European destinations (computing all the country-pair-specific migration costs separately), and its outcomes are depicted in the Figure 3.3.

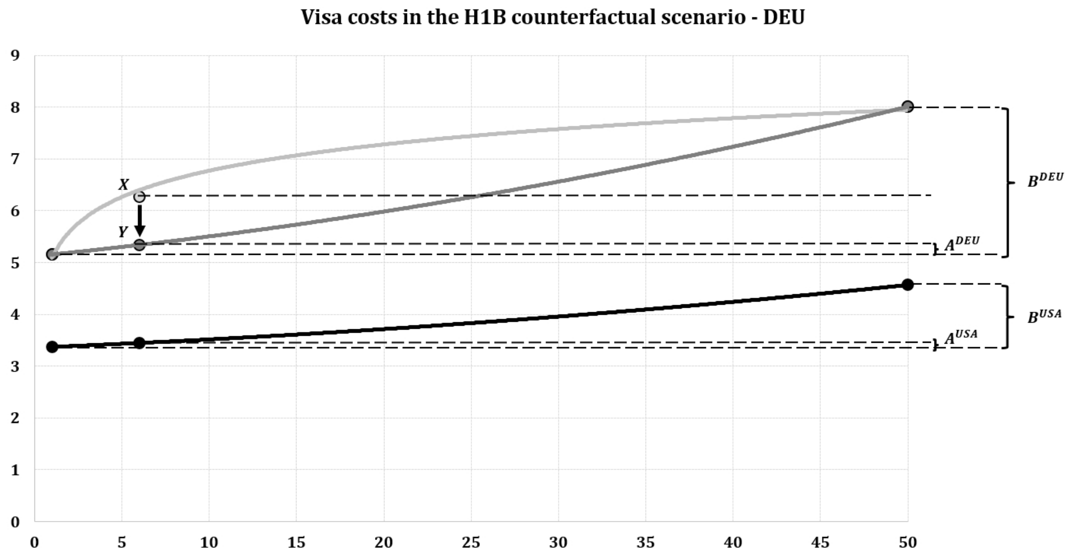

FIGURE 3.2: Reduction of visa costs to the H1B level - example of Germany

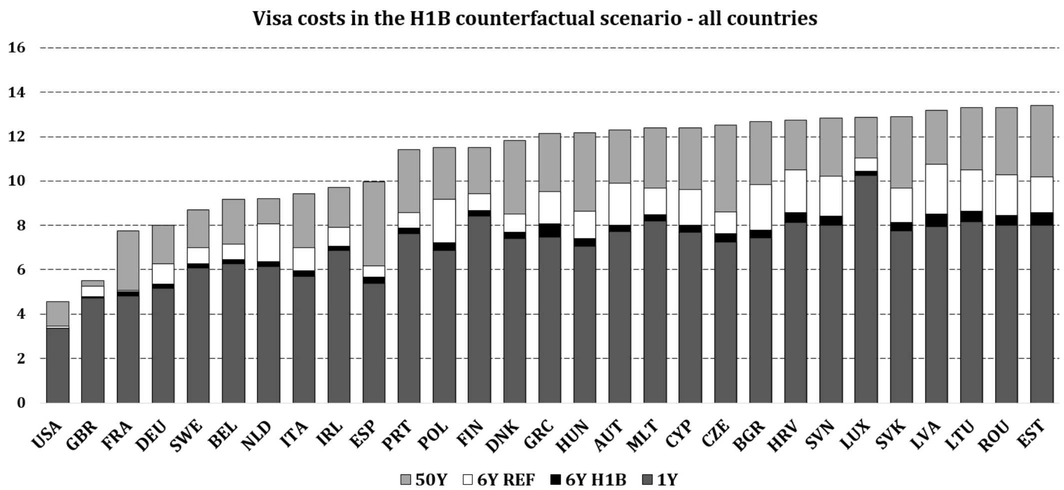

FIGURE 3.3: Visa costs in the reference, and in the counterfactual H1B scenarios in Europe

The second counterfactual policy is considering fiscal exemptions for high-skilled immigrants, instead of migration costs. Considering a briefing by CES-IFO, and following the report OECD (2011), I decided to implement an additional, 10 percent fiscal incentive (FI) in the EU economies. This means, that high-skilled migrants, who come with a 6-year visa pay a 10 p.p. lower income tax, than other citizens. Consequently, the group of medium-term professionals has a higher net wage in comparison to short-term immigrants and permanent stayers.

With new migration policies in the EU, I run another Monte Carlo simulation to calculate the counterfactual yearly flows of workers. In doing so, I take the modified migration costs and net wages as given, for the H1B simulation, and reference migration costs, and counterfactual net wages for the FI simulation. The unforeseen migration costs stay unchanged. For each of 178 sending countries I draw 2,000,000 realizations of the vectors of stochastic preferences towards 35 destinations and compute the optimal migration decisions for these values. This enables to calculate the probabilities of migration, and the actual flows of migrants for each country-pair and visa type.

Another Monte Carlo simulation targets the issue of fitting new duration distributions for each pair of sending and receiving countries. 2,000,000 realizations of the differences of random components $\varepsilon_j - \varepsilon_i$ are drawn, and the optimal durations of stay are determined, according to Proposition 3.10 in the case of three visas. The only things left to calculate are the average durations of stay, which determine the counterfactual stocks of immigrants.

3.6 Consequences of alternative migration policies

This section presents the demographic implications of counterfactual migration policies in the EU. The first part considers an introduction of H1B visas in all the EU member states. In the next subsection, I propose a tax concession mechanism for the high-skilled immigrants. Then, I consider a scenario in which migrants obtain a wage premium after returning to their homelands. Finally, I discuss the quantitative importance of multilateral resistance to migration.

3.6.1 Introduction of H1B visa in the EU

A decrease in migration costs, equivalent to the one of H1B visas in the US, for the medium-term (6-year) immigrants to the European Union, has a substantial impact on the flows and stocks of migrants all over the world (for detailed results see columns labeled with H1B in Table 3.E6, for the ranking see Figure 3.E3a). Considering Europe as a whole, an introduction of H1B immigration policy brings 30,000 new high-skilled immigrants every year. Simultaneously, the total number of foreign professionals increases by 800,000, that is 6.1 percent of the reference stock of high-skilled workers. Due to the loss of relative attractiveness, non-EU destinations (mainly the US, Australia and Canada) encounter a slight loss in the number of well-educated foreigners, not exceeding 1 percent of the reference stock. Thus, an implementation of a more liberal visa policy for high-skilled workers allows Europe to “steal the talents” from the currently popular destinations. The biggest winners of this policy in terms of total stocks are Poland, Germany, the UK (more than 100,000 high-skilled workers), and less popular destinations in terms of the relative change in stocks (Bulgaria, Croatia, Lithuania, Latvia, and Slovenia).

The effects with respect to yearly inflows of immigrants are also heterogeneous across EU-members. The countries which gain the most are: Germany, the UK, the Netherlands and Italy. The only EU-member that loses highly skilled immigrants due to the H1B policy, is France. A possible explanation for this result could be the fact that France is already characterized by low migration costs for the well-educated candidates (which can be observed in Figure 3.2). Therefore, an H1B policy defined in the proposed counterfactual scenario, brings almost no change to the 6-year visa costs. Since other destinations significantly drop the barriers for medium-term immigrants, France is becoming relatively less attractive, and people substitute this destination for other European countries.

The results gathered in Table 3.E6 show that the changes in total stocks are not driven mainly by new inflows. The "new-entry" effect of the proposed H1B policy (that is attracting the current non-migrants from all sources) is almost null. Conversely, the impact on aggregate numbers of high-skilled workers is resulting from visa switching of the current immigrants. For the short-term migrants (who have relatively high preferences towards living in the destination countries, but are at the threshold between 1Y and 6Y visa) and some permanent stayers (who have relatively low preferences towards the destination, and are at the threshold between 6Y and 50Y visa), a cheaper 6-year visa is an encouragement to choose a new H1B emigration option. Thus, without a huge number of new entries, some EU members (such as Sweden, Czech Republic, Estonia, or Poland) manage to visibly increase the number of high-skilled workers. To prove this "visa-substitution" property, consider the structures of immigration flows and stocks by visa types (see Figures 3.E4 and 3.E5). In the reference scenario (first row of graphs), short-term immigrants constitute sizable parts of total inflows and stocks. In contrast, after implementing the H1B visa, the European countries experience a significant drop in the share of those migrants in both flows and stocks. For the permanent migrants the directions of the effects are similar, but the magnitudes are smaller.

To conclude, the results of the proposed experiment call for a serious discussion about the future of European migration program. Simple (and possibly cheap for the national budgets) solutions, like reducing the costs of visas for the medium-term, high-skilled candidates (similar to the European Blue Card program), might attract and retain talented foreign workers, which would have a non-trivial implication for the European economy. With such an open and liberal attitude towards attracting well-educated professionals, Europe could successfully compete for talents with other popular destinations (through the "talent-stealing" effect), and increase the stock of highly skilled workers (as a consequence of "visa-substitution" effect).

3.6.2 Implementation of fiscal incentives in the EU

The alternative migration policy proposed in this chapter, is a tax concession program for the high-skilled immigrants in the EU. Instead of changing visa costs for the medium-term candidates, I propose an augmentation of their net wage through a decrease in income tax rates by 10 p.p. in all member countries. The detailed results (see columns labeled with FI in Table 3.E6) for the stocks of high-skilled immigrants are similar to the case of H1B visa. In general, the EU experiences an increase in the total stock of high-skilled workers by 5.6 percent. Considering the ranking of countries (see Figure 3.E3b), significant differences relative to the H1B scenario may be observed for France, which is winning, and for Poland, that is losing high-skilled workers when applying the FI. While the former is caused by binding of the FI policy in France (and inefficacy of the H1B), the latter shows that in Poland the main barrier for the prospective high-skilled immigrants is the legal migration costs, not the low level of wages (the same is true in the case of Croatia, Bulgaria, and Latvia). Therefore, the H1B counterfactual is generally more beneficial for the countries with high visa costs (and harmful for the states with already well liberalized visa policy), whereas the contrary may be stated about the FI scenario. However, the majority of EU-members are between the two extremes, and both policies have similar impacts on the number of foreign professionals.

The tax concession brings a substantial increase in yearly flows of new high-skilled immigrants to Europe. The total inflow goes up by 10.6 percent, without a significantly stronger negative effect for the non-EU destinations. Even though the "talent-stealing" effect is still present, (because the FI improves the relative attractiveness of Europe comparing to other destinations), its magnitude is lower than in the case of H1B visas. The main impact comes from the improvement of EU's absolute attractiveness. This means that with higher net wages, Europe is capable of attracting some never-migrants from the third countries (a yearly flow of almost 70,000 people), which brings rise to the "new-entry" effect. Simultaneously, the proposed migration policy has a small influence on the structure of inflows and total stocks, relative to the reference scenario (see Figures 3.E4 and 3.E5). This means that the "visa-substitution" effect is far less pronounced then in the case of FI.

All in all, the tax exemption for the prospective high-skilled immigrants to the EU may be considered as a close substitute for the introduction of H1B visas. The overall outcomes, in terms of the numbers of immigrants, are very close in both cases. The main difference between the two policies is the relative importance of three channels through which the total effects are arising. In the case of H1B policy, the "visa-substitution" effect for the current immigrants drives the results, whereas the FI works through inviting new immigrants from the third countries - the "new-entry" effect. This convinces, that only the FI improves the absolute attractiveness of Europe, whereas the relative attractiveness of EU members changes in a similar way in both cases (the two scenarios have the same magnitude of the "talent-stealing" effects from other popular destinations).

The discrepancy between the two proposed migration policies may be of great importance for the policy makers and the authorities in the EU. If a country would like to reduce the number of short stayers, and increase the average duration of stay of immigrants, it should choose the H1B visa policy. Conversely, if the authorities want to keep the structure of migrants constant, they should go for the tax concession policy. The former policy may bring significant fiscal cost in the long-run (due to pension expenditures for the medium and long-term foreign workers), whereas the latter causes an immediate burden on national budgets (through a decrease in tax collection from the current immigrants). Both policies are, nonetheless, expected to fuel national budgets with new tax incomes. An important quantitative question that remains to be answered, but is beyond the scope of this chapter, is the net fiscal effect of both policies in the short- and the long-term.

3.6.3 Accounting for the return premiums

Following the findings by Dustmann et al. (2011) and Dustmann and Görlach (2015), in this section, I propose a modification that includes the skill accumulation process for migrants. Since I do not consider heterogeneity of agents with respect to their skill level, this skill upgrading process is assumed to be reflected in the wages earned by emigrants, who decide to return to their home countries. The gains of returning migrants are assumed to be proportional to the duration of their stay, and the difference in wage levels in the destination and sending countries. The return premium (RP) is set to be equal to 20 percent of the net wage difference (destinations less source), if a person decides to return just before the end of 50-year migration spell, and proportionally lower, if the duration is lower. Comparing the reference scenarios with and without RP, it can be stated that people tend to stay shorter when accounting for return bonuses (see Figure 3.E6). This effect confirms the intuition about the utility maximizing agents, who return home faster due to the expected higher wages at home.

