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On The Fundamental Drivers of International Migration

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Preface

At the Valletta Summit on Migration in November 2015, the European Union launched the EU Emergency Trust Fund for Africa. Made up of 1.8 billion, the Fund constitutes a quick response from the EU to the European migrant crisis, which reached a peak in 2015. In the first place, the Fund is deployed to bring humanitarian aid to refugees and to assist border operations in the Mediterranean to prevent further loss of lives at sea and resettle asylum seekers across the EU member states. In the longer run, it aims to tackle the fundamental causes of irregular migration and forced displacement by creating employment opportunities, improving basic services, and preventing potential conflicts in migrants countries of origin. This attempt to manage migration by governments, especially intending to decrease migration flows from developing to developed countries, is not a new initiative in the history. The literature widely documents two categories of policy which are usually envisaged: the first one is restrictive immigration laws (e.g. selective migration, border control, deterrence and forced return migration policies), and the second is development policies promoted in sending countries to address the root causes of migration (De Haas, 2007; Kim and Park, 2012). The second category consists of aid funds, investment and trade liberalization that are believed to raise wage level in the sending countries and ultimately diminish their people's incentive for migration. The most famous example of this development measure which has ever been documented is the Maquiladora program (1965). The program created an export-processing zone along the US-Mexican border in order to slowdown irregular migration of Mexican workers to the US. Its main goals were later pursued by the North American Free Trade Agreement (NAFTA) (1994). Similarly, it was argued that through this agreement, expanding trade and investment in Mexico would reduce migration flow from that country to the US (Cornelius and Martin, 1993, Aroca and Malony, 2005). However, Martin (1993) proved that NAFTA rather increased than decreased Mexican migration flows. This is suggestive of the fact that ad hoc policies could barely influence migration. We thus have legitimate reason to doubt about the effectiveness of the aforementioned EU investment program for Africa. Would that initiative be a drop in the ocean? Would it be swept away by an underestimated however mightier and unsurpassable driving force behind the migration phenomenon? Do we fully comprehend all the fundamental determinants of migration, how big they are and how they can easily be changed? This thesis contributes to answer to these questions. It consists of three chapters examining the drivers of past and future international migration. It attempts to demystify different factors that cause people to move and to shed light on the most important ones. It also tests the capacity of the two types of policy in managing migration. To this purpose, I make use of diverse research tools in economics such as econometric regression, theoretical modeling, calibration and simulation strategies. The data used comprise various aspects of income, population, education, geography, policy and international trade.

Chapter One, entitled "Global Migration in the 20th and 21st Centuries: the Unstoppable Force of Demography", sheds light on the global migration patterns of the past 40 years, and produces migration projections for the 21st century, for the low- and high-skilled groups, and for all relevant pairs of countries. This chapter is elaborated jointly with Frédéric Docquier, Mathilde Maurel and Pierre Schaus. First, we build a simple model of the world economy, and we parameterize it to match the economic and socio-demographic characteristics of the world in the year 2010. We then conduct a backcasting exercise which demonstrates that our model fits the past trends in international migration very well, and that historical trends were mostly governed by demographic changes. We next describe a set of migration projections for the 21st century. In line with backcasts, our world migration prospects and emigration rates from developing countries are mainly governed by socio-demographic changes: they are virtually insensitive to the technological environment. As far as OECD countries are concerned, we predict a highly robust increase in immigration pressures in general (from 12 in 2010 to 17-19% in 2050 and 25-28% in 2100), and in European immigration in particular (from 15% in 2010 to 23-25% in 2050 and 36-39% in 2100). Using development policies to curb these pressures requires triggering unprecedented economic takeoffs in migrants countries of origin. Increasing migration is therefore a likely phenomenon for the 21st century, and this raises societal and political challenges for most industrialized countries.

Chapter Two, a joint work with Frédéric Docquier, Christopher Parsons and Giovanni Peri entitled "Migration and Development: Dissecting the Anatomy of the Mobility Transition", is inspired by the fact that emigration first increases and then decreases as a country experiences economic development. This inverted U-shaped, cross-sectional relationship between emigration and development was first hypothesized by Zelinsky's theory of the *mobility transition*. Although several mechanisms have been proposed to explain the upward segment of the curve (the most common being the existence of financial constraints), they have not been examined in a systematic way. In this chater, we propose two decomposition methods to disentangle the main drivers of the mobility transition curve to OECD destination countries. Our simple decompositions shed light on the role of both *microeconomic* drivers (i.e., financial incentives and constraints) and *macroeconomic* drivers, as well as the skill composition of the population. Our double decomposition further distinguishes between migration aspirations and realization rates by education level. Overall, we provide consistent evidence that the role of financial constraints, while relevant for the poorest countries, is limited. Rather, a large fraction of the increasing segment is explained by the skill composition and by *macroeconomic* drivers (i.e., by factors that do not change in the short-run).

The last Chapter Three, entitled "The strength of future migration to OECD countries and the potential impact of policy intervention", develops a theoretical framework to forecast migration in the dynamic context of development. It takes into consideration three factors that affect migration: demographic transition, income evolution and human capital growth. The combinations of these three factors give rise to different future migration trends in major geographic areas. The analyses foresee the extent to which OECD destinations will face an increasing foreign labor supply in the upcoming decades. This framework also allows to envision the potential outcomes of policies intending to govern migration, such as border restriction at destination and development measures aiming at reducing migration *pressure* from less to more developed countries. More specifically, in order to predict the effects of income changes on migration a microfounded model is build based on the most recent knowledge developed for the theory of the mobility transition in the previous chapter. This model distinguishes between migration incentives and constraints of low and high skill populations. In the benchmark scenario as a continuation of the 2010 situation, immigration volume to OECD countries will rise by +18.69% over a decade. The contribution of demographic growth is substantial. Future migration will be more skill-intensive. Sub-Saharan African and MENA countries will experience the fastest growth in the number of outmigrants. Lastly, the paper concludes that the development levels at which developing countries in sub-Saharan Africa and MENA should stand in order to reduce the migration *pressure* on OECD destinations should be unprecedented.

Overall, the thesis provides consistent result that migration is an inevitable phenomenon of the first half of the 21st century. It has been shown to be mostly governed by macroeconomic forces such as demography, human capital accumulation and persistent cross-country inequality. Short-term restrictive or development policies could hardly stop of reverse its rising trend. To some extent, a more prominent answer would be to better integrate the migrants into the destination countries, minimize the negative impacts and maximize the positive outcomes of migration in order to harness a triple-win situation for the migrants themselves, the destination and the sending countries.

Chapter 1

Global Migration in the 20th and 21st Centuries: the Unstoppable Force of Demography

Abstract[1]

This paper sheds light on the global migration patterns of the past 40 years, and produces migration projections for the 21st century, for two skill groups, and for all relevant pairs of countries. To do this, we build a simple model of the world economy, and we parameterize it to match the economic and socio-demographic characteristics of the world in the year 2010. We conduct a backcasting exercise which demonstrates that our model fits the past trends in international migration very well, and that historical trends were mostly governed by demographic changes. We then describe a set of migration projections for the 21st century. In line with backcasts, our world migration prospects and emigration rates from developing countries are mainly governed by socio-demographic changes: they are virtually insensitive to the technological environment. As far as OECD countries are concerned, we predict a highly robust increase in immigration pressures in general (from 12 in 2010 to 17-19% in 2050 and 25-28% in 2100), and in European immigration in particular (from 15% in 2010 to 23-25% in 2050 and 36-39% in 2100). Using development policies to curb these pressures requires triggering unprecedented economic takeoffs in migrants countries of origin. Increasing migration is therefore a likely phenomenon for the 21st century, and this raises societal and political challenges for most industrialized countries.

JEL codes: F22, F24, J11, J61, O15.

Keywords: international migration, migration prospects, world economy, inequality

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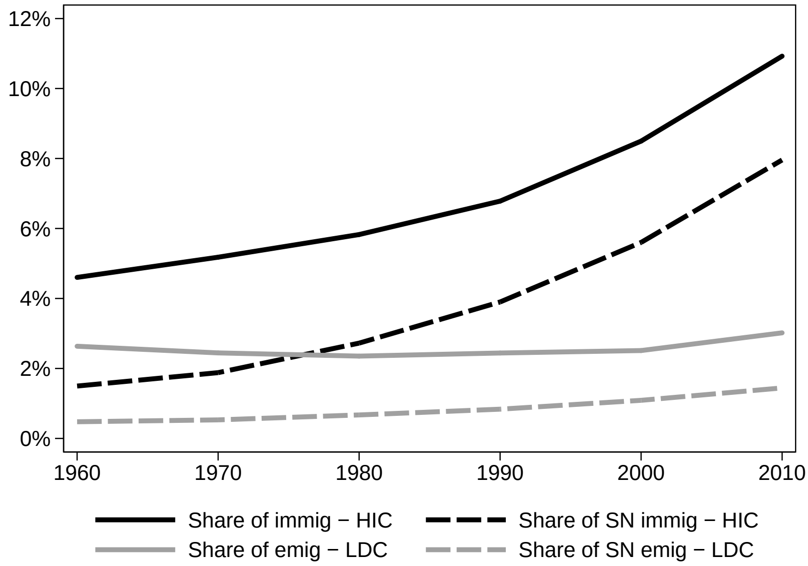
1.1 Introduction

Figure 1.1: Long-run trends in international migration, 1960-2010



Between 1960 and 2010, the worldwide stock of international migrants increased from 92 to 211 million, at the same pace as the world population, i.e. the worldwide share of migrants fluctuated around 3%. This average share masks comparatively significant differences between regions, as illustrated on Figure 1.1. In high-income countries (HICs), the foreign-born population increased more rapidly than the total population, boosting the average proportion of foreigners from 4.5 to 11.0% (+6.5%). A remarkable fact is that this change is totally explained by the inflow of immigrants from developing countries, whose share in the total population increased from 1.5 to 8.0% (once again, +6.5%). By comparison, the share of North-North migrants has been fairly stable.[2] In less developed countries (LDCs), the total stock of emigrants increased at the same pace as the total population, leading to small fluctuations of the emigration rate between 2.6 and 3.0%. As part of this emigration process, the share of emigrants to HICs in the population increased from 0.5 to 1.4%. Hence, the average propensity to emigrate from LDCs to HICs has increased by less than one percentage point over half a century.[3]

[2]Similar patterns were observed in the 15 member states of the European Union (henceforth, EU15). The EU15 average proportion of foreigners increased from 3.9 to 12.2% (+8.2%) between 1960 and 2010. Although intra-European movements have been spurred by the Schengen agreement, the EU15 proportion of immigrants originating from LDCs also increased dramatically, from 1.2 to 7.5% (+6.3%).

[3]Demographic imbalances allow reconciling emigration and immigration patterns. Over the last 50 years, population growth has been systematically greater in developing countries.

The underlying root causes of these trends are known (demographic imbalances, economic inequality, increased globalization, political instability, etc.). However, quantitatively speaking, little is known about their relative importance and about the changing educational structure of past migration flows. Furthermore, the very same root causes are all projected to exert a strong influence in the coming decades, and little is known about the predictability of future migration flows. This paper sheds light on these issues, addressing key questions such as: How have past income disparities, educational changes and demographic imbalances shaped past migration flows? What are the pairs of countries responsible for large variations in low-skilled and high-skilled migration? How many potential migrants can be expected for the 21st century? How will future changes in education and productivity affect migration flows in general, and migration pressures to HIC in particular? Can development policies be implemented to limit these flows?

To do so, we develop a simple, abstract economic model of the world economy that highlights the major mechanisms underlying migration decisions and wage inequality in the long term. It builds on a migration technology and a production technology, uses consensus specifications, and includes a limited number of parameters that can be calibrated to match the economic and socio-demographic characteristics of the world in the year 2010. We first conduct a set of backcasting experiments, which consists in using the model to simulate bilateral migration stocks retrospectively, and in comparing the backcasts with observed migration stocks. We show that our backcasts fit very well the historical trends in the worldwide aggregate stock of migrants, in immigration stocks to all destination countries, and in emigration stocks from all origin countries. This demonstrates the capacity of the model to identify the main sources of variation and to predict long-run migration trends. Simulating counterfactual historical trends with constant distributions of income, education level or population, we show that most of the historical changes in international migration are explained by demographic changes. In particular, the world migration stocks would have virtually been constant if the population size of developing countries had not changed. Solving a *Max-Sum Submatrix* problem, we identify the clusters of origins and destinations that caused the greatest variations in global migration. These include important South-North, North-North and South-South corridors for the low-skilled, and North-North and South-North corridors for the highly skilled.

We then enter exogenous socio-demographic scenarios into the calibrated model, and produce micro-founded projections of migration stocks by education level for the 21st century. The interdependencies between migration, population and income have rarely been accounted for in projection exercises. The demographic projections of the United Nations do not anticipate the economic forces and policy reforms that shape migration flows. In the medium variant, they assume long-run convergence towards low fertility and high life expectancy across coun-

The population ratio between LDCs and HICs increased from 3.1 in 1960 to 5.5 in 2010. This explains why a 0.9% increase in emigration rate from LDCs translated into a 6.5% increase in the share of immigrants to HICs.

tries, and constant immigration flows. The Wittgenstein projections rely on a more complex methodology (see Lutz et al., 2014). Depending on the scenario, they consist of a set of probabilities to emigrate (or to immigrate) multiplied by the native population levels in the origin countries (or in the rest of the world). The size of net immigration flows varies over time and are computed by sex, age and education level. Future migration flows reflect expert opinion about future socio-political and economic trends that could affect migration. From 2060 onwards, it is assumed that net migration flows converge to zero (zero is attained in the 2095-2100 period). As regards to the skill structure, it is assumed to be proportional to that of the origin (or destination) country, implying that skill-selection patterns in migration are disregarded. In contrast, our migration projections are demographically and economically rooted. They result from a micro-founded migration technology and are totally compatible with the endogenous evolution of income disparities.

The economic literature records a limited number of studies that focus on long-run migration trends and on projections of future migration. Hatton and Williamson (2003) examine the determinants of net emigration from Africa using a panel of 21 countries between 1977 and 1995, then subsequently use the regression estimates to predict African emigration pressure until 2025. They allow demography to influence emigration directly (via its impact on the youth share) and indirectly (via its impact on domestic wages). They predict an intensification of migration from Africa by the year 2025. The main reasons lie in the rapid growth of young cohort who has greater potential to migrate, and in the poor economic performance of source countries as a result of demographic pressures. Focusing on the receiving countries' perspective, Hatton and Williamson (2011) identify the various drivers of emigration rates from developing countries to the United States from 1970 to 2004, and then predict immigration trends up to the year 2034. The study reveals abating signs of migration from Latin America and Asia to the United States while rising trend will continue in Africa. The authors conclude that US immigrants will be more African and much less Hispanic. Similar conclusions are obtained in Hanson and McIntosh (2016), who show that the African migration pressures will mostly affect European countries until the mid-21st century. They compare the expanding migration pressure out of sub-Saharan Africa to Europe to that between Latin America and the United States during the second half of the 20th century.

The common features of our present study as compared to these aforementioned papers are the use of past observations and exogenous demographic forecasts to project future migration. However, our contribution is threefold. First, in terms of modeling, our paper builds on a general equilibrium framework to account for the interactions between labor and wage. As a consequence, labor absorption capacity of each economy is not disregarded in the face of demographic shock. A similar approach is used in Mountford and Rapoport (2014) or in Docquier and Machado (2017). Second, the use of a random utility specification allows to allocate the world labor across multiple corridors as a function of the relative attractiveness of all destinations. Third, in terms of country coverage, our world-economy model includes the majority of countries in the world (i.e., 180 countries). The simulation results therefore offer a better overview of future global migration, although we acknowledge that migrant concentrate in a small number of corridors.

Our general equilibrium projection model produces striking results. In line with the backcasting exercise, we find that the future trends in international migration are hardly affected by the technological environment; they are mostly governed by socio-demographic changes (i.e., changes in population size and in educational attainment). Focusing on OECD member states, we predict a highly robust increase in their proportion of immigrants. The magnitude of the change is highly insensitive to the technological environment, and to the education scenario. In particular, a rise in schooling in developing countries increases the average propensity to emigrate but also reduces population growth rates; as far as migrant stocks are concerned, these effects are balancing each other. Overall, under constant immigration policies, the average immigration rate of OECD countries increases from 12 to 25-28% during the 21st century. Given their magnitude, expected changes in immigration are henceforth referred to as *migration pressures*, although we do not make any value judgments about their desirability or about their welfare effects within the sending and receiving countries. The *Max-Sum Submatrix* reveals that this surge is mostly due to rising migration flows from sub-Saharan Africa, from the Middle East, and from a few Asian countries. In line with Hanson and McIntosh (2016) or with Docquier and Machado (2007), expected immigration pressures are greater in European countries (+21.2 percentage points) than in the United States (+14.3 percentage points). The greatest variations in immigration rates are observed in the United Kingdom, France, Spain; Canada is also strongly affected. Curbing such migration pressures is difficult. For the 20 countries inducing the greatest migration pressures on the EU15 by the year 2060 or for the combined geographic region of Middle-East and sub-Saharan Africa, we show that keeping their total emigration stock constant requires triggering unprecedented economic takeoffs.

The remainder of the paper is organized as follows. Section 1.2 describes the model, defines its competitive equilibrium, and discusses its parameterization. Section 1.3 presents the results of the backcasting exercise. Forecasts are then provided in Section 1.4. Finally, Section 1.5 concludes.

1.2 Model

The model distinguishes between two classes of workers and J countries ($j = 1, ..., J$). The skill type s is equal to h for college graduates, and to l for the less educated. We first describe the migration technology, which determines the condition under which migration to a destination country j is profitable for type-s workers born in country i. This condition depends on wage disparities, differences in amenities and migration costs between the source and destination countries. We then describe the production technology, which determines wage disparities. The latter are affected by the allocation of labor which itself depends on the size and structure of migration flows. The combination of endogenous migration decisions and equilibrium wages jointly determines the world distribution of income and the allocation of the world population.

Migration technology. – At each period t, the number of working age natives of type s and originating from country i is denoted by $N_{i,s,t}$. Each native decides whether to emigrate to another country or to stay in their home country; the number of migrants from i to j is denoted by $M_{ij,s,t}$ (hence, $M_{ii,s,t}$ represents the number of non-migrants). After migration, the resident labor force of type s in country j is given by $L_{j,s,t}$.

For simplicity, we assume a "drawing-with-replacement" migration process. Although one period is meant to represent 10 years, we ignore path dependency in migration decisions (i.e., having migrated to country j at time t influences the individual location at time $t+1$). In addition, by considering the population aged 15 to 64 as a homogenous group, our model abstracts from the heterogeneity in the propensity to migrate across age groups, i.e. ignoring the effect of age on migration.[4] Individual decisions to emigrate result from the comparison of discrete alternatives.

To model them, we use a standard Random Utility Model (RUM) with a deterministic and a random component. The deterministic component is assumed to be logarithmic in income and to include an exogenous dyadic component.[5] At time t, the utility of a type-s individual born in country i and living in country j is given by:

$$u_{ij,s,t} = \widetilde{\gamma} \ln w_{j,s,t} + \ln v_{ij,s,t} + \varepsilon_{ij,s,t},$$

where $w_{j,s,t}$ denotes the wage rate attainable in the destination country j; $\widetilde{\gamma}$ is a parameter governing the marginal utility of income; $v_{ij,s,t}$ stands for the non-wage income and amenities in country j (public goods and transfers minus taxes and non-monetary amenities) and is netted from the legal and private costs of moving from i to j; $\varepsilon_{ij,s,t}$ is the random taste component capturing heterogeneity in the preferences for alternative locations, in mobility costs, in assimilation costs, etc.

The utility obtained when the same individual stays in his origin country is given by

$$u_{ii,s,t} = \widetilde{\gamma} \ln w_{i,s,t} + \ln v_{ii,s,t} + \varepsilon_{ii,s,t}.$$

The random term $\varepsilon_{ij,s,t}$ is assumed to follow an iid extreme-value distribution

[4] It is often shown that individual aged 15 to 34 are more migratory than older age groups (Hatton and Williamson, 1998; UNDESA, 2013) due to higher present values of migration in intertemporal utility function (Hatton and Williamson, 2011; Djajic et al., 2016).

[5] Although Grogger and Hanson (2011) find that a linear utility specification fits the patterns of positive selection and sorting in the migration data well, most studies rely on a concave (logarithmic) utility function (Bertoli and Fernandez-Huertas Moraga, 2013; Beine et al., 2013a; Beine and Parsons, 2015; Ortega and Peri, 2013).

of type I with scale parameter μ.[6] Under this hypothesis, the probability that a type-s individual born in country i moving to country j is given by the following logit expression (McFadden, 1984):

$$\frac{M_{ij,s,t}}{N_{i,s,t}} = \Pr\left[u_{ij,s,t} = \underset{k}{max}\ u_{ik,s,t}\right] = \frac{\exp\left(\frac{\widetilde{\gamma}\ln w_{j,s,t}+\ln v_{ij,s,t}}{\mu}\right)}{\sum_k \exp\left(\frac{\widetilde{\gamma}\ln w_{k,s,t}+\ln v_{ik,s,t}}{\mu}\right)}.$$

Hence, the emigration rate from i to j depends on the characteristics of all potential destinations k (i.e., a crisis in Greece affects the emigration rate from Romania to Germany). The staying rates ($M_{ii,s,t}/N_{i,s,t}$) are governed by the same logit model. It follows that the emigrant-to-stayer ratio is given by:

$$m_{ij,s,t} \equiv \frac{M_{ij,s,t}}{M_{ii,s,t}} = \left(\frac{w_{j,s,t}}{w_{i,s,t}}\right)^{\gamma} V_{ij,s,t}, \tag{1.1}$$

where $\gamma \equiv \widetilde{\gamma}/\mu$, the elasticity of migration choices to wage disparities, is a combination of preference and distribution parameters, and $V_{ij,s,t} \equiv v_{ij,s,t}/(\mu v_{ii,s,t})$ is a scale factor of the migration technology.[7] Hence, the ratio of emigrants from i to j to stayers only depends on the characteristics of the two countries.