The results of H1B and FI counterfactual policies with return premiums are depicted in Table 3.E7 and in the Figures 3.E3c, d. Quantitatively, both the flows and stocks of high-skilled migrants are now higher after implementing both migration policies (comparing to a reference state of the world with RP). Therefore the overall effects are reinforced due to the reduced form the skill accumulation. Two economic processes drive these results. Firstly, those who already migrated, reduce their duration of stay, due to a bigger reward to returning. Secondly, people are more prone to emigrate due to a shift in wages, conditional on their return. Since the latter implication dominates, both flows and stocks of migrants are positively affected comparing to the outcomes of both policies without the RP. Qualitatively, the ranking of countries for both H1B and FI counterfactuals is slightly changed. Since the differences in RP are small across European destinations, one observes only minor modifications in the order of states.

3.6.4 Multilateral resistance to migration

This subsection comments on the importance of multilateral resistance to migration in the overall results. To provide the quantitative results, I simulated the model assuming that all the agents decide only about the destination country (as in the classic RUM model with a permanent visa), so that the choice options are independent. Then, people randomly decide about the duration of their visa, according to the actual distribution of visas for all the country pairs. The reference, and the two counterfactual scenarios are computed using the above described procedure. In this way, I am able to neutralize the multilateral resistance to migration (MRM), which is the consequence of correlation between the utilities ascribed to discrete choice options.

The comparison of the aggregated results with and without the MRM is depicted in Figure 3.E7. The solid bars (left hand side axis) represent changes in the flows of immigrants, while the dashed bars (right hand side axis) give the results for stocks (in both cases the values are differences between model with MRM, and without MRM). The results show that MRM strengthens the positive effects of both migration policies for Europe. Consequently, the lack of MRM would benefit the non-EU countries, through lower losses of high-skilled workers. Indeed, due to correlations between migration options, agents are more responsive to migration shocks, when MRM is allowed. This concerns mainly the current migrants, who can substitute between the destinations more easily. The above mentioned phenomenon gives rise to a stronger “talent-stealing” effect, discussed with the previous results. In contrast, without MRM, all choice options are independent, so that a positive shock in migration policy is followed by a smaller response from the current emigrants, thus the “talent-stealing” effect is partially neutralized. The above exercise gives evidences that it is relevant to consider both geographical and time dimension of agents’ decisions, when conducting multi-country migration policy experiments. Omitting either of two elements (destination or duration choices) dampens the multilateral resistance to migration, and might have substantial consequences for the quantitative evaluation of the simulated policies.

3.7 Conclusion

This chapter introduces a novel approach towards modeling international migration in the context of many source and destination countries, with endogenous choices of the length of stay. I propose a model in which people have heterogeneous tastes for living in different host countries, and may experience unforeseen costs after emigrating. The individual preferences govern the discrete choice of destination and the type of visa to apply for, while the unexpected migration costs determine the continuous decisions about the optimal duration of emigration spell.

Since agents compare lifetime benefits from living temporarily or permanently in all the available destinations, the random utility ascribed to each possibility may be correlated with other options. Hence, the choice probabilities are not independent and the decision rule does not fulfill the IIA axiom, which provides a micro-foundation for multilateral resistance to migration.

Beyond the theoretical contribution, the chapter quantifies the outcomes of implementing two migration policies targeted at the high-skilled individuals in the European Union. Introducing an H1B visa in Europe (a preferential 6-year visa for the college-educated) increases the total stock of high-skilled immigrants in the EU by 6.1 percent (800,000 people). The main winners are big EU-members, whereas the non-EU countries like the US, Canada or Australia are losing their high-skilled immigrants. This is the consequence of "talent-stealing" effect which is explained by an increase in the relative attractiveness of the EU states after liberalizing legal migration barriers. However, the major importance may be ascribed to the "visa-substitution" effect: since the medium-term visas are now cheaper, the current short-term and permanent immigrants are more prone to choosing a 6-year emigration option.

The above results are compared to an alternative migration policy in the EU: a fiscal incentive for the high-skilled, medium-term immigrants. In this case, the change in total stock of immigrants is similar to the previous case (5.6 percent, over 700,000 people), but one observes a higher number of inflowing professionals. This is the consequence of "new-entry" effect, which works through an increase in the absolute attractiveness of European countries (through reducing the income taxes and increasing net wages of prospective high-skilled immigrants). Simultaneously, the "visa-substitutions" effect is of less importance, while the "talent-stealing" effect remains unchanged.

The study provides also two additional results. With a help of a reduced form exercise, I compute the consequences of both migration policies, when emigrants are subject to a wage premium after returning to their home countries. The quantitative results (in terms of changes in yearly flows and total stocks of skilled immigrants) are more pronounced: a return bonus decreases the average duration of stay, but, at the same time, more people emigrate. Qualitatively, the relative ordering of countries with respect to their gains in labor, is slightly changed, in reference to the benchmark case. Finally, I calculate the difference in flows and stocks of immigrants in the EU when multilateral resistance to migration is ruled out. This scenario shows, that independence between choice options favors the non-EU states which do not implement the analyzed policy reforms. Therefore, not accounting for multilateral resistance to migration in international context (by disregarding either destination or duration choices of agents) may result in a downward biased quantification of the impact of migration policies.

Acknowledgments

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Appendices

3.A Proofs of the properties of the model

Proof. (*Proposition 3.1*) Consider a migrant from country i to country j, characterized by $\rho_{ji} > 0$. Taking the first derivative of equation 3.3 with respect to duration d:

$$\frac{\partial U_{j^*i}(\bar{d}^*, d)}{\partial d} = V_{j^*i} + \varepsilon_{j^*} - \varepsilon_i - d^* \rho_{j^*i} = 0$$

Therefore: $d^* = \rho_{j^*i}^{-1} (V_{j^*i} + \varepsilon_{j^*} - \varepsilon_i)$. Since: $d^* \leq 1$, then: $d = \min \left\{ \rho_{j^*i}^{-1} (V_{ji} + \varepsilon_{j^*} - \varepsilon_i) ; 1 \right\}$, if $\rho_{ji} > 0$.

Consider now the situation when $\rho_{j^*i} < 0$. From the fact that a person did emigrate, one knows that the marginal gains in the host country exceed the marginal gains in the sending country: $V_{j^*i} + \varepsilon_{j^*} - \varepsilon_i > 0$. On top of that: $-d\rho_{j^*i} > 0$, so that the total instantaneous utility ascribed to emigration is greater than the instantaneous utility associated with staying at home. Thus, there are no incentives for an agent to leave the destination country throughout the duration of stay. In consequence the maximization program hits the corner solution, so that: $d^* = 1$. □

Proof. (*Corollary 3.3*) The conditional PDF, defined for $d > 0$ is equivalent to the unconditional PDF divided by the probability that $d > 0$, equation 3.12:

$$f_{d>0}(d) = \frac{\rho_{ji} e^{\rho_{ji} d + V_{ji}}}{\left(e^{\rho_{ji} d} + e^{V_{ji}}\right)^2} \cdot \frac{1 + e^{V_{ji}}}{e^{V_{ji}}} = \frac{\rho_{ji} e^{\rho_{ji} d} (1 + e^{V_{ji}})}{(e^{\rho_{ji} d} + e^{V_{ji}})^2}. \tag{3.A1}$$

The conditional CDF for a given δ is simply an integral from 0 to δ of $f_{d>0}(d)$:

$$\begin{aligned} F_{d>0}(\delta) &= \int_0^{\delta} \frac{\rho_{ji} e^{\rho_{ji} t} (1 + e^{V_{ji}})}{(e^{\rho_{ji} t} + e^{V_{ji}})^2} dt = (1 + e^{V_{ji}}) \int_{1+e^{V_{ji}}}^{e^{\rho_{ji}\delta} + e^{V_{ji}}} \frac{1}{k^2} dk \\ &= (1 + e^{V_{ji}}) \left(\frac{1}{1 + e^{V_{ji}}} - \frac{1}{e^{\rho_{ji}\delta} + e^{V_{ji}}} \right) = \frac{e^{\rho_{ji}\delta} - 1}{e^{\rho_{ji}\delta} + e^{V_{ji}}}, \end{aligned} \tag{3.A2}$$

where the change of variables: $k \equiv e^{\rho_{ji} t} + e^{V_{ji,t}}$ was made. □

Proof. (*Proposition 3.5*) The expected, conditional duration of stay (for the temporary migrants characterized by $\rho_{ji} > 0$) is calculated from the definition:

$$\begin{aligned} \mathbb{E}_{d>0}[d|d < 1] &= \int_0^1 t dF_{t>0}(t) dt = \int_0^1 t \frac{\rho_{ji} e^{\rho_{ji} t} (1 + e^{V_{ji}})}{\left(e^{\rho_{ji} t} + e^{V_{ji}}\right)^2} dt \\ &= \frac{1 + e^{V_{ji}}}{\rho_{ji} e^{V_{ji}}} \ln \frac{1 + e^{V_{ji}}}{1 + e^{V_{ji} - \rho_{ji}}} - \frac{1 + e^{V_{ji}}}{e^{\rho_{ji}} + e^{V_{ji}}}. \end{aligned} \tag{3.A3}$$

These people constitute a fraction of $1/2$ of total gross inflow of migrants. The rest of people (that is temporary migrants characterized by $\rho_{ji} < 0$ and the permanent migrants) is staying until the expiration of their visa, so their average duration of stay is $d = 1$. Consider a gross inflow of immigrants equal to N_{ji} people. Now adding all the groups (temporary, nostalgic, permanent nostalgic and non-nostalgic people respectively), I get the aggregated labor force which is present in the host country during the 50-year period:

$$\begin{aligned} L_{ji}(V_{ji},\rho_{ji}) &= \frac{N_{ji}}{2}\left(\frac{1+e^{V_{ji}}}{\rho_{ji}e^{V_{ji}}}\ln\frac{1+e^{V_{ji}}}{1+e^{V_{ji}-\rho_{ji}}} - \frac{1+e^{V_{ji}}}{e^{\rho_{ji}}+e^{V_{ji}}}\right) + \frac{N_{ji}}{2}\frac{1+e^{V_{ji}}}{e^{\rho_{ji}}+e^{V_{ji}}} + \frac{N_{ji}}{2} \\ &= \frac{N_{ji}}{2}\left(\frac{1+e^{V_{ji}}}{\rho_{ji}e^{V_{ji}}}\ln\left(\frac{1+e^{V_{ji}}}{1+e^{V_{ji}-\rho_{ji}}}\right)+1\right). \end{aligned} \tag{3.A4}$$

□

Proof. (*Corollary 3.6*) In computing the limits, whenever there appears an undefined symbol (i.e. $0\cdot\infty$, $0/0$ or ∞/∞), I write $\doteq$ to inform that the L'Hôpital's rule is used.

$$\begin{aligned} \lim_{\rho_{ji}\to 0} L_{ji}(V_{ji},\rho_{ij}) &= \frac{N_{ji}}{2}\left(\lim_{\rho_{ji}\to 0}\frac{\ln\left(\frac{1+e^{V_{ji}}}{1+e^{V_{ji}-\rho_{ji}}}\right)}{\frac{\rho_{ji}e^{V_{ji}}}{1+e^{V_{ji}}}}+1\right) \\ &\doteq \frac{N_{ji}}{2}\left(\lim_{\rho_{ji}\to 0}\frac{1+e^{V_{ji}}}{e^{V_{ji}}}\cdot\frac{e^{V_{ji}-\rho_{ji}}}{1+e^{V_{ji}-\rho_{ji}}}+1\right) = N_{ji}, \\ \lim_{V_{ji}\to\infty} L_{ji}(V_{ji},\rho_{ji}) &= \lim_{V_{ji}\to\infty}\frac{N_{ji}}{2}\left(\frac{1+e^{V_{ji}}}{\rho_{ji}e^{V_{ji}}}\ln\left(\frac{1+e^{V_{ji}}}{1+e^{V_{ji}-\rho_{ji}}}\right)+1\right) \\ &= \frac{N_{ji}}{2}\left(\frac{1}{\rho_{ji}}\cdot\ln(e^{\rho_{ji}})+1\right) = N_{ji}, \\ \lim_{\rho_{ji}\to\infty} L_{ji}(V_{ji},\rho_{ji}) &= \lim_{\rho_{ji}\to\infty}\frac{N_{ji}}{2}\left(\frac{1+e^{V_{ji}}}{\rho_{ji}e^{V_{ji}}}\ln\left(\frac{1+e^{V_{ji}}}{1+e^{V_{ji}-\rho_{ji}}}\right)+1\right) = \frac{N_{ji}}{2}, \\ \lim_{V_{ji}\to-\infty} L_{ji}(V_{ji},\rho_{ji}) &= \frac{N_{ji}}{2}\left(\lim_{V_{ji}\to-\infty}\frac{\ln\left(\frac{1+e^{V_{ji}}}{1+e^{V_{ji}-\rho_{ji}}}\right)}{\frac{\rho_{ji}e^{V_{ji}}}{1+e^{V_{ji}}}}+1\right) \\ &\doteq \frac{N_{ji}}{2}\left(\lim_{V_{ji}\to-\infty}\frac{1-e^{-\rho_{ji}}}{1+e^{V_{ji}-\rho_{ji}}}\cdot\frac{(1+e^{V_{ji}})}{\rho_{ji}}+1\right) = \frac{N_{ji}}{2}\left(\frac{1-e^{-\rho_{ji}}}{\rho_{ji}}+1\right). \end{aligned}$$