Production technology. – Income is determined based on an aggregate production function. Each country has a large number of competitive firms characterized by the same production technology and producing a homogenous good. The output in country j, $Y_{j,t}$, is a multiplicative function of total factor productivity (TFP), $A_{j,t}$,[8] and the total quantity of labor in efficiency units, denoted by $L_{j,T,t}$, supplied by low-skilled and high-skilled workers. Such a model without physical capital features a globalized economy with a common international interest rate. This hypothesis is in line with Kennan (2013) or Klein and Ventura (2009) who assume that capital "chases" labor.[9] Following the recent literature on labor markets, immigration and growth,[10] we assume that labor

[6] Bertoli and Fernandez-Huertas Moraga (2012, 2013), or Ortega and Peri (2012) used more general distributions, allowing for a positive correlation in the application of shocks across similar countries.

[7] The model will be calibrated using migration stock data, which are assumed to reflect the long-run migration equilibrium. We thus consider that $V_{ij,s,t}$ accounts for network effects (i.e., effect of past migration stocks on migration flows). Additionally, $V_{ij,s,t}$ embeds migration costs. They represent monetary moving costs, utility-loss equivalents of migration quotas (similar to tariff equivalent of non-tariff bariers in trade), etc. Migration costs in this study are treated as exogenous. However in practice, visa restrictions depend on the intensity of immigration pressures as well as on origin and/or destination countries' characteristics.

[8] In fact, there is a slight abuse of terms here as $A_{j,t}$ implicitly includes capital in supplement to the usual TFP, which is by definition the residual that explains a country's output level apart from capital and labor. Therefore, $A_{j,t}$ is rather a "modified TFP".

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

[10] See Katz and Murphy (1992), Card and Lemieux (2001), Caselli and Coleman (2006), Borjas (2003, 2009), Card (2009), or Ottaviano and Peri (2012), Docquier and Machado (2017) among others.

in efficiency units is a CES function of the number of college-educated and less educated workers employed. We have:

$$Y_{j,t} = A_{j,t}L_{j,T,t} = A_{j,t}\left[\theta_{j,h,t}L_{j,h,t}^{\frac{\sigma-1}{\sigma}} + \theta_{j,l,t}L_{j,l,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{1.2}$$

where $\theta_{j,s,t}$ is the country and time-specific value share parameter for workers of type s (such that $\theta_{j,h,t} + \theta_{j,l,t} = 1$), and σ is the common elasticity of substitution between the two groups of workers.

Firms maximize profits and the labor market is competitive. The equilibrium wage rate for type-s workers in country j is equal to the marginal productivity of labor:

$$w_{j,s,t} = \theta_{j,s,t}A_{j,t}\left(\frac{L_{j,T,t}}{L_{j,s,t}}\right)^{1/\sigma}. \tag{1.3}$$

Hence, the wage ratio between college graduates and less educated workers is given by:

$$\frac{w_{j,h,t}}{w_{j,l,t}} = \frac{\theta_{j,h,t}}{\theta_{j,l,t}}\left(\frac{L_{j,h,t}}{L_{j,l,t}}\right)^{-1/\sigma} \tag{1.4}$$

As long as this ratio is greater than one, a rise in human capital increases the average productivity of workers. Furthermore, greater contributions of human capital to productivity can be obtained by assuming technological externalities. Two types of technological externality are factored in. First, we consider a simple Lucas-type, aggregate externality (see Lucas, 1988) and assume that the TFP scale factor in each sector is a concave function of the skill-ratio in the resident labor force. This externality captures the fact that educated workers facilitate innovation and the adoption of advanced technologies. Its size has been the focus of many recent articles and has generated a certain level of debate. Using data from US cities (Moretti, 2004) or US states (Acemoglu and Angrist, 2001; Iranzo and Peri, 2009), some instrumental-variable approaches give substantial externalities (Moretti, 2004) while others do not (Acemoglu and Angrist, 2001). In the empirical growth literature, there is evidence of a positive effect of schooling on innovation and technology diffusion (see Benhabib and Spiegel, 1994; Caselli and Coleman, 2006; Ciccone and Papaioannou, 2009). In parallel, another set of contributions highlights the effect of human capital on the quality of institutions (Castello-Climente, 2008; Bobba and Coviello, 2007; Murtin and Wacziarg, 2014). We write:

$$A_{j,t} = \lambda_t\overline{A}_j\left(\frac{L_{j,h,t}}{L_{j,l,t}}\right)^{\epsilon}, \tag{1.5}$$

where λ_t captures the worldwide time variations in productivity (common to all countries), $\overline{A}_j$ is the exogenous country-specific component of TFP in country j (reflecting exogenous factors such as arable land, climate, geography, etc.), and ϵ is the elasticity of TFP to the skill ratio.

Second, we assume skill-biased technical change. As technology improves, the relative productivity of high-skilled workers increases (Acemoglu, 2002; Restuccia and Vandenbroucke, 2013). For example, Autor et al. (2003) show that computerization is associated with a declining relative demand in industry for routine manual and cognitive tasks, and increased relative demand for non-routine cognitive tasks. The observed relative demand shift favors college versus non-college labor. We write:

$$\frac{\theta_{j,h,t}}{\theta_{j,l,t}} = \overline{Q}_j \left(\frac{L_{j,h,t}}{L_{j,l,t}} \right)^{\kappa}, \tag{1.6}$$

where $\overline{Q}_j$ is the exogenous country-specific component of the skill bias in productivity in country j, and κ is the elasticity of the skill bias to the skill ratio.

Competitive equilibrium. – The link between the native and resident population is tautological:

$$\sum\nolimits_j N_{j,s,t} = \sum\nolimits_j L_{j,s,t} = \sum\nolimits_i \sum\nolimits_j m_{ij,s,t} M_{ii,s,t} \tag{1.7}$$

Given our "drawing-with-replacement" migration hypothesis and given the absence of any accumulated production factor, the dynamics of the world economy is governed by a succession of temporary equilibria defined as:

Definition 1. *For a set $\{\gamma, \sigma, \epsilon, \kappa, \lambda_t\}$ of common parameters, a set $\{\overline{A}_j, \overline{Q}_j\}_{\forall j}$ of country-specific parameters, a set $\{V_{ij,s,t}\}_{\forall i,j,s}$ of bilateral (net) migration costs, and for given distribution of the native population $\{N_{j,s,t}\}_{\forall j,s}$, a temporary competitive equilibrium for period t is an allocation of labor $\{M_{ij,s,t}\}_{\forall i,j,s}$ and a vector of wages $\{w_{j,s,t}\}_{\forall j,s}$ satisfying (i) utility maximization conditions, Eq. (1.1), (ii) profit maximization conditions, Eq. (1.3), (iii) technological constraints, Eqs. (1.5) and (1.6), and (iv) the aggregation constraints, Eq. (1.7).*

A temporary equilibrium allocation of labor is characterized by a system of $2 \times J \times (J+1)$ i.e., $2 \times J \times (J-1)$ bilateral ratio of migrants to stayers, $2 \times J$ wage rates, and $2 \times J$ aggregation constraints. In the next sub-sections, we use data for 180 countries (developed and developing independent territories) and explain how we parameterize our system of 65,160 simultaneous equations per period. Once properly calibrated, this model can be used to conduct a large variety of numerical experiments.

Parameterization for the year 2010. – The model can be calibrated to match the economic and socio-demographic characteristics of 180 countries as well as skill-specific matrices of 180×180 bilateral migration stocks in the year 2010.

Regarding production technology, on the basis of GDP in PPP values ($Y_{j,2010}$) from the *Maddison's project* described in Bolt and Van Zanden (2014), we collect data on the size and structure of the labor force from the *Wittgenstein Centre for Demography and Global Human Capital* ($L_{j,s,2010}$), and data on the wage ratio between college graduates and less educated workers, $w_{j,h,2010}/w_{j,l,2010}$, from Hendriks (2004). When missing, the latter are supplemented using the estimates of Docquier and Machado (2015). We assume the labor force corresponds to the population aged 25 to 64.

Using these data, we proceed in three steps to calibrate the production technology. First, in line with the labor market literature (e.g., Ottaviano and Peri, 2012), we assume that the elasticity of substitution between college-educated and less educated workers, σ, is equal to 2. This level fits well labor market interactions in developed countries. Greater levels have been identified in developing countries (e.g., Angrist, 1995). Therefore, we also consider a scenario with $\sigma = 3$. Second, for a given σ, we calibrate the ratio of value shares, $\theta_{j,h,2010}/\theta_{j,l,2010}$, as a residual from Eq. (1.4) to match the observed wage ratio. Since $\theta_{j,h} + \theta_{j,l} = 1$, this determines both $\theta_{j,h,2010}$ and $\theta_{j,l,2010}$ as well as the quantity of labor per efficiency unit, $L_{j,T,2010}$, defined in Eq. (1.2). Third, we use Eq. (1.2) and calibrate the TFP level, $A_{j,2010}$, to match the observed GDP and we normalize λ_{2010} to unity (without loss of generality). When all technological parameters are calibrated, we use Eq. (1.3) to proxy the wage rates for each skill group.

With regards to the migration technology, we use the DIOC-E database of the OECD. DIOC-E builds on 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 country of origin, demographic characteristics and level of education of the population of 34 OECD member states. DIOC-E extends the latter by characterizing the structure of the population of 86 non-OECD destination countries. Focusing on the populations aged 25 to 64, we thus end up with matrices of bilateral migration from 180 origin countries to 120 destination countries (34 OECD + 86 non-OECD countries) by education level, as well as proxies for the native population ($N_{i,s,2010}$). We assume that immigration stocks in the 60 missing countries are zero, which allows us to compute comprehensive migration matrices.

Regarding the elasticity of bilateral migration to the wage ratio, γ, we follow Bertoli and Fernandez-Huertas Moraga (2013) who find a value between 0.6 and 0.7. We use 0.7. Finally, we calibrate $V_{ij,s,2010}$ as a residual of Eq. (1.1) to match the observed ratio of bilateral migrants to stayers. In sum, the migration and technology parameters are such that our model perfectly matches the world distribution of income, the world population allocation and skill structure as well as bilateral migration stocks as of the year 2010.

1.3 Backcasting

Our first objective is to gauge the ability of our parameterized model to replicate aggregate historical data, and to backcast the educational structure of these flows. Our backcasting exercise consists in using the model to simulate retrospectively bilateral migration stocks by education level, and comparing the backcasts with proxies for observed migration stocks for the years 1970, 1980, 1990 and 2000. This exercise can also shed light on the relevance of technological hypotheses (i.e. what value for σ, κ or ϵ should be favored?), and on the role of socio-demographic and technological changes in explaining the aggregate variations in past migration.

There is no database documenting past migration stocks by education level and by age group. Nonetheless, Özden et al. (2011) provides decadal data on bilateral migration stocks from 1960 to 2000 with no disaggregation between age and skill groups, which can be supplemented by the matrix of the United Nations for the year 2010 (UNPOP division). To enable comparisons, we rescale these bilateral matrices using the destination-specific ratios of the immigration stock aged 25 to 64 (from DIOC-E) to total immigration (from the United Nations) observed in 2010. We then apply these ratios to the decadal years 1970 to 2000, and construct proxies for the stocks of the total stock of working-age migrants, $\widehat{M}_{ij,T,t}$.[11] We then use the model to predict past stocks of migrants by education level, and aggregate them $M_{ij,T,t} = M_{ij,h,t} + M_{ij,l,t}$. To assess the predictive performance of the model, we compare the (rescaled) worldwide numbers of international migrants with the simulated ones; coefficients of correlation between $M_{ij,T,t}$ and $\widehat{M}_{ij,T,t}$ can be computed for each period t.

Backcasting methodology. – Historical data allow us to document the size and structure of the resident population ($L_{j,s,t}$) and the level GDP ($Y_{j,t}$) of each country from 1970 to 2010. However, data on within-country wage disparities and bilateral migration are missing prior to 2010. The model is used to predict these missing variables.

We begin by predicting past wage ratios between college graduates and less-educated workers. Eq. (1.4) governs the evolution of these ratios. It depends on the (observed) skill ratio, $L_{j,h,t}/L_{j,l,t}$, on the elasticity of substitution σ, and on the ratio of value share parameters, $\theta_{j,h,t}/\theta_{j,l,t}$. We consider two possible values for σ (2 or 3). For a given σ, it should be recalled that we identified the ratio $\theta_{j,h,2010}/\theta_{j,l,2010}$ which matches wage disparities in 2010. In line with Eq. (1.6), regressing the log of this ratio on the log of the skill ratio gives an estimate for κ, the skill biased externality. We obtain $\kappa = 0.214$ when $\sigma = 2$, and $\kappa = 0.048$ when $\sigma = 3$.[12] Given the bidirectional causation relationship between the skill

[11] We assume rescaled immigration stocks are zero for the destination countries that are unavailable in the DIOC-E database.

[12] The regression lines are $\log(R_j) = 0.214. \log\left(L_{j,h}/L_{j,l}\right) + 0.540$ with $\sigma = 2$, and $\log(R_j) = 0.048. \log\left(L_{j,h}/L_{j,l}\right) + 0.540$ with $\sigma = 3$.

bias and education decisions (i.e. incentives to educate increase when the skill bias is greater), we consider these estimates as an upper bound for the skill biased externality.[13]

Our backcasting exercise distinguishes between six technological scenarios:

- Elasticity of substitution $\sigma = 2$
  - No skill biased externality: $\kappa = 0.000$
  - Skill biased externality equal to 50% of the correlation: $\kappa = 0.107$
  - Skill biased externality equal to 100% of the correlation: $\kappa = 0.214$
- Elasticity of substitution $\sigma = 3$
  - No skill biased externality: $\kappa = 0.000$
  - Skill biased externality equal to 50% of the correlation: $\kappa = 0.024$
  - Skill biased externality equal to 100% of the correlation: $\kappa = 0.048$

For each level of κ, we calibrate the scale parameter $\overline{Q}_j$ to match exactly the wage ratio in 2010. Then, for each year prior to 2010, we retrospectively predict $\theta_{j,h,t}$ and $\theta_{j,l,t}$ using Eq. (1.6), and calibrate the TFP level $A_{j,t}$ that matches the observed GDP level using Eq. (1.2). Finally, we use Eq. (1.3) to proxy the wage rates of each skill group.

Turning to the migration backcasts, we assume constant scale factors in the migration technology ($V_{ij,s,t} = V_{ij,s,2010}\ \forall t$). We thus assume constant net migration costs. Plugging $V_{ij,s,t}$ and wage proxies into Eq. (1.1), we obtain estimates for $m_{ij,s,t}$, the ratio of bilateral migrants to stayers, for all years. We then rewrite Eq. (1.7) in a matrix format:

$$\begin{pmatrix} M_{11,s,t} \; M_{22,s,t} \; ... \; M_{JJ,s,t} \end{pmatrix} \begin{pmatrix} m_{11,s,t} & m_{12,s,t} & ... & m_{1J,s,t} \\ m_{21,s,t} & m_{22,s,t} & ... & m_{2J,s,t} \\ ... & ... & ... & ... \\ m_{J1,s,t} & m_{J2,s,t} & ... & m_{JJ,s,t} \end{pmatrix} = \begin{pmatrix} L_{1,s,t} \; L_{2,s,t} \; ... \; L_{J,s,t} \end{pmatrix}.$$

The matrices $m_{ij,s,t}$ and $L_{j,s,t}$ are known. The latter observations of past resident populations from 1970 to 2000 are collected from the Wittgenstein database. The only unknown matrix is that of non-migrant populations, $M_{jj,s,t}$. We identify it by multiplying the matrix of $L_{j,s,t}$ by the inverse of the matrix of $m_{ij,s,t}$. Finally, when $M_{jj,s,t}$ and $m_{ij,s,t}$ are known, we use Eq. (1.1) to predict bilateral migration stocks by education level.

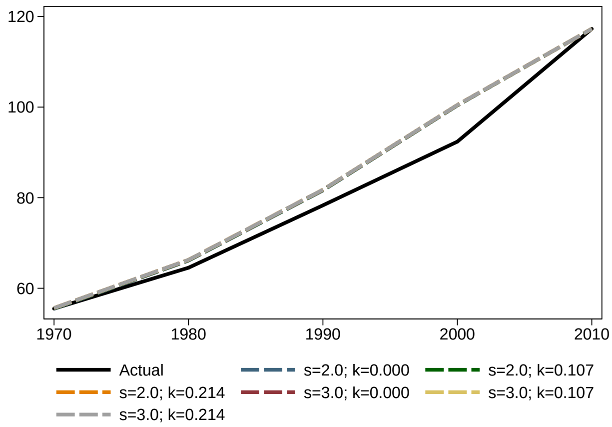
Worldwide migration backcasts. – Aggregate backcasts are depicted in Figure 1.2. Figure 1.2.a compares the evolution of actual and predicted worldwide

[13] Estimated κ is needed because we do not observe the past levels of the skill premium. On the contrary, our backasting methodology ignores the elasticity of TFP to the skill ratio ϵ. From Eq. 1.2, the TFP levels, $A_{j,t}$, are calibrated to match the observed levels of GDP, $Y_{j,t}$, using data for $L_{j,s,t}$ and the estimated level of $\theta_{j,s,t}$.

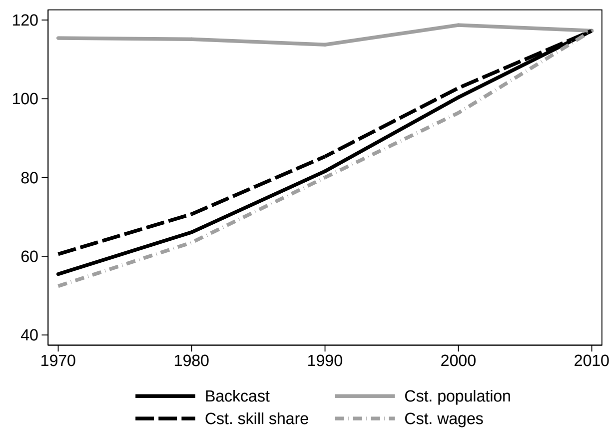
migration stocks by decade. For the 180 × 120 corridors, the (rescaled) data gives a stock of 55 million migrants aged 25 to 64 in 1970, and of 120 million migrants in 2010. The model almost exactly matches this evolution whatever the technological scenario (by definition, the model perfectly matches the 2010 data). The six variants of the model cannot be visually distinguished, as the lines almost perfectly coincide. Although technological variants drastically affect within-country income disparities (in particular, the wage rate of college graduates), they have negligible effects on aggregate migration stocks. This is due to the fact that income disparities are mostly governed by between-country inequality (i.e., by the TFP levels, which are calibrated under each scenario to match the average levels of income per worker), and that the worldwide proportion of college graduates is so small that changes in their migration propensity have negligible effects on the aggregate.

Figure 1.2: Actual and predicted migrant stocks, 1970-2010 (in million)

1.2.a. Actual and predicted migrant stocks



1.2.b. Counterfactual historical stocks



Considering the scenario with $\sigma = 2$ and $\kappa = 0.214$, Figure 1.2.b compares our backcasts with counterfactual retrospective simulations. The first counterfactual neutralizes demographic changes that occurred between 1970 and 2010; it assumes that the size of the working age population is kept constant at the 2010 level in all countries. The second counterfactual neutralizes the changes in education; it assumes that the share of college graduates is kept constant in all countries. The third counterfactual neutralizes the changes in income disparities; it assumes constant wage rates in all countries.

On the one hand, the simulations reveal that past changes/rises in education marginally increased the worldwide migration stock, while the past changes/ decreases in income inequality marginally reduced it. These effects are quantitatively small. This is because the rise in human capital has been limited in poor countries, and income disparities have been stable for the last fifty years (with the exception of emerging countries). On the other hand, Figure 1.2.b shows that demographic changes explain a large amount of the variability in migration stocks. The stock of worldwide migrants in 1970 would have almost been equal to the current stocks (in fact, it would have been 2% smaller only) if the population size of each country had been identical to the current level. This confirms that past changes in aggregate migrant stocks were predominantly governed by population growth and demographic imbalances: the population ratio between developing and high-income countries increased from 3.5 in 1970 to 5.5 in 2010.

Bilateral migration backcasts. – We now investigate the capacity of the model to match the decadal distributions of immigrant stocks by destination, and the decadal distributions of emigrant stocks by origin. Table 1.1 provides the coefficient of correlation between our backcasts and the actual observations aggregate at country level for each scenario and for each decade. Figure 1.3 provides a graphical visualization of the goodness of fit by comparing the observed and simulated bilateral stocks of immigrants and emigrants for each decade. By definition, as the observed past immigration stocks of all ages are scaled to match the working-age ones in 2010, the predicted immigrant stocks are perfectly matched in that year. Predicted emigrant stocks for 2010 do not perfectly match observations but the correlation with observations is above 0.99. For previous years, the correlation is unsurprisingly smaller; it decreases with the distance from the year 2010. This is because our model does neither identify past variations in migration policies (e.g. the Schengen agreement in the European Union, changes in the H1B visa policy in the US, the points-system schemes in Canada, Australia, New Zealand, guest worker programs in the Persian Gulf, etc.) nor past changes in net amenities and non-pecuniary push/pull factors (e.g., conflicts, political unrest, etc.). The biggest gaps between the observed and predicted migration stocks recorded in our data come from the non-consideration of the partition of Pakistan from India, the collapse of the Soviet Union, the end of the French-Algerian war and of the Vietnam war, the conflict between Cuba and the US. In addition, the model imperfectly predicts the evolution of intra-EU migration, the evolution of labor mobility to

Persian Gulf countries, the evolution of migrant stocks from developing countries to the US, Canada and Australia, and the evolution of immigration to Israel (especially the flows of Russian Jews after the late 1980 - the so-called Post-Soviet aliyah). Nevertheless, the scatterplots on Figure 1.3 show high correlations between the observed and predicted bilateral migration volumes throughout all decades. The lowest reported R-squared are 0.76 for immigrant stocks and 0.69 for emigrant stocks in 1970. These numbers reach 0.93 and 0.90 respectively in 2000. This demonstrates that the constant V_{ij} hypothesis does a good job on average despite big changes in immigration policies in the past whose restrictiveness was either increasing or decreasing.[14] In the former case, it may be that stricter entry policies have been balanced by increasing network effects.