Additionally, concerning the third limit, one can state that:

$$\begin{aligned} \lim_{\rho_{ji}\to 0} L_{ji}(-\infty,\rho_{ji}) &= \lim_{\rho_{ji}\to 0}\frac{N_{ji}}{2}\left(\frac{1-e^{-\rho_{ji}}}{\rho_{ji}}+1\right) \doteq \lim_{\rho_{ji}\to 0}\frac{N_{ji}}{2}\left(e^{-\rho_{ji}}+1\right) = N_{ji}, \\ \lim_{\rho_{ji}\to\infty} L_{ji}(-\infty,\rho_{ji}) &= \lim_{\rho_{ji}\to\infty}\frac{N_{ji}}{2}\left(\frac{1-e^{-\rho_{ji}}}{\rho_{ji}}+1\right) = \frac{N_{ji}}{2}. \end{aligned}$$

□

Proof. (*Proposition 3.7*) Let us concentrate on calculating the probability of choosing to stay in the homeland, that is: $P[\bar{U}_{ii}=\max]$, where, for simplicity, I take $i=1$. Therefore, all the source-destination-specific variables are now denoted with a subscript i, instead of $i1$.

$$\begin{aligned} &P[\bar{U}_1=\max] = P[\forall i\in\{2,...,N\}\ \bar{U}_1\geq\bar{U}_i^t\wedge\bar{U}_1\geq\bar{U}_i^p] = \\ &P[\forall i\in\{2,...,N\}\ \alpha v_1+\varepsilon_1\geq d^t\left(\alpha(v_i-x_i^t)+\varepsilon_i\right)+(1-d^t)(\alpha v_1+\varepsilon_1) \\ &\wedge\alpha v_1+\varepsilon_1\geq\alpha(v_i-x_i^p)+\varepsilon_i] = \\ &P[\forall i\in\{2,...,N\}\ \alpha v_1+\varepsilon_1\geq\alpha(v_i-x_i^t)+\varepsilon_i\wedge\alpha v_1+\varepsilon_1\geq\alpha(v_i-x_i^p)+\varepsilon_i]. \end{aligned}$$

Noticing that $\forall i \in \{2,...,N\}\ x_i^p > x_i^t$, one can reduce the number of events only to the temporary migration inequalities:

$$P[\forall i \in \{2,...,N\}\ \alpha v_1 + \varepsilon_1 \geq \alpha(v_i - x_i^t) + \varepsilon_i].$$

The left and right hand sides of the inequality are *iid*, so one can use the McFadden's theorem to compute the logit probability:

$$P[\bar{U}_1 = \max] = \frac{e^{\alpha v_1}}{\sum_{k=1}^{N} e^{\alpha(v_k - x_k^t)}} \tag{3.A5}$$

Moving to the probability of temporary migration to a given destination $i \in \{2,...,N\}$, taking that j is a counter which represents all other possible foreign countries: $j \in \{2,...,N\} \wedge j \neq i$, one obtains that:

$$\begin{aligned}
&P[\bar{U}_i^t = \max] = P[\bar{U}_i^t \geq \bar{U}_1 \wedge \bar{U}_i^t \geq \bar{U}_i^p \wedge \bar{U}_i^t \geq \bar{U}_j^t \wedge \bar{U}_i^t \geq \bar{U}_j^p] = \\
&P[d^t\left(\alpha(v_i - x_i^t) + \varepsilon_i\right) + (1-d^t)(\alpha v_1 + \varepsilon_1) \geq \alpha v_1 + \varepsilon_1 \wedge \\
&\quad d^t\left(\alpha(v_i - x_i^t) + \varepsilon_i\right) + (1-d^t)(\alpha v_1 + \varepsilon_1) \geq \alpha(v_i - x_i^p) + \varepsilon_i \wedge \\
&\quad d^t\left(\alpha(v_i - x_i^t) + \varepsilon_i\right) + (1-d^t)(\alpha v_1 + \varepsilon_1) \geq d^t\left(\alpha(v_j - x_j^t) + \varepsilon_j\right) + (1-d^t)(\alpha v_1 + \varepsilon_1) \wedge \\
&\quad d^t\left(\alpha(v_i - x_i^t) + \varepsilon_i\right) + (1-d^t)(\alpha v_1 + \varepsilon_1) \geq \alpha(v_j - x_j^p) + \varepsilon_j] = \\
&P[\alpha(v_i - x_i^t) + \varepsilon_i \geq \alpha v_1 + \varepsilon_1 \wedge \alpha v_i + \varepsilon_i \geq \alpha(v_i - x_i^t) + \varepsilon_i \\
&\quad \wedge \alpha(v_i - x_i^t) + \varepsilon_i \geq \alpha(v_j - x_j^t) + \varepsilon_j \wedge \\
&\quad d^t\left(\alpha(v_i - x_i^t) + \varepsilon_i\right) + (1-d^t)(\alpha v_1 + \varepsilon_1) \geq \alpha(v_j - x_j^p) + \varepsilon_j] = \\
&P[\alpha(v_1 - v_i + x_i^t) \leq \varepsilon_i - \varepsilon_1 \leq \alpha\left(v_1 - v_i - \frac{d^t}{1-d^t}x_i^t + \frac{1}{1-d^t}x_i^p\right) \wedge \\
&\quad \varepsilon_i - \varepsilon_j \geq \\
&\quad \max\left\{\alpha(v_j - x_j^t - v_i + x_i^t); \alpha\left[d^t(x_i^t - v_i) - (1-d^t)v_1 + v_j - x_j^p\right] - (1-d^t)(\varepsilon_1 - \varepsilon_i)\right\}].
\end{aligned}$$

Consider a situation that the first argument of the max function is the greatest one. This leads to:

$$\begin{aligned}
&\alpha(v_j - x_j^t - v_i + x_i^t) \geq \alpha\left[d^t(x_i^t - v_i) - (1-d^t)v_1 + v_j - x_j^p\right] - (1-d^t)(\varepsilon_1 - \varepsilon_i) \\
&\iff \alpha\left(v_1 - v_i - \frac{1}{1-d^t}x_j^t + x_i^t + \frac{1}{1-d^t}x_j^p\right) \geq \varepsilon_i - \varepsilon_1.
\end{aligned} \tag{3.A6}$$

But, by the assumption made in the Theorem, one obtains that this inequality is equivalent to the inequality (taken from the first module of the probability): $\varepsilon_i - \varepsilon_1 \leq \alpha(v_1 - v_i - \frac{d^t}{1-d^t}x_i^t + \frac{1}{1-d^t}x_i^p)$. By comparing the deterministic values one gets that:

$$\begin{aligned}
&\alpha\left(v_1 - v_i - \frac{d^t}{1-d^t}x_i^t + \frac{1}{1-d^t}x_i^p\right) = \left(v_1 - v_i - \frac{1}{1-d^t}x_j^t + x_i^t + \frac{1}{1-d^t}x_j^p\right) \\
&\iff x_i^p - x_i^t = x_j^p - x_j^t.
\end{aligned}$$

Therefore, the inequality in 3.A6 cannot be reversed, provided that the measure of the set of solutions is not zero. Finally, one arrives at the probability equal to:

$$P[\alpha(v_1 - v_i + x_i^t) \leq \varepsilon_i - \varepsilon_1 \leq \alpha\left(v_1 - v_i - \frac{d^t}{1-d^t}x_i^t + \frac{1}{1-d^t}x_i^p\right) \wedge$$
$$\varepsilon_i - \varepsilon_j \geq \alpha(v_j - x_j^t - v_i + x_i^t)] =$$

$$P[\varepsilon_1 \in \left[\varepsilon_i - \alpha\left(v_1 - v_i - \frac{d^t}{1-d^t}x_i^t + \frac{1}{1-d^t}x_i^p\right); \varepsilon_i - \alpha(v_1 - v_i + x_i^t)\right] \wedge$$
$$\varepsilon_j \leq \varepsilon_i - \alpha(v_j - x_j^t - v_i + x_i^t)]$$

Rewriting it in a way that ε_i is the integrated variable, and keeping in mind that ε_1 and ε_j are independent Extreme Value Type I random variables, one can calculate the exact value of the probability by solving the integral:

$$P[\bar{U}_i^t = \max] =$$
$$\int_{-\infty}^{+\infty} \prod_{j=2}^{N} e^{-e^{-\varepsilon_i} e^{\alpha\left(v_j - x_j^t - v_i + x_i^t\right)}} \left(e^{-e^{-\varepsilon_i}\left(e^{\alpha(v_1 - v_i + x_i^t)} - e^{\alpha\left(v_1 - v_i - \frac{d^t}{1-d^t}x_i^t + \frac{1}{1-d^t}x_i^p\right)}\right)} \right) e^{-e^{-\varepsilon_i}} e^{-\varepsilon_i} d\varepsilon_i =$$
$$\frac{1}{\sum_{j=2}^{N} e^{\alpha\left(v_j - x_j^t - v_i + x_i^t\right)} + e^{\alpha(v_1 - v_i + x_i^t)}} - \frac{1}{\sum_{j=2}^{N} e^{\alpha\left(v_j - x_j^t - v_i + x_i^t\right)} + e^{\alpha\left(v_1 - v_i - \frac{d^t}{1-d^t}x_i^t + \frac{1}{1-d^t}x_i^p\right)}} =$$
$$\frac{e^{\alpha(v_i - x_i^t)}}{\sum_{k=1}^{N} e^{\alpha(v_k - x_k^t)}} - \frac{e^{\alpha(v_i - x_i^t)}}{\sum_{k=2}^{N} e^{\alpha(v_k - x_k^t)} + e^{\alpha(v_1 + \frac{1}{1-d^t}(x_i^p - x_i^t))}}.$$

The same algorithm leads to calculation of $P[\bar{U}_i^p = \max] = \frac{e^{\alpha(v_i - x_i^t)}}{\sum_{k=2}^{N} e^{\alpha(v_k - x_k^t)} + e^{\alpha(v_1 + \frac{1}{1-d^t}(x_i^p - x_i^t))}}$.

□

Proof. (*Proposition 3.9*)

$$E_{ii}^{\mathbb{P}} \equiv \frac{\partial \mathbb{P}_i}{\partial y_i}\frac{y_i}{\mathbb{P}_i} =$$
$$\frac{\partial V_i}{\partial y_i}\frac{y_i}{\mathbb{P}_i}\left[\frac{e^{V_i}}{\sum_{k=1}^{N} e^{V_k}} - \left(\frac{e^{V_i}}{\sum_{k=1}^{N} e^{V_k}}\right)^2 - \frac{e^{V_i}}{\sum_{k=2}^{N} e^{V_k} + e^{V_1}C(\Delta)} + \left(\frac{e^{V_i}}{\sum_{k=2}^{N} e^{V_k} + e^{V_1}C(\Delta)}\right)^2\right] =$$
$$\frac{\partial V_i}{\partial y_i}\frac{y_i}{\mathbb{P}_i}\left[\pi_i - \pi_i^2 - p_i + p_i^2\right] = \frac{\partial V_i}{\partial y_i} y_i \left(\frac{\pi_i(1-\pi_i)}{\pi_i - p_i} - \frac{p_i(1-p_i)}{\pi_i - p_i}\right).$$
$$E_{ji}^{\mathbb{P}} \equiv \frac{\partial \mathbb{P}_j}{\partial y_i}\frac{y_i}{\mathbb{P}_j} =$$
$$\frac{\partial V_i}{\partial y_i}\frac{y_i}{\mathbb{P}_i}\left[-\frac{e^{V_i}e^{V_j}}{(\sum_{k=1}^{N} e^{V_k})^2} + \frac{e^{V_i}e^{V_j}}{(\sum_{k=2}^{N} e^{V_k} + e^{V_1}C(\Delta))^2}\right] =$$
$$\frac{\partial V_i}{\partial y_i}\frac{y_i}{\mathbb{P}_i}\left[-\pi_i\pi_j + p_i p_j\right] = \frac{\partial V_i}{\partial y_i} y_i \left(\frac{-\pi_i\pi_j + p_i p_j}{\pi_i - p_i}\right).$$

□

3.B Visas by destination country

The most desired country for immigration, the United States, provides about 90 types of temporary visas, as well as green-cards for permanent immigrants. To apply for a particular type of temporary visa, a potential immigrant has to fulfill specific requirements connected with her education level, purpose of stay, international status (refugees) or affiliation (representatives). Not all the visas allow to work in the US, for example the widely popular B visas are issued only for short business or touristic visits. The potential duration of stay ranges from 1 year (in the case of D - crew visas, H-1A and H-2 - worker visas, P - athletes visas or Q - cultural exchange visas) to indefinite length of stay (as it is for the E - trade business partners visas or NATO - representatives visas). However, the most popular US visas which are issued for working purposes are the medium-term ones. The F-1 student visa allows the beneficiary to take full-time studies and to have a part-time job (or a full-time internship) during the period of stay (which mainly does not exceed 6 years). In 2013 the US issued more than 500,000 such permits. The J-1 "exchange visitor" visa for teachers and scholars, which can be extended up to 7 years, was the second popular type of permission in 2013 with over 310,000 applications. Finally, the H1-B visa program for high-skilled workers is constantly gaining popularity among professionals across all the countries. US companies are allowed to employ foreign highly educated workers for a period of 3 years. In fact, the majority of H1-B workers decides to prolong their stay for another 3 years. In 2014, the total number of accepted new applications was 124,326, whereas 191,531 workers continued their employment.[23] All in all, over 1.2 million immigrants out of 2 million new entrants to the US in 2013 were the medium-term temporary workers.