Table 1.1: Correlation between backcasts and actual migrant stocks

(Results by year, destination vs origin)

Techn. variants	1970	1980	1990	2000	2010
	Immigration stock by destination				
$\sigma = 2, \kappa = 0.000$	0.7653	0.8365	0.9409	0.9801	1.0000
$\sigma = 2, \kappa = 0.107$	0.7650	0.8360	0.9407	0.9801	1.0000
$\sigma = 2, \kappa = 0.214$	0.7649	0.8358	0.9405	0.9800	1.0000
$\sigma = 3, \kappa = 0.000$	0.7649	0.8359	0.9406	0.9801	1.0000
$\sigma = 3, \kappa = 0.107$	0.7649	0.8358	0.9406	0.9800	1.0000
$\sigma = 3, \kappa = 0.214$	0.7649	0.8358	0.9405	0.9800	1.0000
	1970	1980	1990	2000	2010
	Emigration stock by origin				
$\sigma = 2, \kappa = 0.000$	0.6904	0.7716	0.8616	0.9505	0.9904
$\sigma = 2, \kappa = 0.107$	0.6920	0.7714	0.8612	0.9502	0.9904
$\sigma = 2, \kappa = 0.214$	0.6934	0.7713	0.8608	0.9498	0.9904
$\sigma = 3, \kappa = 0.000$	0.6928	0.7713	0.8610	0.9500	0.9904
$\sigma = 3, \kappa = 0.107$	0.6931	0.7713	0.8609	0.9499	0.9904
$\sigma = 3, \kappa = 0.214$	0.6934	0.7713	0.8608	0.9498	0.9904

As far as the technological variants are concerned, Table 1.1 confirms that they play a negligible role. The correlation between variants is always around 0.99. The variant with $\sigma = 2$ and no skill-biased externality marginally outperforms the others in replicating immigrant stocks; the one with $\sigma = 3$ and with skill biased externalities does a slightly better job in matching emigrant stocks.

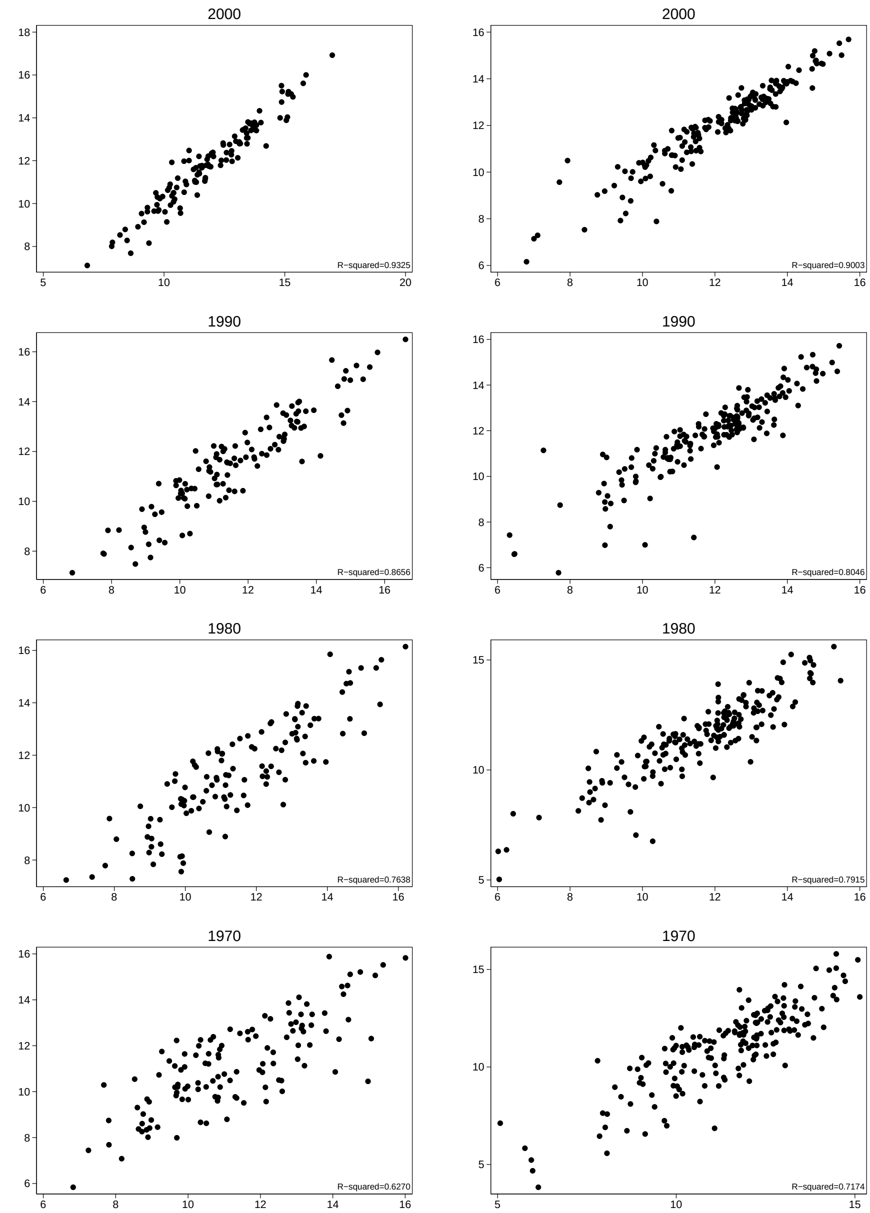
[14]In the late 20th century from 1970 to 2000, we document both forms of tighter and loosened immigration policies in major receiving countries. In Western Europe, the Guest Worker program came to an end following the 1973-4's oil crisis. While in the US, a serie of immigration acts were introduced allowing more entry of family immigrants (the 1990 Immigration Act), legalization of illegal immigrants (the 1986 Reform and Control Act) (see Clark et al. (2007) for an overview) before immigration policies became restrictive again after the September 11 attacks in 2001. The third wave of immigration to the Gulf region also took place during this period after 1971 - year of official independence of GCC countries from the United Kingdom. Mass industrialization and modernization have led to large importation of foreign workers.

Hence, the backcasting exercise shows that our model does a very good job in explaining the long term evolution of migration stocks; however, it does not help eliminating irrelevant technological scenarios.

Figure 1.3: Comparison between actual and predicted migrant stocks, 1970-2010

(Technological variant with $\sigma = 2$ and with skill biased externality)

Dyadic immigrant stocks (in logs) | Dyadic emigrant stocks (in logs)



Backcasts by skill group. – As historical migration data by skill group do not exist, we use our model to backcast the global net flows of college-educated and less educated workers between regions. We use the scenario with $\sigma = 2$ and with full skill-biased externalities. Assuming κ is large, we may overestimate the causal effect of the skill ratio on the skill bias. However, disregarding causation issues, this technological scenario is the most compatible with the cross-country correlation between human capital and the wage structure: it fits the cross-country correlation between the skill bias and the skill ratio in the year 2010.

For each pair of countries, we compute the net flow as the difference between the stock of migrants in 2010 and that of 1970, $\Delta M_{ij,s} \equiv M_{ij,s,2010} - M_{ij,s,1970}$. These net flows form the matrix $\mathcal{M}$. On Figure 1.4, we group countries into eight regions and use circular ideograms following Kzrywinski et al. (2009) to highlight the major components of $\mathcal{M}$. We distinguish between Europe (in dark blue), Western offshoots (NAM in light blue),[15] the Middle East and Northern Africa (MENA in red), sub-Saharan Africa (SSA in yellow), South and East Asia including South and South-East Asia (SEA in pink), the former Soviet countries (CIS in orange), Latin America and the Caribbean (LAC in grey), and Others (OTH in green). Net flows are colored according to their origin, and their width is proportional to their size. The direction of the flow is captured by the colors of the outside (i.e., country of origin) and inside (i.e., country of destination) borders of the circle.

Figure 1.4.a focuses on the net flows of less educated workers. The net flow of low-skilled immigrants equals 35.2 million over the 1970-2010 period. The ten main regional corridors account for 79% of the total, and industrialized regions appear 6 times as a main destination. By decreasing the order of magnitude, they include Latin America to North America (27.6%), migration within the South and East Asian region (13%), from MENA to Europe (6.8%), migration between former Soviet countries (5.2%), migration within sub-Saharan Africa (5.1%), intra-European movements (4.5%), Latin America to Europe (4.4%), South and East Asia to Western offshoots (4.2%), Others to Europe (4.0%), and migration between Latin American countries (4.0%). It is worth noting the low-skilled mobility from sub-Saharan Africa to Europe is not part of the top ten: it only represents 3.8% of the total (the 11th largest regional corridor).

Figure 1.4.b represents the net flows of college graduates. The net flow of high-skilled immigrants equals 27.6 million over the 1970-2010 period. The ten main regional corridors account for 74% of the total. A major difference with the low-skilled is that industrialized regions appear 9 times as a main destination, at least if we treat the Persian Gulf countries (as part of the MENA region) as industrialized. By decreasing order of magnitude, the top-10 includes South and East Asia to Western offshoots (19.8% of the total), intra-European movements (10.7%), migration between former Soviet countries (10.5%), Latin America to Western offshoots (9.7%), Europe to Western offshoots (6.5%), South and East Asia to Europe (4.6%), MENA to Europe (3.3%), sub-Saharan

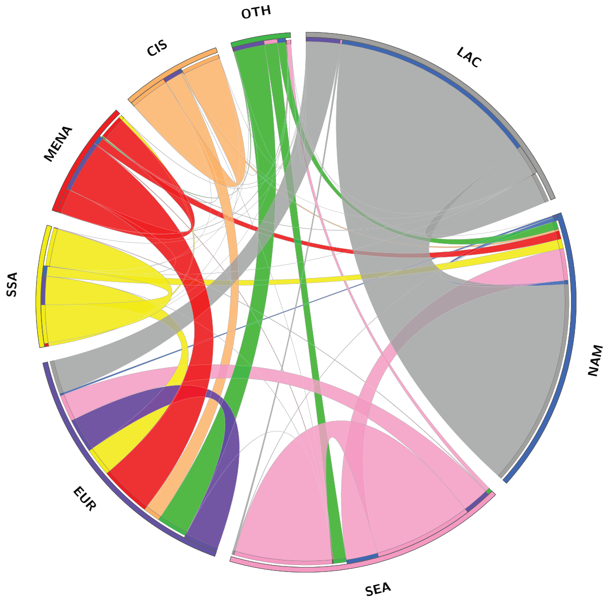
[15] These include the United States, Canada, Australia and New Zealand.