Australia, Canada and New Zealand have unified approaches towards immigration. On the one hand, these states introduce temporary migration offers that rely on a demand-driven process in which national firms invite specific workers (the duration of stay is generally restricted from 1 to 5 years like in the US H1-B program, but all occupations are considered). On the other hand, they provide permanent migration programs whose main pillar is a point system - the preferential channel for the well-educated candidates. In the first case, immigrants are granted visas on the basis of the contract signed with hosting company. Thus, the duration of stay is limited, but may vary across industries, firms and regions. Considering the permanent migration channel, in order to be qualified, an applicant has to provide information on her education and professional achievements along with a proof of proficiency in official languages. The selection process concentrates on choosing those candidates who either have outstanding scores or are ready to be employed in strategic industries. In this way, Australia, Canada and New Zealand remain the main competitors for the US in the game of attracting global talents.

The EU (along with EEA countries) has a less restrictive immigration policy and shows an attitude far less oriented towards high-skilled workers. Any person from a third country may become eligible to enter the Schengen Area for a temporary stay of 3, 6 or 12 months. Then, after the expiration of current permission, one might prolong it for another period. An alternative, temporary migration option, introduced in 2009 by the European Parliament, is the European Blue Card Program. This device is targeted at high-skilled non-EU candidates who wish to work in the EU. The main restriction is connected with the salary of beneficiary, which has to be "at least 1.5 times the average gross annual salary paid in the Member State concerned".[24] The Blue Card program is still at its early stages and is not commonly used by the potential residents (in

[23] Over 72 percent of all new applications originated from India, 6.5 percent from China. 64 percent of the beneficiaries worked in the computer-related industry, the rest were mainly architects, mathematicians, physicians and medical doctors. For further details, consult the US Department of Homeland Security report: http://www.uscis.gov/sites/default/files/USCIS/Resources/Reports%20and%20Studies/H-1B/h-1B-characteristics-report-14.pdf

[24] http://europa.eu/legislation_summaries/internal_market/living_and_working_in_the_internal_market/l14573_en.htm

2014 the EU granted about 13,000 documents, almost 90 percent of them concerned Germany). After 5 years of continuous living, working legally and paying taxes a non-EU worker may apply for a long-term immigrant status.[25] Finally, a long-term immigrant may apply for a citizenship after at least 5 years of long-term status.

3.C Data sources

For the US, I use the data from the 2013 Report of the Visa Office on the non-immigrant visas. This rich dataset provides the numbers of all visas (by type) issued each year for people originating from every country in the world. Additionally, I gather the data on permanent immigrants (by country of origin and cause of immigration). Both reports are available on the Visa Office web page.[26].

In the case of Australia, I use the data on temporary work visa grants published by the Department of Immigration and Border Protection for years 2012-2013.[27] From this dataset I extract the number of visas issued for the short term business visitors and working holidays (less than 1 year), and temporary skilled workers (less than 6 years). Then, using the Australia's Migration Trends 2012-2013 report, I collect the numbers of permanent immigrants to Australia for ten most popular sources and for all the OECD countries.[28] For the rest of countries, which constitute approximately 15 percent of total inflows, I estimate the yearly flows using current stocks of immigrants.

In terms of New Zealand, I take the data on flows of work permits issued by the government in 2012-2013.[29] The applications in the published dataset are divided into 90 categories, each of them characterized by a specific duration of stay (ranging from 1 year to indefinite). Additionally, using the data on flows of new permanent residents (divided into 22 categories), it is possible to define the yearly flows of immigrants to New Zealand.

Concerning Canada, I collect the available data from Facts and Figures 2013: Immigration Overview database, provided by Research and Evaluation Branch, Citizenship and Immigration Canada (CIC).[30] For the temporary immigrants, Canada proposes two types of visas: International Mobility Program work permit, and Temporary Foreign Worker Program work permit. The numbers of new inflows for both categories by citizenship are available for top 50 sending countries. The rest, which constitutes less than 5 percent, is estimated using the structure of current stocks of immigrants. CIC publishes also the number of new permanent residents for the full set of source countries.

The UK provides a comprehensive dataset with country-specific flows of immigrants considering 24 types of visas. Using the immigration statistics published by Home Office I can compute the number of short and medium-term immigrants coming to the UK in 2013.[31] Finally, using

[25] In general, this status equalizes the treatment of immigrants to the one of natives in terms of social benefits, access to education or traveling across the EU. Detailed regulations are subject to a specific member-country legislations. For further details consult:
http://europa.eu/legislation_summaries/justice_freedom_security/free_movement_of_persons_asylum_immigration/l23034_en.htm

[26] The data are available in pdf and xls formats:
http://travel.state.gov/content/visas/english/law-and-policy/statistics.html

[27] The access to the data on stocks and flows of temporary workers to Australia is restricted, and they are published in protected xls files: http://www.immi.gov.au/media/statistics/statistical-info/temp-entrants/subclass-457.htm

[28] The report is available on-line: http://www.immi.gov.au/pub-res/Documents/statistics/migration-trends-2012-13.pdf

[29] See: http://www.immigration.govt.nz/migrant/general/generalinformation/statistics/

[30] The resources are published on: http://www.cic.gc.ca/english/resources/statistics/menu-fact.asp

[31] Available at: https://www.gov.uk/government/collections/migration-statistics#data-tables

the data on granted permanent settlements and citizenships, I compute the inflow of permanent immigrants.

For the EU 27 and three EEA countries, I collect the data on first issued residence permits from Eurostat. Having no other information, I assume that people who applied for 3-month and 6-month permissions are short-term immigrants (less than 1 year). Simultaneously, those who obtained a 12-month residence permit are classified as medium-term immigrants (temporary, more than 1 year). Eurostat publishes also the data on citizenships granted, which are the reference for an inflow of permanent immigrants.

In terms of immigrants' skills, using the above mentioned datasets, I extracted the inflows of high-skilled immigrants for Australia, the UK, New Zealand, and the US. The skill structure of inflows to other countries was assumed to be equal to the one in the current stock (taken from the DIOC database, OECD). Table 3.E3 presents the data on yearly flows and stock of immigrants by visa type in 35 receiving countries.

3.D Computation of probabilities of staying

In the first strategy, I collect the data from Database on Immigrants in OECD Countries (DIOC) created by the OECD.[32] There are three sets of data for three reference years: 2000, 2005 and 2010. For each package, I extract the number of immigrants who arrived to the host country 0-5 years ago, 5-10 years ago, 10-20 years ago and earlier than 20 years ago. The key assumption made in this calibration procedure is about invariability in time of the duration distribution. If one accepts this limitation, it is simple to compute the above mentioned conditional probabilities.

Consider the stock of immigrants from country i to country j, whose actual length of stay in the year 2010 was between 5 and 10 years. This means that all of them must have emigrated between year 2000 and 2005, thus they must have been registered in the year 2005 as immigrants from i to j with a duration of less than 5 years. However, in the group 0-5 in year 2005 there are also people who decided to leave the destination country before 2010. These persons are registers in 2005, but they are not registered in 2010. Assuming that the only cause of leaving is returning to the home country (disregarding re-emigration to other countries and deaths), the probability of staying at least 5-10 years, conditional on having stayed at least 0-5 years is equal to the ratio of the stock of immigrants in group 5-10 in 2010 to the stock of immigrants in group 0-5 in 2005.[33] Similarly, I compute the conditional probability of staying 10 years or more conditional on being in a 0-10 years group ten years before. I take the quotient of the stock of immigrants in group 10-20 in year 2010 to the stock of immigrants in group 0-10 in year 2000. The third empirical moment to fit is the probability of staying at least 20 years conditional on staying at least 10 years ten years before. Once again, I take the ratio of the stock of immigrants in group >20 in year 2010, to the stock of immigrants in groups 10-20 and >20 in year 2000.

The main problem with DIOC database is the fact that it is constructed using a random rounding procedure from national censuses, or the Labor Force Survey. As a consequence, the consistency

[32] Data and metadata are available at: http://www.oecd.org/els/mig/dioc.htm

[33] An important comment is that in the data provided by DIOC, the exact duration of stay of people in not explicitly given. Therefore, hypothetically, a group of 0-5 immigrants could be composed from new immigrants only or just from those who stayed 4 years and 11 months (if from that time the gross inflow of new immigrants was zero). As a solution to this problem I calculate the average duration of stay in each group (for 0-5 years and 5-10 years separately) according to the endogenous distribution of the duration of stay, which is being calibrated. In this way, I force all the conditional moments to be dependent on the structure of distribution and provide its best fit without imposing additional constraints.

of data from one release to another is not perfect, in a sense that the number of stayers in later groups may be larger than the number of stayers in the earlier groups. This leads to the values of conditional probabilities greater than one. When encountering such problem, I drop these observations. The final number of observations is 3880 values (out of 8316 data points), which gives 46.7 percent of data coverage.

Considering the above mentioned problems, and the fact that there are many missing observations, I decided to reinforce the set of observables with the values of unconditional probabilities: the shares of stayers in groups 0-5, 5-10 and 10-20 in year 2010 to the total flows of immigrants who came in years 2005-2010, 2000-2010 and 1990-2000 respectively. The latter, country-pair-specific data for the whole 196×196 country matrix are provided by Abel and Sander (2014). They estimate the gross flows of immigrants in 5-year intervals using the data on stocks of migrants, population of countries and births and deaths statistics.[34] Apart from controlling for values greater than one, one also has to notice that the unconditional probability of being in group 0-5 (that is the unconditional probability of staying at least the average number of years in group 0-5) is greater than the respective value for 5-10 years, which, in turn, exceeds the value for 10-20. The share of acceptable data equals 54.8 percent. All in all, for each of 2,772 country pairs I obtain one to six data points which characterize the distributions of duration of stay.

[34] The outcomes of this estimation procedure, that is four matrices of 5-year flows from 1990 to 2010, are available on-line as supplementary materials: http://www.sciencemag.org/content/343/6178/1520/suppl/DC1

3.E Additional figures and tables

TABLE 3.E1: Sample and country codes

Code	Country	Code	Country	Code	Country
AFG	Afghanistan	GHA	Ghana	NOR	Norway
AGO	Angola	GIN	Guinea	NPL	Nepal
ALB	Albania	GMB	Gambia, The	NZL	New Zealand
ARE	United Arab Emirates	GNB	Guinea-Bissau	OMN	Oman
ARG	Argentina	GRC	Greece	PAK	Pakistan
ARM	Armenia	GRD	Grenada	PAN	Panama
AUS	Australia	GTM	Guatemala	PER	Peru
AUT	Austria	GUY	Guyana	PHL	Philippines
AZE	Azerbaijan	HND	Honduras	PNG	Papua New Guinea
BDI	Burundi	HRV	Croatia	POL	Poland
BEL	Belgium	HTI	Haiti	PRT	Portugal
BEN	Benin	HUN	Hungary	PRY	Paraguay
BFA	Burkina Faso	IDN	Indonesia	QAT	Qatar
BGD	Bangladesh	IND	India	ROU	Romania
BGR	Bulgaria	IRL	Ireland	RUS	Russian Federation
BHR	Bahrain	IRN	Iran, Islamic Rep.	RWA	Rwanda
BHS	The Bahamas	IRQ	Iraq	SAU	Saudi Arabia
BIH	Bosnia and Herzegovina	ISL	Iceland	SDN	Sudan
BLR	Belarus	ISR	Israel	SEN	Senegal
BLZ	Belize	ITA	Italy	SGP	Singapore
BOL	Bolivia	JAM	Jamaica	SLB	Solomon Islands
BRA	Brazil	JOR	Jordan	SLE	Sierra Leone
BRB	Barbados	JPN	Japan	SLV	El Salvador
BRN	Brunei Darussalam	KAZ	Kazakhstan	SOM	Somalia
BTN	Bhutan	KEN	Kenya	SRB	Serbia
BWA	Botswana	KGZ	Kyrgyz Rep.	SSD	South Sudan
CAF	Central African Rep.	KHM	Cambodia	STP	São Tomé and Principe
CAN	Canada	KOR	Korea, Rep.	SUR	Suriname
CHE	Switzerland	KWT	Kuwait	SVK	Slovak Rep.
CHL	Chile	LAO	Lao PDR	SVN	Slovenia
CHN	China	LBN	Lebanon	SWE	Sweden
CIV	Côte d'Ivoire	LBR	Liberia	SWZ	Swaziland
CMR	Cameroon	LBY	Libya	SYR	Syrian Arab Rep.
COD	Congo, Dem. Rep.	LCA	St. Lucia	TCD	Chad
COG	Congo, Rep.	LKA	Sri Lanka	TGO	Togo
COL	Colombia	LSO	Lesotho	THA	Thailand
COM	Comoros	LTU	Lithuania	TJK	Tajikistan
CPV	Cabo Verde	LUX	Luxembourg	TKM	Turkmenistan
CRI	Costa Rica	LVA	Latvia	TLS	Timor-Leste
CUB	Cuba	MAR	Morocco	TON	Tonga
CYP	Cyprus	MDA	Moldova	TTO	Trinidad and Tobago
CZE	Czech Rep.	MDG	Madagascar	TUN	Tunisia
DEU	Germany	MDV	Maldives	TUR	Turkey
DJI	Djibouti	MEX	Mexico	TZA	Tanzania
DNK	Denmark	MKD	Macedonia, FYR	UGA	Uganda
DOM	Dominican Rep.	MLI	Mali	UKR	Ukraine
DZA	Algeria	MLT	Malta	URY	Uruguay
ECU	Ecuador	MMR	Myanmar	USA	United States
EGY	Egypt, Arab Rep.	MNE	Montenegro	UZB	Uzbekistan
ERI	Eritrea	MNG	Mongolia	VCT	St. Vincent and the Gr.
ESP	Spain	MOZ	Mozambique	VEN	Venezuela, RB
EST	Estonia	MRT	Mauritania	VNM	Vietnam
ETH	Ethiopia	MUS	Mauritius	VUT	Vanuatu
FIN	Finland	MWI	Malawi	WSM	Samoa
FJI	Fiji	MYS	Malaysia	YEM	Yemen, Rep.
FRA	France	NAM	Namibia	ZAF	South Africa
FSM	Micronesia, Fed. Sts.	NER	Niger	ZMB	Zambia
GAB	Gabon	NGA	Nigeria	ZWE	Zimbabwe
GBR	United Kingdom	NIC	Nicaragua		
GEO	Georgia	NLD	Netherlands		

Source: ISO.

TABLE 3.E2: Net wages and fiscal burden

Code	Net wage in USD PPP	Ratio of net/gross	Code	Net wage in USD PPP	Ratio of net/gross	Code	Net wage in USD PPP	Ratio of net/gross
AFG	7,951.36	98.66%	GHA	13,266.66	85.74%	NOR	51,064.28	70.92%
AGO	14,958.29	84.04%	GIN	6,627.41	88.66%	NPL	7,834.08	99.00%
ALB	20,950.98	90.27%	GMB	5,659.97	77.66%	NZL	33,575.45	81.54%
ARE	120,530.17	100.00%	GNB	6,176.26	80.00%	OMN	74,200.01	100.00%
ARG	37,332.66	75.21%	GRC	24,711.51	74.00%	PAK	11,646.91	92.98%
ARM	7,240.38	74.11%	GRD	20,422.39	85.00%	PAN	39,930.90	91.66%
AUS	40,433.62	78.25%	GTM	34,931.27	95.00%	PER	20,428.80	89.30%
AUT	39,158.69	68.61%	GUY	15,593.77	77.64%	PHL	11,158.24	79.98%
AZE	28,189.99	86.00%	HND	19,996.10	91.15%	PNG	4,052.60	78.00%
BDI	4,148.66	95.38%	HRV	29,363.66	73.23%	POL	30,460.14	82.00%
BEL	31,319.63	59.80%	HTI	3,304.85	86.26%	PRT	46,013.82	69.92%
BEN	6,398.46	70.00%	HUN	28,000.02	84.00%	PRY	19,191.68	90.00%
BFA	6,447.83	79.66%	IDN	20,012.24	90.99%	QAT	216,535.78	100.00%
BGD	11,308.55	85.00%	IND	17,090.45	85.40%	ROU	31,207.31	84.00%
BGR	19,121.54	90.00%	IRL	50,341.63	70.61%	RUS	27,669.88	87.00%
BHR	82,544.59	100.00%	IRN	24,521.96	75.00%	RWA	7,908.89	75.30%
BHS	42,526.73	100.00%	IRQ	33,020.36	85.87%	SAU	81,741.55	100.00%
BIH	18,598.32	90.00%	ISL	26,001.55	54.46%	SDN	14,764.06	85.00%
BLR	29,557.35	88.00%	ISR	35,693.38	85.01%	SEN	7,239.37	83.98%
BLZ	17,988.89	85.28%	ITA	38,674.05	70.85%	SGP	192,706.83	90.10%
BOL	9,716.00	87.00%	JAM	17,924.82	86.24%	SLB	7,954.34	90.00%
BRA	58,019.84	76.27%	JOR	28,549.05	97.58%	SLE	5,475.17	70.89%
BRB	17,827.40	76.64%	JPN	35,591.73	69.82%	SLV	17,615.86	85.37%
BRN	117,606.98	100.00%	KAZ	35,485.63	90.00%	SOM	5,791.69	90.00%
BTN	16,438.94	95.18%	KEN	11,287.74	81.07%	SRB	21,111.79	85.00%
BWA	39,372.59	88.89%	KGZ	6,941.65	90.00%	SSD	7,405.16	85.00%
CAF	4,249.31	80.00%	KHM	16,163.00	96.55%	STP	7,658.22	75.00%
CAN	41,629.35	82.85%	KOR	46,310.80	87.37%	SUR	22,759.55	73.25%
CHE	74,174.99	81.36%	KWT	129,177.10	100.00%	SVK	26,238.74	81.00%
CHL	45,253.41	93.39%	LAO	13,215.24	84.23%	SVN	29,941.58	73.23%
CHN	14,981.27	82.93%	LBN	31,184.03	94.99%	SWE	35,753.90	66.05%
CIV	11,056.94	76.56%	LBR	2,093.19	78.50%	SWZ	16,582.93	77.42%
CMR	12,681.17	86.81%	LBY	44,996.13	91.86%	SYR	12,471.83	85.00%
COD	2,698.12	89.05%	LCA	18,539.99	83.58%	TCD	5,835.29	65.85%
COG	10,819.00	72.98%	LKA	19,716.77	94.20%	TGO	4,574.21	72.00%
COL	39,743.86	90.69%	LSO	7,848.40	78.00%	THA	34,692.31	94.99%
COM	5,000.45	100.00%	LTU	29,090.47	85.00%	TJK	6,245.08	90.00%
CPV	13,137.35	83.50%	LUX	96,047.65	78.42%	TKM	25,002.60	90.00%
CRI	29,617.37	97.77%	LVA	24,088.46	76.00%	TLS	8,100.27	96.19%
CUB	23,325.71	80.00%	MAR	18,288.17	88.83%	TON	8,982.34	74.00%
CYP	35,972.45	87.99%	MDA	7,256.94	87.91%	TTO	44,759.46	75.00%
CZE	25,325.71	78.00%	MDG	6,254.33	80.89%	TUN	19,274.80	81.54%
DEU	35,857.26	66.16%	MDV	24,210.59	100.00%	TUR	35,487.84	77.63%
DJI	9,229.53	90.00%	MEX	40,616.14	80.94%	TZA	12,164.79	85.08%
DNK	39,332.64	64.65%	MKD	22,508.13	90.00%	UGA	6,696.35	80.59%
DOM	24,115.92	96.94%	MLI	6,517.81	70.00%	UKR	8,802.07	83.00%
DZA	27,183.16	75.20%	MLT	52,175.83	82.30%	URY	36,610.30	90.15%
ECU	23,325.97	98.90%	MMR	12,603.28	96.61%	USA	62,212.03	86.24%
EGY	27,358.27	85.69%	MNE	25,471.15	91.00%	UZB	11,156.98	81.38%
ERI	5,168.64	70.00%	MNG	30,583.78	90.00%	VCT	20,000.34	90.00%
ESP	35,141.02	74.74%	MOZ	6,540.14	88.47%	VEN	38,721.73	92.74%
EST	24,502.15	79.00%	MRT	11,344.64	70.00%	VNM	11,832.32	93.13%
ETH	6,752.75	87.96%	MUS	40,499.86	85.00%	VUT	10,242.57	100.00%
FIN	58,356.62	86.86%	MWI	5,432.47	78.20%	WSM	13,784.35	94.86%
FJI	22,135.53	96.91%	MYS	44,683.12	90.44%	YEM	12,009.98	85.00%
FRA	44,941.10	81.88%	NAM	28,530.42	83.25%	ZAF	40,079.82	79.40%
FSM	9,796.94	90.00%	NER	2,861.70	70.00%	ZMB	19,615.75	84.02%
GAB	38,046.45	77.08%	NGA	12,625.50	87.67%	ZWE	9,964.13	90.47%
GBR	43,983.47	75.79%	NIC	11,966.26	97.71%			
GEO	13,505.22	80.00%	NLD	49,636.20	80.09%			

Source: World Bank, and own calculations based on Barro and Lee (2013).

TABLE 3.E3: Yearly inflows and total stocks of immigrants (by visa type)

Code	Flow				Stock			
	1Y	6Y	50Y	Total	1Y	6Y	50Y	Total
EUR	246,945	426,740	294,356	968,041	238,561	2,299,216	10,490,861	13,028,638
AUT	6,218	12,634	785	19,638	6,058	66,213	25,617	97,888
BEL	1,856	11,836	4,812	18,503	1,802	67,026	204,186	273,014
BGR	2,117	1,825	377	4,320	2,037	9,286	11,375	22,698
CYP	3,189	3,243	907	7,339	3,093	17,449	27,068	47,609
CZE	2,009	6,864	202	9,074	1,859	36,452	6,630	44,940
DEU	37,809	64,858	30,455	133,122	36,293	351,853	1,017,105	1,405,251
DNK	2,367	7,954	523	10,843	2,279	42,079	19,329	63,687
ESP	12,241	54,290	16,685	83,215	11,849	303,865	708,586	1,024,301
EST	762	991	52	1,805	739	5,421	2,042	8,201
FIN	1,987	4,445	1,594	8,027	1,911	24,177	54,732	80,820
FRA	7,452	97,294	21,651	126,398	6,947	519,637	806,627	1,333,211
GBR	42,091	37,468	167,022	246,581	39,926	187,638	5,762,345	5,989,909
GRC	3,837	2,487	1,286	7,611	3,787	14,720	60,555	79,063
HRV	1,240	683	203	2,126	1,192	3,651	6,257	11,100
HUN	2,949	5,911	4,440	13,300	2,856	31,692	136,542	171,090
IRL	11,108	13,747	11,753	36,608	10,841	73,911	462,246	546,997
ITA	16,822	28,738	6,590	52,150	16,394	160,809	250,328	427,531
LTU	1,090	1,059	22	2,171	1,046	5,729	702	7,478
LUX	1,456	4,929	1,683	8,067	1,424	28,727	76,589	106,740
LVA	2,181	443	36	2,660	2,116	2,489	1,136	5,741
MLT	4,566	3,326	370	8,263	4,424	18,145	11,370	33,939
NLD	18,475	18,007	6,083	42,564	17,989	95,617	224,042	337,649
POL	51,326	2,412	705	54,442	50,389	13,410	22,374	86,173
PRT	2,044	7,203	3,577	12,824	1,897	36,927	117,378	156,203
ROU	1,417	5,901	11	7,329	1,349	30,512	368	32,228
SVK	1,192	1,559	103	2,854	1,165	8,704	3,713	13,581
SVN	1,459	978	154	2,591	1,417	5,490	5,150	12,058
SWE	5,684	25,657	12,274	43,615	5,482	137,589	466,469	609,541
AUS	464,039	98,917	156,884	719,840	460,228	588,201	6,638,961	7,687,390
CAN	92,483	62,615	149,367	304,465	90,615	359,186	5,643,203	6,093,005
CHE	13,809	39,489	8,021	61,319	13,405	207,025	259,733	480,163
ISL	1,043	809	88	1,940	1,012	4,439	3,021	8,472
NOR	3,062	15,138	2,134	20,334	2,991	83,728	86,657	173,376
NZL	268	31,051	15,002	46,320	232	177,891	655,205	833,328
USA	31,668	695,216	277,553	1,004,437	28,077	3,837,517	11,618,245	15,483,839
ALL	853,316	1,369,975	903,406	3,126,696	835,121	7,557,203	35,395,887	43,788,211

Note: The table provides the numbers immigrants in 35 destination countries (the EU as a whole: EUR, and all 35 destinations: ALL). First (last) four columns present the flows (stocks) of migrants by visa types and total sums. Source: Destination country publications (flows) and DIOC, OECD (stocks).