Africa to Europe (3.2%), South and East Asia to the MENA (3.1%), and Latin America to Europe (2.9%).

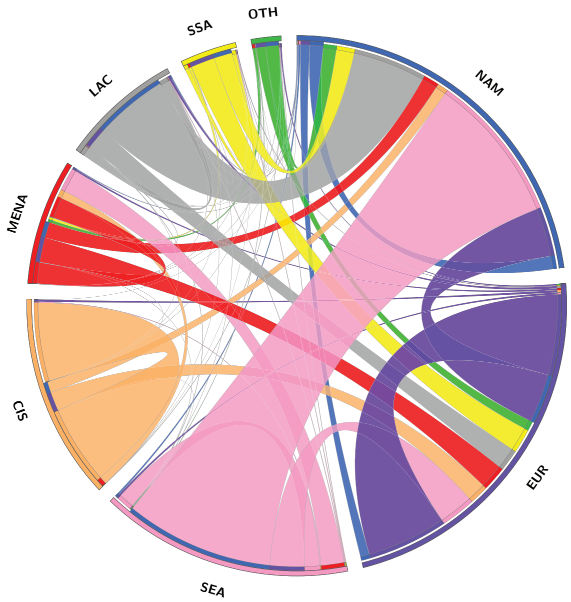
Figure 1.4: Global migration net flows, 1970-2010

(Technological variant with $\sigma = 2$ and with skill biased externality)

1.4.a. Less educated workers



1.4.b. College-educated workers



Major corridors by skill group. – We now characterize the clusters of origins and destinations that caused the greatest variations in global migration between 1970 and 2010. Using the same matrix of migration net flows as above (denoted by $\mathcal{M}$ and including the $J \times J$ net flows between 1970 and 2010, $\Delta M_{ij,s}$), our objective is to identify a sub-matrix with a fixed dimension $o \times d$ that maximizes the total migration net flows (i.e., that captures the greatest fraction of the worldwide variations in migration stocks). The *Max-Sum Submatrix* problem can be defined as:

Definition 2. *Given the squared matrix $\mathcal{M} \in \mathbb{R}^{J\times J}$ of net migration flows between J origin and J destination countries, and given two numbers o and d (the dimensions of the submatrix), the Max-Sum submatrix is a submatrix (O^*, D^*) of maximal sum , with $O^* \subseteq \mathcal{J}$ and $D^* \subseteq \mathcal{J}$, such that:*

$$
\begin{aligned}
(O^*, D^*) &=_{O\subseteq\mathcal{J},D\subseteq\mathcal{J}} \textstyle\sum_{i\in O,j\in D} \mathcal{M}_{ij} \ . && (1.8)\\
|O| &= o \ \ and \ \ |D| = d && (1.9)
\end{aligned}
$$

where $\mathcal{J} = \{1, \ldots, J\}$.

This problem is a variant of the one introduced in Dupont et al. (2017) or Le Van et al. (2014). The difference is that we fix the dimension of the submatrix. It also has some similarity with the bi-clustering class of problems for which a comprehensive review is provided in Madeira and Oliveira (2004). To solve the *Max-Sum Submatrix* problem, we formulate it as a Mixed Integer Linear Program (MILP):[16]

$$
\begin{aligned}
\text{maximize} \quad & \textstyle\sum_{i\in\mathcal{O},j\in\mathcal{D}} \mathcal{M}_{ij} \times X_{ij} \ , && (1.10)\\
\text{s.t.} \quad & X_{ij} \leq R_i, \quad \forall i \in \mathcal{O}, \forall j \in \mathcal{D} \ , && (1.11)\\
& X_{ij} \leq C_j, \quad \forall i \in \mathcal{O}, \forall j \in \mathcal{D} \ , && (1.12)\\
& X_{ij} \geq R_i + C_j - 1, \quad \forall i \in \mathcal{O}, \forall j \in \mathcal{D} \ , && (1.13)\\
& \textstyle\sum_{i\in\mathcal{O}} R_i = o \ , && (1.14)\\
& \textstyle\sum_{j\in\mathcal{D}} C_j = d \ , && (1.15)\\
& X_{ij} \in \{0,1\}, \quad \forall i \in \mathcal{O}, \forall j \in \mathcal{D} \ , && (1.16)\\
& C_i \in \{0,1\}, \quad \forall i \in \mathcal{O} \ , && (1.17)\\
& R_j \in \{0,1\}, \quad \forall j \in \mathcal{D} \ . && (1.18)
\end{aligned}
$$

A binary decision variable is associated to each origin-row R_i, and to each destination-column C_j, and to each matrix entry X_{ij}. The objective function is computed as the sum of matrix entries whose decision variable is set to one. Eqs. (1.11) to (1.13) enforce that variable $X_{i,j} = 1$ if and only both the row i and column j are selected ($R_i = 1$ and $C_j = 1$). This formulation is the standard linearization of the constraint $X_{ij} = R_i \cdot C_j$. Constraints (1.14) and

[16]See Nemhauser and Wolsey (1988) for an introduction to MILP.

(1.15) enforce the $o \times d$ dimension of the submatrix to identify.

Applying the *Max-Sum problem* to the net flows of low-skilled migrants, we can identify the 25 origins and the 25 destinations of the *Max-Sum submatrix.* These 625 entries of the submatrix account for 64% of the worldwide net flows of low-skilled migrants between 1970 and 2010.

- The main destinations (in alphabetical order) are: Australia, Austria, Belarus, Belgium, Canada, Dominican Republic, France, Germany, Greece, Hong Kong, India, Israel, Italy, Kazakhstan, Malaysia, Nepal, the Netherlands, Oman, Russia, Saudi Arabia, Spain, Thailand, the United Kingdom, the United States, and Venezuela.
- The main origins (in alphabetical order) are: Albania, Algeria, Bangladesh, Colombia, the Dominican Republic, Ecuador, Guatemala, Haiti, India, Indonesia, Jamaica, Kazakhstan, Mexico, Morocco, Myanmar, Pakistan, the Philippines, Poland, Romania, Russia, Slovenia, Turkey, Ukraine, Uzbekistan, and Vietnam.

As far as high-skilled migrants are concerned, the set of main destinations mostly includes high-income countries. The 625 entries of the submatrix account for 55% of the worldwide net flow of college-educated migrants between 1970 and 2010.

- The 25 main destinations (in alphabetical order) are: Australia, Austria, Belarus, Canada, France, Germany, India, Ireland, Israel, Italy, Japan, Kazakhstan, the Netherlands, New Zealand, Oman, Russia, Saudi Arabia, Spain, Sweden, Switzerland, Thailand, Ukraine, the United Arab Emirates, the United Kingdom, and the United States.
- The 25 main origins (in alphabetical order) are: Algeria, Bangladesh, Canada, China, Colombia, Egypt, France, Germany, India, Iran, Japan, Kazakhstan, Mexico, Morocco, Pakistan, the Philippines, Poland, Romania, Russia, South Korea, Ukraine, the United Kingdom, the United States, Uzbekistan, and Vietnam.

Aggregate TFP externalities. – Finally, the backcasting exercise allows calibration of the TFP level ($A_{j,t}$) for each country, for each decadal year, and for each pair (σ, κ). We can use these calibrated TFP levels to estimate the size of the aggregate TFP externality, ϵ. In line with Eq. (1.5), we regress the log of TFP on the log of the skill ratio, controlling for time fixed effects (capturing λ_t) and for country fixed effects (capturing $\overline{A}_j$). Identifying the size of the TFP externality is important for conducting the forecasting exercise. Results are reported in Table 1.2. We identify a significant and positive effect when the skill biased externality operates fully; the greatest level (0.207) is obtained in column 1, when $\sigma = 2$ and $\kappa = 0.214$. Lower levels of ϵ are obtained when $\sigma = 3$ (0.105) and/or when κ increases.

Table 1.2: Estimating ϵ using panel regressions, 1970-2010

($Dependent = \log A_{j,t}$)

	(1) $\sigma = 2$ $\kappa = 0.000$	(2) $\sigma = 2$ $\kappa = 0.107$	(3) $\sigma = 2$ $\kappa = 0.214$	(4) $\sigma = 3$ $\kappa = 0.000$	(5) $\sigma = 3$ $\kappa = 0.024$	(6) $\sigma = 3$ $\kappa = 0.048$
$\log(L_{j,h,t}/L_{j,l,t})$	0.041	0.132***	0.207***	0.063	0.085**	0.105**
	(0.043)	(0.043)	(0.044)	(0.043)	(0.043)	(0.043)
Constant	8.055***	8.493***	8.865***	8.392***	8.490***	8.568***
	(0.260)	(0.254)	(0.252)	(0.257)	(0.256)	(0.255)
Time FE	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes
R-squared	0.912	0.915	0.918	0.899	0.900	0.901
Nb. obs.	900	900	900	900	900	900

1.4 Forecasting

We now use the parameterized model to produce projections of migration stocks and income disparities for the 21st century. Availability of population projection until the end of the century allows us to systematically predict migration for that entire period. Nonetheless since the accuracy of prediction decreases with time, we will mainly focus on interpreting results of the medium-term forecasts (up to 2050). We first define the two socio-demographic scenarios that feed our model; one has optimistic predictions for human capital while the other is more pessimistic. We then describe the global trends in international migration and income inequality involved in these two scenarios, with a special focus on migration flows to OECD countries. We finally discuss the policy options than can be used to curb future migration pressures.

Socio-demographic scenarios. – Our socio-demographic scenarios are drawn from Lutz et al. (2014), who produce projections by age, sex and education levels for all countries of the world. As human capital changes affect the distribution of productive capacities, income inequality and the propensity to migrate of people, we distinguish between an optimistic and a pessimistic scenario (labeled as SSP2 and SSP3, respectively). The authors define SSP2 as a *Continuation/Medium Population* scenario, which is described as follows: *"this is the middle-of-the-road scenario in which trends typical of recent decades continue, with some progress towards achieving development goals, reductions in resource and energy intensity, and slowly decreasing fossil fuel dependency. Development of low income countries is uneven, with some countries making good progress, while others make less."* As for SSP3, it is defined as the *Fragmentation/Stalled Social Development* scenario, which is described as followsg: *"this scenario portrays a world separated into regions characterized by extreme poverty, pockets of moderate wealth, and many countries struggling to maintain living standards for rapidly growing populations. The emphasis is on security at the expense of international development."*

The SSP2 and SSP3 scenarios involve international migration hypotheses, which are not in line with our migration technology. To neutralize these migration hypotheses, we use the scenario-specific projections of net immigration flows ($I_{i,s,t}$) from Lutz et al. (2014), and we proxy the evolution of the native population ($N_{i,s,t}$) by education level from 2010 to 2100. In practice, the dynamics of the resident population is governed by:

$$\Delta L_{i,s,t} = \Delta M_{ii,s,t} + I_{i,s,t},$$

where $\Delta L_{i,s,t} = L_{i,s,t} - L_{i,s,t-1}$ is the change in the level of the resident, working-age population (available at each period), $I_{i,s,t}$ stands for the net inflow of working-age immigrants (i.e. immigrants minus emigrants) to country i and for the education level s, and $\Delta M_{ii,s,t} = M_{ii,s,t} - M_{ii,s,t-1}$ stands for the change in the number of native non-migrants.