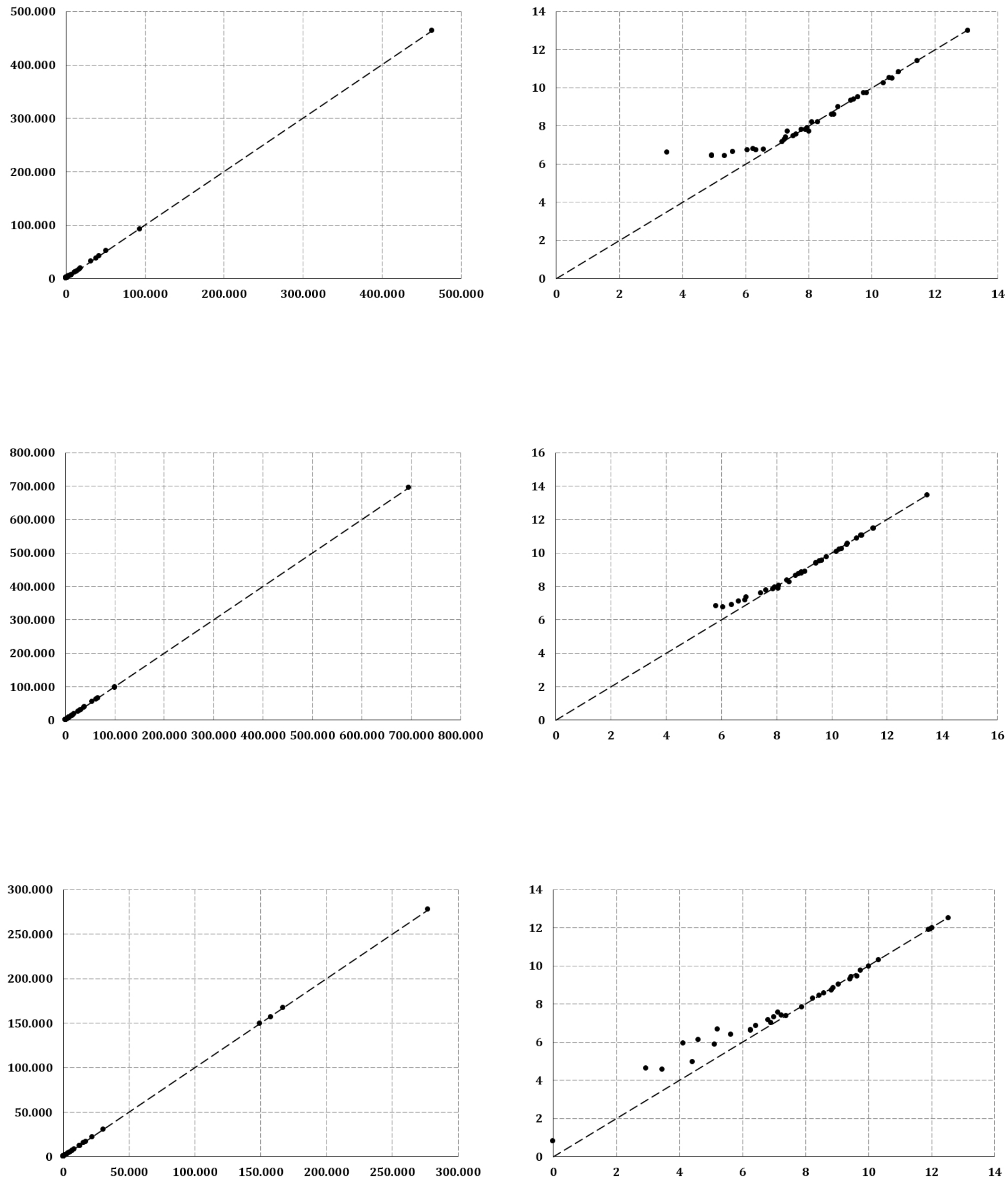

FIGURE 3.E1: Data (X axis) versus model outcomes (Y axis) for the yearly flows of short-term (first row), medium-term (second row), long-term (third row) high-skilled immigrants in 35 destination countries. First (second) column represents the values in number of people (in logs of the number of people).

Source: own calculations.

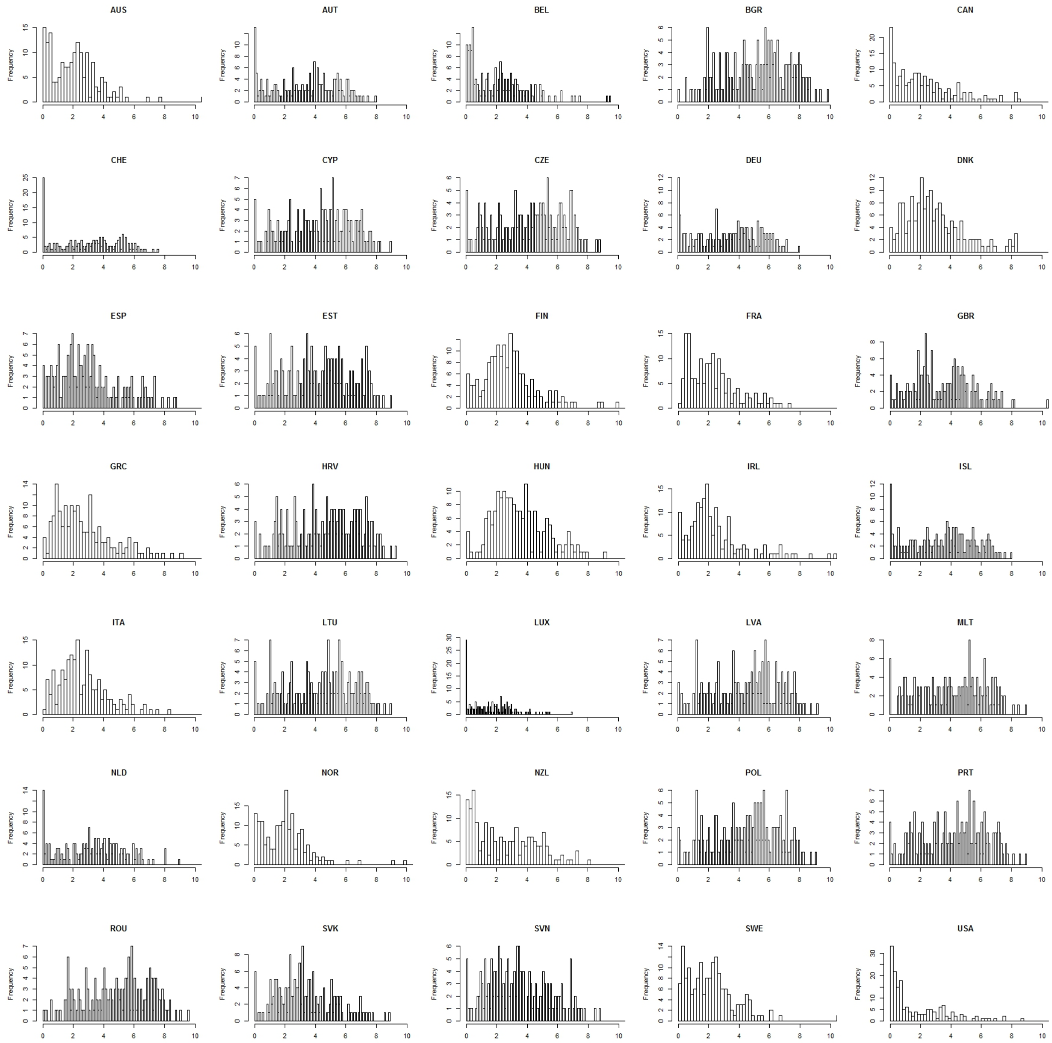

FIGURE 3.E2: Histograms of the computed values of unforeseen costs of living abroad, ρ_{ij}. Each figure presents the empirical distribution of the parameters for a particular destination country, and all 177 sending states.

Source: own calculations.

TABLE 3.E4: Decomposition of the expected migration costs, x

	(1)	(2)	(3)	(4)	(5)	(6)
Border	-0.616***	0.562***	0.555***	0.401***	0.162	
	(0.180)	(0.144)	(0.144)	(0.0924)	(0.143)	
Language	-3.297***	-1.554***	-1.530***	-1.141***	-1.173***	-0.896***
	(0.0804)	(0.0665)	(0.0673)	(0.0458)	(0.0688)	(0.0554)
Colony	2.243***	1.194***	1.191***	0.714***	1.158***	0.856***
	(0.156)	(0.125)	(0.125)	(0.0885)	(0.121)	(0.0850)
Distance (log)	0.484***	-0.0707***	-0.0555**	0.336***	-0.329***	0.191***
	(0.0282)	(0.0232)	(0.0240)	(0.0172)	(0.0364)	(0.0348)
Networks (log)		-0.594***	-0.596***	-0.404***	-0.723***	-0.515***
		(0.00581)	(0.00585)	(0.00529)	(0.00743)	(0.00844)
GDP ratio			-0.0362**	-0.00706	0.511***	
			(0.0149)	(0.0101)	(0.0506)	
Constant	4.786***	11.72***	11.65***	4.346***	11.05***	6.379***
	(0.242)	(0.205)	(0.207)	(0.214)	(0.419)	(0.398)
Observations	18,585	18,585	18,585	18,585	18,585	18,585
R-squared	0.103	0.426	0.426	0.770	0.493	0.810
Destination FE	NO	NO	NO	YES	NO	YES
Source FE	NO	NO	NO	NO	YES	YES

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Source: own calculations.

TABLE 3.E5: Extrapolation of unexpected migration costs, ρ

	(1)	(2)	(3)	(4)
Language	-0.138	-0.276	-0.338	-0.261
	(0.275)	(0.322)	(0.292)	(0.346)
Legislation	-0.0575	-0.195	0.225	0.158
	(0.211)	(0.231)	(0.226)	(0.243)
Networks (log)	-0.0272	0.0498	-0.129**	-0.00140
	(0.0418)	(0.0482)	(0.0541)	(0.0756)
Distance (log)	-0.389***	-0.241*	-0.653***	-0.261
	(0.104)	(0.141)	(0.121)	(0.191)
GDP ratio	-0.159**	-0.469	-0.208***	-1.698*
	(0.0769)	(0.329)	(0.0799)	(0.877)
Border	-0.671	-0.714	-0.678	-0.666
	(0.586)	(0.596)	(0.582)	(0.595)
Constant	6.747***	7.164*	9.493***	8.275***
	(0.922)	(3.786)	(1.435)	(2.700)
Observations	1,826	1,826	1,826	1,826
R-squared	0.015	0.170	0.062	0.209
Origin FE	NO	YES	NO	YES
Destination FE	NO	NO	YES	YES

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Source: own calculations.

TABLE 3.E6: The results of H1B and FI simulations as deviations from the reference

Code	H1B				FI			
	Δ flow	Δ% flow	Δ stock	Δ% stock	Δ flow	Δ% flow	Δ stock	Δ% stock
EUR	29,157	3.0%	800,432	6.1%	102,382	10.6%	727,125	5.6%
AUT	553	2.8%	20,765	21.2%	3,063	15.6%	18,662	19.1%
BEL	443	2.4%	7,716	2.8%	2,561	13.8%	16,422	6.0%
BGR	175	4.1%	6,879	30.3%	66	1.5%	848	3.7%
CYP	539	7.3%	12,302	25.8%	342	4.7%	3,415	7.2%
CZE	22	0.2%	5,422	12.1%	308	3.4%	4,467	9.9%
DEU	7,319	5.5%	148,384	10.6%	9,453	7.1%	108,418	7.7%
DNK	233	2.1%	7,931	12.5%	1,832	16.9%	12,994	20.4%
ESP	900	1.1%	33,589	3.3%	9,207	11.1%	72,239	7.1%
EST	13	0.7%	1,841	22.4%	26	1.5%	660	8.1%
FIN	245	3.0%	7,447	9.2%	1,281	16.0%	10,558	13.1%
FRA	-2,026	-1.6%	-4,401	-0.3%	22,575	17.9%	129,259	9.7%
GBR	8,530	3.5%	132,469	2.2%	26,063	10.6%	157,738	2.6%
GRC	490	6.4%	14,761	18.7%	-98	-1.3%	1,819	2.3%
HRV	127	6.0%	4,278	38.5%	-13	-0.6%	485	4.4%
HUN	420	3.2%	11,815	6.9%	361	2.7%	2,749	1.6%
IRL	1,645	4.5%	35,289	6.5%	5,669	15.5%	30,212	5.5%
ITA	2,594	5.0%	64,411	15.1%	2,398	4.6%	38,249	8.9%
LTU	154	7.1%	3,978	53.2%	21	1.0%	1,060	14.2%
LUX	233	2.9%	6,082	5.7%	4,090	50.7%	26,506	24.8%
LVA	236	8.9%	7,624	132.8%	4	0.2%	372	6.5%
MLT	649	7.9%	15,983	47.1%	447	5.4%	5,461	16.1%
NLD	2,672	6.3%	59,688	17.7%	4,523	10.6%	24,760	7.3%
POL	2,373	4.4%	164,167	190.5%	-1,300	-2.4%	523	0.6%
PRT	104	0.8%	3,255	2.1%	2,403	18.7%	14,270	9.1%
ROU	81	1.1%	4,483	13.9%	752	10.3%	4,953	15.4%
SVK	106	3.7%	4,041	29.8%	101	3.5%	1,071	7.9%
SVN	262	10.1%	5,484	45.5%	-15	-0.6%	622	5.2%
SWE	63	0.1%	14,753	2.4%	6,262	14.4%	38,331	6.3%
AUS	-9,968	-1.4%	-54,233	-0.7%	-12,146	-1.7%	-20,204	-0.3%
CAN	-4,139	-1.4%	-24,142	-0.4%	-4,605	-1.5%	-30,377	-0.5%
CHE	-711	-1.2%	-3,366	-0.7%	-1,698	-2.8%	-6,787	-1.4%
ISL	-6	-0.3%	169	2.0%	-31	-1.6%	137	1.6%
NOR	-322	-1.6%	-1,671	-1.0%	-958	-4.7%	-4,469	-2.6%
NZL	-831	-1.8%	-5,584	-0.7%	-771	-1.7%	-7,005	-0.8%
USA	-12,886	-1.3%	-77,693	-0.5%	-13,238	-1.3%	-75,679	-0.5%
ALL	293	0.0%	633,912	1.4%	68,935	2.2%	582,741	1.3%

Note: The table provides the changes in the numbers immigrants (counterfactual less reference) in 35 destination countries (the EU as a whole: EUR, and all 35 destinations: ALL). First (last) four columns present the results after introducing an H1B visa in the EU (a fiscal incentive, FI in the EU). Source: own calculations.