Using official projections for $\Delta L_{i,s,t}$ and $I_{i,s,t}$, we extract $\Delta M_{ii,s,t}$ from this equation. Remember that the DIOC-E database of the OECD allows us to estimate the size of the native population, $N_{i,s,2010}$, and of the native non-migrant population, $M_{ii,s,2010}$, for the year 2010. We can thus recursively compute $\Delta M_{ii,s,t}/M_{ii,s,t-1}$ and the level of $M_{ii,s,t}$ for all years after 2010. Assuming that $\Delta N_{i,s,t}/N_{i,s,t-1} = \Delta M_{ii,s,t}/M_{ii,s,t-1}$ (i.e. the growth rate of the native population equals the growth rate of the native non-migrant population), we then proxy the evolution of the native population for all years after 2010.

Figure 1.5 describes the two socio-demographic scenarios. Figure 1.5.a compares the trajectories of the worldwide population aged 25 to 64 over the 21st century. In the SSP2 scenario, the working-age population increases by 31%, from 3.28 billion in 2010 to 4.29 billion in 2100. Figure 1.5.c illustrates the evolution of the regional shares in the world population. The breakdown by region and the choice of colors are similar to Figure 1.4, albeit slightly less detailed for expositional convenience. The demographic share of OECD member states decreases from 19.2 to 14.8% (-4.4 percentage points), and that of Asia decreases from 54.6 to 40.0% (-14.6 percentage points). By contrast, the share of sub-Saharan Africa drastically increases from 8.4 to 28.5% (+20.1 percentage points). The shares of MENA countries (+2.3 percentage points), of Latin American countries (-1.1 percentage points), and of the rest of the world (-2.2 percentage points) exhibit smaller variations. In the SSP3 scenario, the working-age population increases by 90% and reaches 6.26 billion in 2100. Figure 1.5.d shows that the demographic share of OECD member states decreases from 19.2 to 8.8% (-10.4 percentage points), and that of Asia decreases from 54.6 to 45.8% (-8.8 percentage points). The share of sub-Saharan Africa increases from 8.4 to 27.0% (+18.6 percentage points). Demographically speaking, the difference between these two scenarios is mainly perceptible after the year 2050, and concerns the shares of OECD and Asian countries.

Figure 1.5: Socio-demographic scenarios, 2010-2100

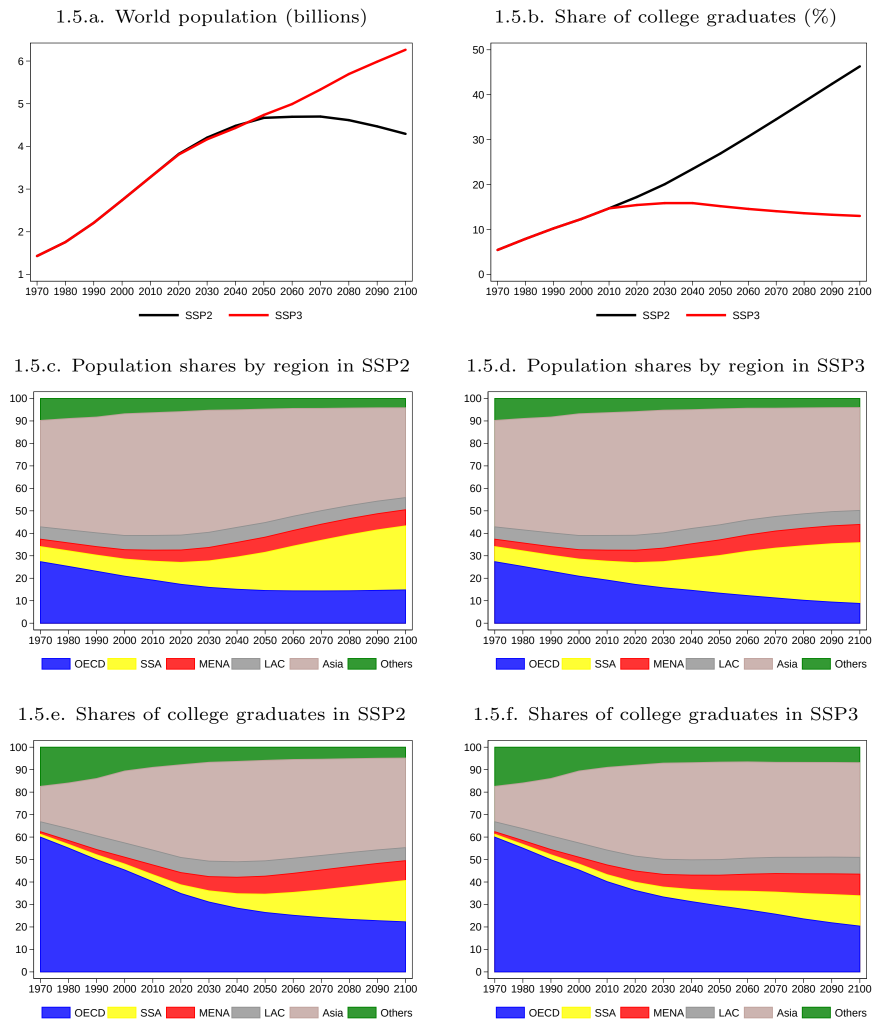


Figure 1.5.b compares the trajectories of the worldwide proportion of college graduates in the working-age population. In the SSP2 scenario, this proportion increases by 31.6 percentage points, from 14.7% in 2010 to 46.3% in 2100. Between 1970 and 2010, the worldwide share of college graduates increased by 2.3 percentage point per year under the impetus of high-income countries; it increased by 1.9 percentage points per year in developing countries, and by 2.1 percentage points per year in sub-Saharan Africa. For the years 2010 to 2100, SSP2 predicts a rise of 3.5 percentage point per year for the world and for the set of developing countries, against +0.5 percentage points in Africa. By contrast, SSP3 predicts a slight decrease in human capital for the world and for the set of developing countries, and +1.2 per year in Africa. Figure

1.5.e illustrates the evolution of the regional shares in the world stock of human capital. In 2100, 40.1% of college graduates are living in the OECD member states; this share decreases by 17.9 percentage points between 2010 and 2100. The share of Asia increases from 36.9 to 39.9% (+3.0 percentage points), and the share of sub-Saharan Africa drastically increases from 3.1 to 18.4% (+15.3 percentage points); the latter change is due to the rising demographic share of Africa. In the SSP3 scenario, the proportion of college graduates decreases slightly, from 14.7% in 2010 to 13.0% in 2100. Figure 1.5.f shows that the human capital share of OECD member states decreases from 40.2 to 20.4% (-19.8 percentage points). The share of Asia increases from 36.9 to 42.2% (+5.3 percentage points). The share of sub-Saharan Africa increases from 3.1 to 13.5% (+10.4 percentage points). As far as education is concerned, the major difference between these two scenarios is the evolution of human capital in low-income countries in general, and in sub-Saharan Africa in particular.

Global implications. – We turn now to the implications of our two socio-demographic scenarios for income growth, global inequality and migration pressures. It is important to acknowledge the reverse impacts of migration on population growth in sending countries. They are however not accounted for in this prospective paper, which takes socio-demographic scenarios as given in order to analyze their effects on income and migration. In addition to that, the longer the distance from 2010, the more uncertain are our projections. We can infer the predictability of our model from the reported coefficients of determination in Table 1.1 and Figure 1.3, which decrease with time departing from 2010 back to the past. Moreover, our forecasts do not account for future conflict, global warming,[17] etc.. Compared to these factors that also affect migration, demography has higher level of predictability and can be seen as the driver of natural migration trend. Lastly, in all simulations we consider constant net migration costs $V_{ij,s,2010}$, which perform very well in backcasting past migration.

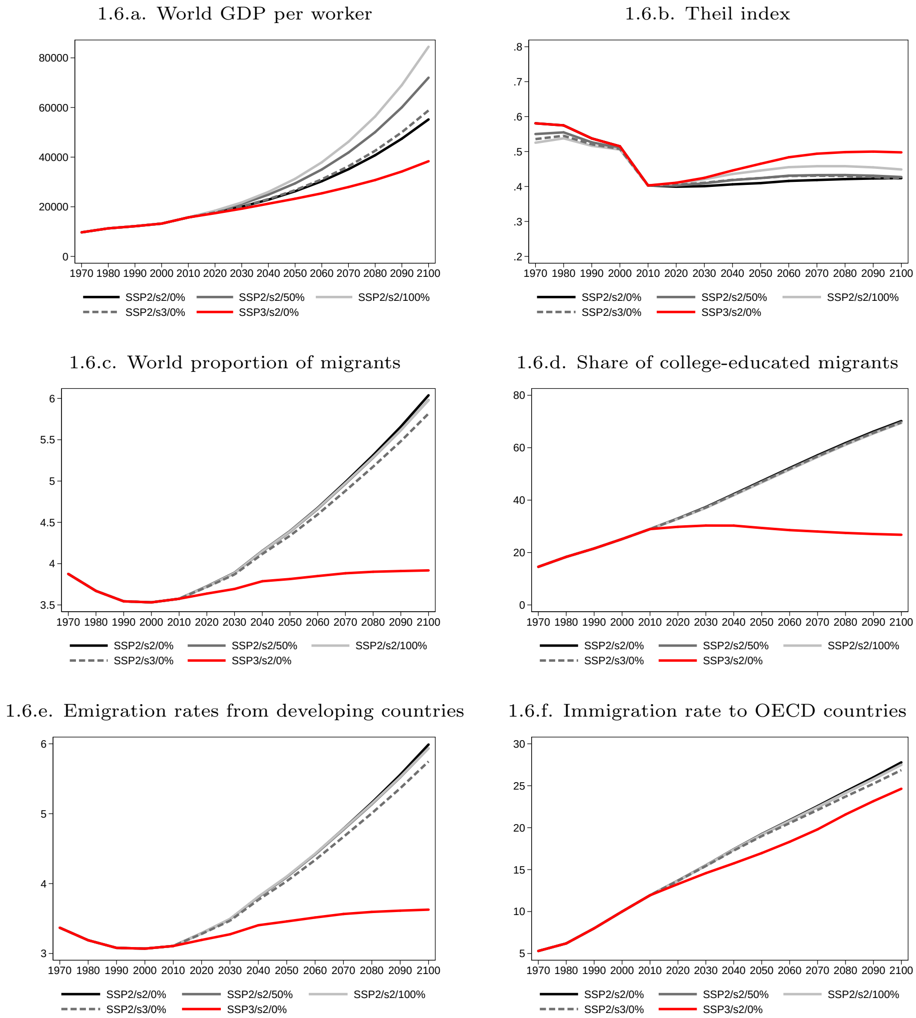
The global income and migration forecasts are depicted on Figure 1.6, which combines the data for the period 1970-2010, and the model forecasts for the subsequent years. We distinguish between five scenarios. In the first three ones, we consider that socio-demographic variables are governed by SSP2, and we combine it with the three technological variants defined in Columns (1), (2) and (3) of Table 1.2 (i.e., $\sigma = 2$ and technological externalities equal to 0, 50 or 100% of the correlation between productivity levels and the skill ratio). While keeping SSP2, the fourth scenario assumes $\sigma = 3$ and zero technological externalities(as in Column (4) of Table 1.2). Finally, the fifth scenario combines SSP3 with $\sigma = 2$ and full technological externalities (as in Column (6) of Table 1.2). In all scenarios with or without technological externalities, we assume an exogenous increase in TFP of 1.5% per year. It is worth noticing that under SSP3, worldwide changes in human capital are negligible; eliminating technological externalities hardly modifies the results.