TABLE 3.E7: The results of H1B and FI simulations as deviations from the reference, with return premiums

Code	H1B RP				FI RP			
	Δ flow	Δ% flow	Δ stock	Δ% stock	Δ flow	Δ% flow	Δ stock	Δ% stock
EUR	42,330	3.6%	1,033,057	8.0%	114,592	9.7%	971,689	7.6%
AUT	977	3.9%	22,861	19.7%	3,352	13.5%	18,794	16.2%
BEL	80	0.4%	4,594	1.7%	2,645	11.6%	18,677	6.9%
BGR	411	8.1%	8,258	33.5%	455	8.9%	1,152	4.7%
CYP	386	4.3%	14,327	29.2%	147	1.6%	4,006	8.2%
CZE	294	2.6%	5,643	10.5%	466	4.1%	3,791	7.0%
DEU	13,131	7.9%	203,092	14.0%	12,312	7.4%	145,498	10.0%
DNK	162	1.2%	11,498	16.3%	1,977	14.2%	16,950	24.1%
ESP	769	0.7%	37,673	3.7%	9,156	8.7%	85,955	8.5%
EST	83	3.9%	2,470	31.3%	283	13.4%	3,715	47.2%
FIN	771	8.0%	10,946	13.3%	2,068	21.4%	19,594	23.8%
FRA	-4,465	-2.9%	-11,883	-0.9%	23,412	15.2%	147,717	10.8%
GBR	11,382	3.9%	180,760	3.2%	28,723	9.7%	246,243	4.3%
GRC	823	9.9%	17,160	22.4%	-64	-0.8%	-544	-0.7%
HRV	386	14.6%	6,003	48.5%	203	7.7%	1,264	10.2%
HUN	145	0.9%	8,345	4.8%	8	0.1%	465	0.3%
IRL	3,061	6.7%	64,046	12.1%	6,679	14.7%	40,434	7.6%
ITA	4,131	6.5%	84,883	19.1%	3,186	5.0%	51,244	11.5%
LTU	44	1.6%	3,387	36.8%	-182	-6.6%	648	7.0%
LUX	359	3.4%	6,053	6.2%	4,822	45.9%	36,261	37.3%
LVA	0	0.0%	8,071	104.0%	-297	-8.6%	-320	-4.1%
MLT	583	5.7%	21,830	59.8%	236	2.3%	7,263	19.9%
NLD	4,820	9.1%	89,703	26.4%	5,788	10.9%	31,722	9.3%
POL	3,118	5.2%	181,972	196.0%	-1,275	-2.1%	1,871	2.0%
PRT	-39	-0.2%	8,793	5.5%	2,576	15.8%	19,468	12.3%
ROU	1	0.0%	4,560	11.1%	372	3.9%	4,007	9.8%
SVK	31	0.9%	6,342	43.2%	271	7.6%	1,836	12.5%
SVN	360	11.5%	7,288	55.8%	258	8.2%	1,618	12.4%
SWE	521	1.0%	24,383	4.2%	7,012	13.1%	62,357	10.6%
AUS	-16,659	-1.8%	-51,063	-0.7%	-18,991	-2.1%	5,208	0.1%
CAN	-5,360	-1.4%	-17,165	-0.3%	-4,922	-1.3%	3,474	0.1%
CHE	-955	-1.2%	-13,408	-2.5%	-3,666	-4.5%	-24,338	-4.5%
ISL	-277	-10.8%	-1,358	-13.9%	186	7.2%	1,420	14.6%
NOR	-699	-2.8%	-3,467	-1.9%	-1,688	-6.8%	-11,576	-6.3%
NZL	-1,095	-1.8%	-28,358	-3.5%	-607	-1.0%	-16,104	-2.0%
USA	-21,641	-1.7%	-192,662	-1.3%	-20,415	-1.6%	-110,137	-0.7%
ALL	-4,355	-0.1%	725,575	1.7%	64,489	1.7%	819,635	1.9%

Note: The table provides the changes in the numbers immigrants (counterfactual less reference) in 35 destination countries (the EU as a whole: EUR, and all 35 destinations: ALL). First (last) four columns present the results after introducing an H1B visa in the EU (a fiscal incentive, FI in the EU), when the return premiums are accounted for. Source: own calculations.

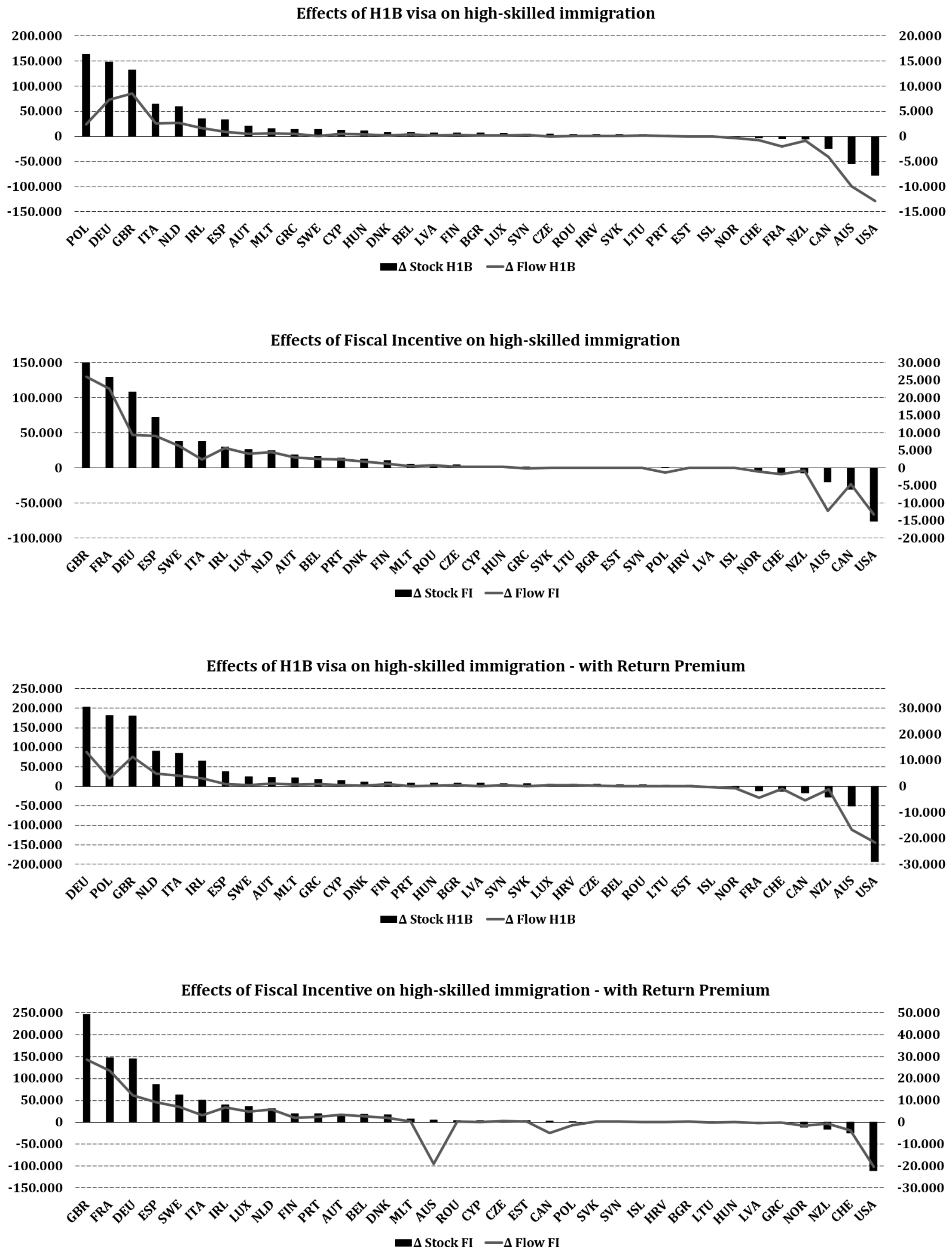

FIGURE 3.E3: The results of simulations

Changes in stocks (black bars, left axis) and flows (gray lines, right axis) of high-skilled immigrants (counterfactual less reference) after introducing: a) H1B visas in the EU, b) fiscal incentives in the EU, c) H1B visas in the EU with return premium, d) fiscal incentives in the EU with return premium. Source: own calculations.

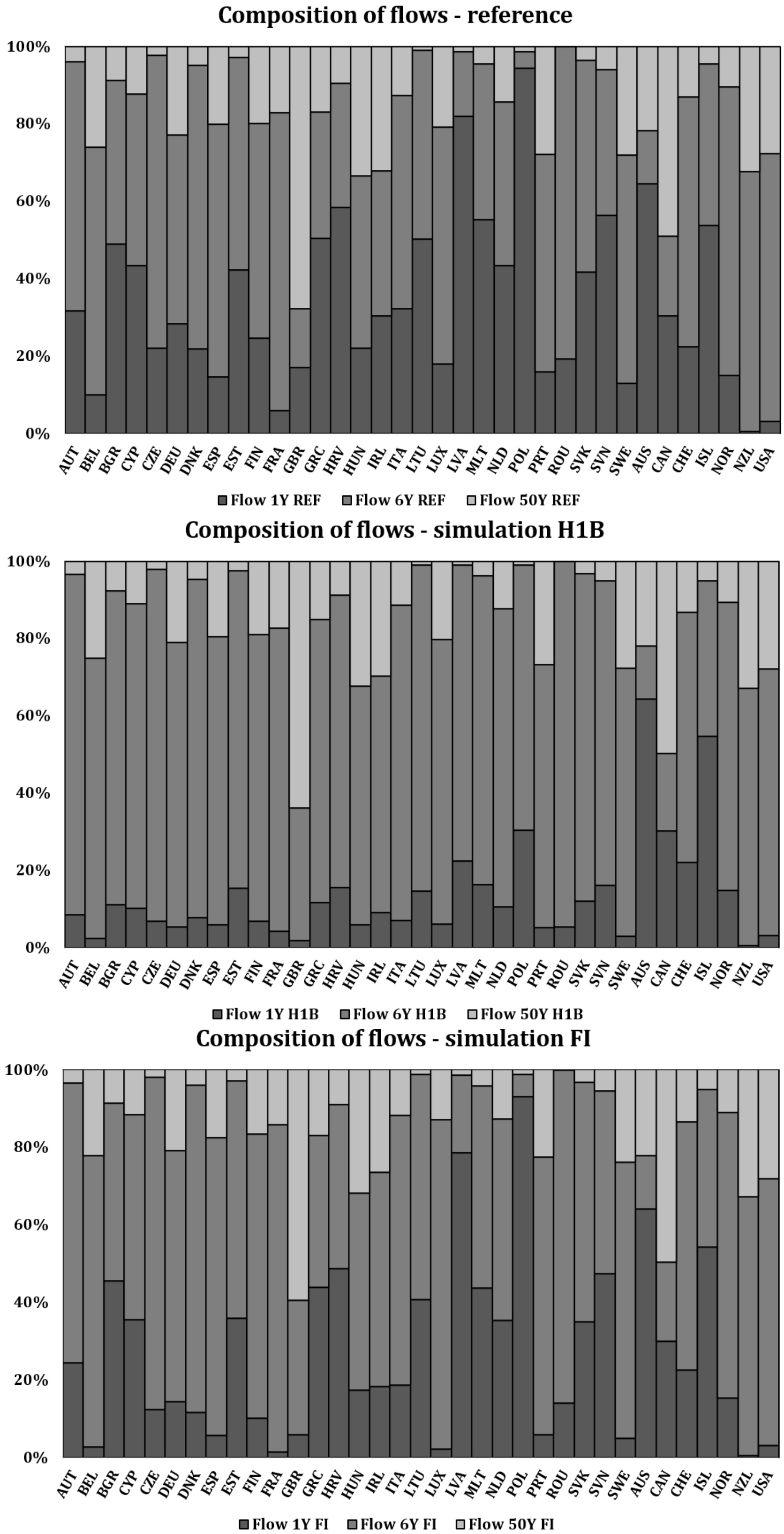

FIGURE 3.E4: Composition of migrants flows and stocks

The actual compositions of migrants with respect to their duration of visa, in flows. First figure represents the reference scenario, second figure: the composition after introducing an H1B visa in the EU, and the third figure: the composition after introducing a fiscal incentive in the EU. Source: own calculations.

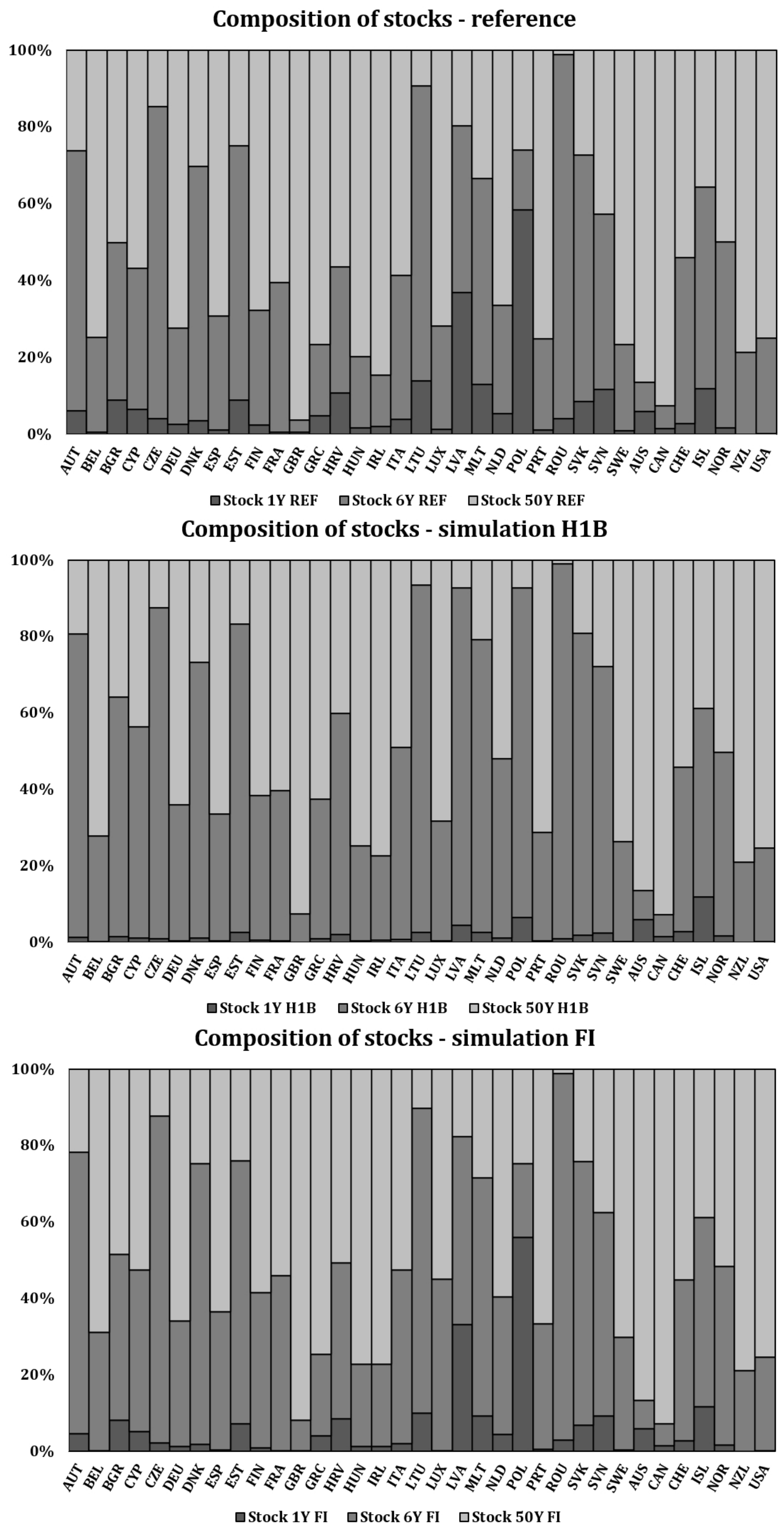

FIGURE 3.E5: Composition of migrants flows and stocks

The actual compositions of migrants with respect to their duration of visa, in stocks. First figure represents the reference scenario, second figure: the composition after introducing an H1B visa in the EU, and the third figure: the composition after introducing a fiscal incentive in the EU. Source: own calculations.

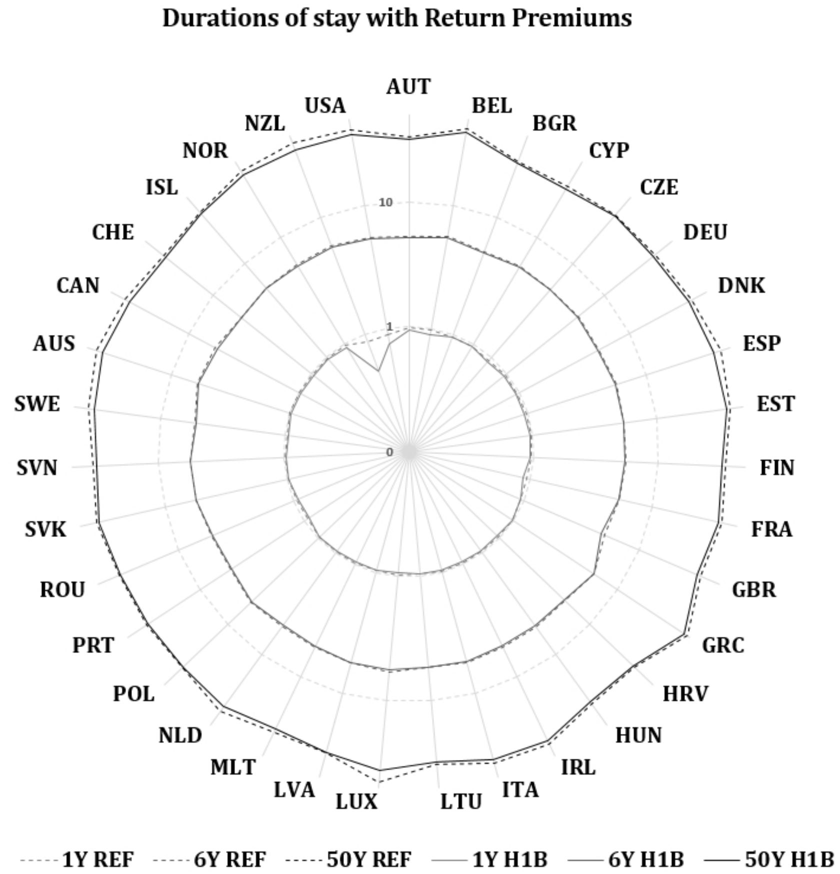

FIGURE 3.E6: The effects on average durations of stay after including return premiums

The graph present the average durations of stay by destination countries and visa types. The broken lines show the reference scenario, whereas the solid lines depict the reference scenario with return premiums. Source: own calculations.

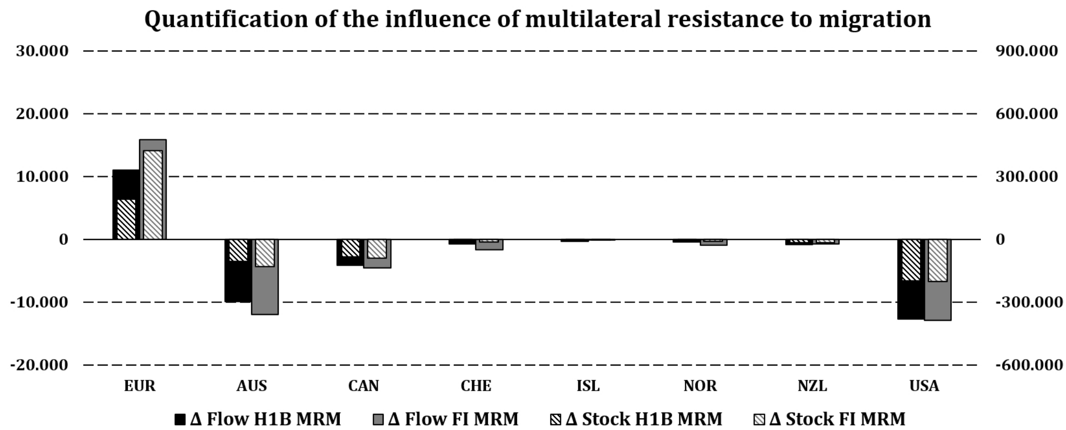

FIGURE 3.E7: The effects of multilateral resistance to migration

The figure shows the changes in flows (solid bars, left axis) and stocks (striped bars, right axis) of high-skilled migrants due to multilateral resistance to migration. Source: own calculations.

Conclusion

This PhD thesis presents some recent developments in quantitative economic theory of international migration. I propose three models of world economy, which enable to answer key questions about how global flows of people impact the economies of the developed countries.

The first Chapter analyzes the variation in natives' welfare due to recent net flows (and total net stocks) of migrants. The main contribution of this article is the quantification and the comparison of the main channels which determine the economic impact of migration: the market size effect, the labor market effect and the fiscal effect. Observing significant interdependencies among these elements, we find that the market size effect (which has been understudied in the literature) can substantially affect the well-being of natives in the OECD states. Moreover, both labor market and fiscal effects might reach significant magnitudes when the inflow of migrants is large and selective enough. Our results give evidence that a positive net migration flow is followed by a welfare gain in a receiving country, although natives in the host states have rather negative attitudes towards newcomers.

The second Chapter proposes a policy of further integration between the EU and five key partners in terms of international trade and migration. I evaluate the welfare consequences of liberalizing the flows of goods and people between those country pairs. Hypothetically, the EU citizens would lose after freeing migration to Australia, Canada and the US due to a sizable outflow of workers. Simultaneously, a trade agreement would always be beneficial for both parties. An important contribution of this paper is the quantification of relations between trade and migration in a general equilibrium model. I provide conditions for substitutability and complementarity between these two phenomena, and conclude that liberalizing migration (trade) causes the latter (the former) co-relation.

The third Chapter presents a novel model of international migration, in which agents individually choose the destination, visa type, and the duration of stay. The contribution of this paper to the literature on international migration comprises in developing and solving a model that violates the Independence of Irrelevant Alternatives axiom, and gives micro-foundations for the multilateral resistance to migration. The developed theoretical framework is used to quantify the demographic implications of alternative migration policies in the EU. I conclude that a visa policy targeted at the high-skilled immigrants, as well as a tax concession program for the college-educated, may attract new waves of professional workers. Since the two policies act through different macroeconomic channels, by providing current and new immigrants with various incentives, they are expected to have different short- and long-term impacts on fiscal budgets.

An interesting research question could also be the quantification of the extent to which migrants may influence on labor markets and national pension systems, especially in those countries that suffer from serious aging processes. Immigrants, who come to the host states as regular candidates, compete with nationals on local labor markets. However, natives and immigrants have different individual motives for their economic behavior (in terms of job acceptance, bargaining power, labor market participation and aversion to being unemployed). The efficacy of utilization of incoming work force (which depends not only on the institutions of the receiving country, but also on the individual characteristics of immigrants, i.e. their reservation wages and the potential to assimilate) is decisive in terms of the social and economic outcomes. Various scenarios are possible: fiscal authorities financing unsuccessful immigrants through benefits, and immigrants being net contributors to fiscal scheme. The sign and the magnitude of the overall effects of immigration on local labor markets and public finances (worker-group-specific unemployment rates and net fiscal contributions) are crucial issues debated in many developed economies

Furthermore, since the European Union strives at attracting new waves of highly skilled foreign workers (through implementing novel, skill-biased migration policies like the European Blue Card program), three important questions arise: Is a skill-selective migration policy a remedy for the EU to insure positive outcomes from immigration? What would be the preferred migration policy, if the EU citizens could explicitly vote for it? Which policy is optimal for the EU citizens, and which one is feasible from the political economy perspective? The literature lacks a quantitative answer to these questions, which would provide a comparison between the optimal migration policy (visa policy and other fiscal or labor market incentives) from the point of view of the welfare of domestic citizens in the receiving countries, and the political economy outcomes, when people are allowed to vote and endogenously decide on the level of migration costs and benefits for the foreign workers.

Finally, until now, there is no global study of the influence of current and past migration flows on cross- and within-country inequality. Although contemporary migration patterns reveal the features of brain drain (exodus of high-skilled emigrants from poor to rich countries) and brain gain (intensification of skill acquisition in poor sending states, due to migration opportunities), the literature provides mixed evidence on which force dominates. The literature does not give quantitative evidence about international migration being a source of convergence or divergence in earnings, income, and wealth.

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