[17] For instance, Missirian and Schlenker (2017) show that asylum applications increased when global temperatures rose.

Let us first focus on income projections. Figure 1.6.a shows the evolution of the worldwide level of GDP per worker. Under SSP3, the average GDP level in the year 2100 is 2.4 times greater than the level observed in 2010 (i.e., a growth rate of 1.0% per year). Under SSP2 and due to the rise in the level of schooling, the GDP level in 2100 is 3.5 times greater than the level observed in 2010 (i.e., a growth rate of 1.4% per year). Productivity growth is boosted when technological externalities are factored in. Assuming externalities are equal to 50 or 100% of the correlation, the annual growth rate reaches 1.7 and 1.9%, respectively. Finally, assuming a higher level for σ generates very similar income projections. Figure 1.6.b describes the evolution of the Theil index between 1970 and 2100. We combine our backcasts and forecasts, and account for between-country inequality and within-country inequality (between the college-educated and less educated representative workers, only). Globally, we show that the Theil index decreases from 1970 to 2010, a phenomenon that can be due to convergence in the productivity scale factors. Our projections do not account for convergence forces that are not driven by human capital. Under SSP2, the model predicts that the Theil index is constant over time, or is increasing slightly when externalities are included. Under SSP3, we predict a larger increase in the Theil index.

Figures 1.6.c and 1.6.d depict the evolution of the worldwide proportion of international migrants and of the skill structure of migration. Under SSP3, the proportion of migrants (ranging from 3.6 and 3.9%) and the share of college-educated (around 30%) are fairly stable. By contrast, under SSP2, progress in education makes people more mobile. Under constant migration policies, the proportion of migrants increases from 3.6% in 2010 to 4.5% in 2050 and to 6.0% in 2100, and the share of college graduates increases from 29% in 2010 to 34% in 2050 and to 70% in 2100. It is worth noticing that in Figure 1.6.c the important gap between the proportions of migrants in SSP2 and SSP3 does not result from a big difference in terms of migrant volume. In 2010, the working-age population is estimated at 3.28 billion, it will increase by 2100 to 4.29 billion according to SSP2, and more drastically to 6.26 billion following SSP3. While using SSP2 we predict a net increase in total migrants between 2010 and 2100 of about 111 million people, this number is a little bit smaller using SSP3 which is about 82 million. As regards the proportion of the high skill population, it should be recalled that our backcasts reveal that past changes in educational attainment were small in developing countries; they hardly affected the trajectory of global migration (see Figure 1.2.b). SPP2 predicts large educational changes in the coming decades, with strong implications for global migration. Another remarkable result is that the global trends in international migration are virtually unaffected by the technological environment; they are totally governed by socio-demographic changes.

Figure 1.6: Global income and migration forecasts, 2010-2100



We now focus on emigration and immigration rates, separately. Figure 1.6.e depicts the evolution of emigration rates, defined as the ratio of emigrants to natives originating from developing countries. The average emigration rate equals 3.1% in 2010. Under SSP2, it is predicted to reach 4.1% in 2050 and to be twice as large in the year 2100; under SSP3, it reaches 3.6% only by the end of the century. As explained above, the emigration rate is governed by the change in the average level of education in the developing world. Under SSP2 progress in education makes people more mobile (remember college graduates migrate more than the less educated). Under SSP3 emigration rates remain fairly stable over time given the slower progress in education. Similar patterns exhibit in both Figures 1.6c and 1.6e suggesting that the world proportion of migrants is shaped by emigration rates from developing countries. Finally, Figure 1.6.f depicts the evolution of the average immigration rate of OECD member states, defined as the proportion of foreign-born in the total population. This proportion equals 12% in the year 2010 and it is expected to increase drastically over the 21st century. Nevertheless, a remarkable result is that the magnitude of the change is highly insensitive to socio-demographic and technological scenarios. Under SSP3, emigration rates from developing countries vary little, but population growth is large. Under the SSP2 scenario, the rise in emigration rates is larger, but it is partly offset by the fall in the population growth rates of developing countries. By the year 2100, the share of immigrants reaches 27.8% under SSP2, and 24.6% under SSP3.

In Figure 1.7, we represent the net flows of low-skilled and high-skilled migrants over the 21st century. Origin and destination regions are represented by circular ideograms (Kzrywinski et al., 2009), and we use the same regions and colors as in Figure 1.4. Net flows are colored according to their origin, and their width is proportional to their size. The direction of the flow is captured by the colors of the outside (i.e., country of origin) and inside (i.e., country of destination) borders of the circle.

Figures 1.7.a and 1.7.b show the net flows of low-skilled migrants under the SSP2 and SPP3 socio-demographic scenario, respectively. Under SPP2, the total net flows amount to 32 million. The top-5 regional corridors are intra-African migration (24.3% of the total), migration from South and East Asia to the MENA (13.8%), migration from sub-Saharan Africa to Europe (13.7%), intra-MENA migration (8.7%), and migration from Latin America to Western offshoots (8.4%). Outflows from sub-Saharan Africa and South and East Asia to Europe are large. Under SPP3, the total net flows amount to 60 million and are greater for all regional corridors. Compared to Figure 1.7.a, Figure 1.7.b of scenario SSP3 with slower growth and greater fertility rates shows large outflows from Latin America to North America and within African regions. The top-5 regional corridors are Latin America to Western offshoots (16.4% of the total), intra-African migration (15.3%), intra-MENA migration (11%), migration from South and East Asia to Western offshoots (21.1%), and migration within South and East Asian countries (9.3%).

Figures 1.7.c and 1.7.d show the net flows of college-educated migrants under the SSP2 and SPP3 socio-demographic scenario, respectively. Under SPP2, the total net flows amount to 79 million. The top-5 regional corridors are migration from South and East Asia to Western offshoots (21.1%), migration from sub-Saharan Africa to Europe (10.2%), migration from Latin America to Western offshoots (10.1%), migration from sub-Saharan Africa to Western offshoots (7.8%), and migration from South and East Asia to the MENA (6.6%). Inflows to Western offshoots and Europe are large. Under SPP3, the total net flow amounts to 22 million only, but the structure of worldwide migration is similar than under SSP2. The top-5 regional corridors are migration from South and East Asia to Western offshoots (24.2%), migration from Latin America to Western offshoots (11.5%), migration from sub-Saharan Africa to Europe

(10.4%), migration from sub-Saharan Africa to Western offshoots (8.2%), and intra-MENA migration (8.0%).

Implications for HI countries. – Table 1.3 provides projections of immigration rates for the main high-income, destination countries and for constant immigration policies (remember this hypothesis performed well when producing backcasting results). Results obtained under the SSP2 socio-demographic scenario are presented in the top panel; results obtained under SSP3 are presented in the bottom panel. In both cases, we consider the variant with $\sigma = 2$ and full technological externalities, the scenario that is the most compatible with future educational changes.[18] Under SSP2 and over the 21st century, the proportion of immigrants increases by 21.2% in the EU15 and by 14.3% in the United States. The greatest variations are obtained for the United Kingdom (+35.9%) and for Canada (+35.6%). Under SSP3, the average population growth rates are larger in developing countries, with the exception of Asia. The proportion of immigrants increases by 24.3% in the EU15 and by 22.4% in the United States. The greatest variations are obtained for Spain (+27%), the United Kingdom (+26.2%) and for Canada (+29.8%). Projections for the coming 50 years are rather insensitive to the socio-demographic scenario.

Table 1.3: Proportion of working-age immigrants by main destination

(Scenario with $\sigma = 2$ and full technological externality)

	2010	2020	2030	2040	2050	2100	Δ
	SSP2, $\sigma = 2$, full technological externalities						
EU15	14.5	16.8	19.3	22.2	24.7	36.5	+21.2
France	14.7	18.0	21.0	24.0	26.2	36.5	+21.8
Germany	15.9	17.3	19.3	21.3	22.0	24.9	+9.0
Italy	10.5	11.8	13.1	14.8	15.9	18.7	+8.2
Spain	14.9	16.8	19.2	22.0	25.2	29.9	+15.0
United Kingdom	16.5	19.9	24.2	28.8	32.8	52.3	+35.9
Switzerland	31.4	33.2	35.7	38.8	40.7	51.0	+19.6
United States	17.7	20.4	23.3	25.2	26.7	31.9	+14.3
Canada	24.5	29.4	35.3	40.1	44.3	60.0	+35.6
Australia	28.7	31.2	33.8	36.3	38.4	48.2	+19.4
OECD	11.9	13.7	15.5	17.4	19.2	27.5	+15.6
	SSP3, $\sigma = 2$, full technological externalities						
EU15	14.5	16.4	18.4	20.7	22.8	38.9	+24.3
France	14.7	17.4	19.4	21.2	22.7	36.3	+22.2
Germany	15.9	17.3	19.3	21.5	23.2	40.0	+24.1
Italy	10.5	11.8	13.2	15.2	17.3	32.1	+21.6
Spain	14.9	16.6	18.7	21.4	25.2	41.9	+27.0
United Kingdom	16.5	18.6	21.3	23.4	25.5	43.6	+26.2
Switzerland	31.4	32.5	34.1	36.1	37.3	49.7	+18.4
United States	17.7	19.8	22.2	23.5	25.3	40.1	+22.4
Canada	24.5	27.4	31.2	33.5	35.7	54.2	+29.8
Australia	28.7	29.9	31.4	32.4	33.5	47.0	+18.2
OECD	11.9	13.3	14.6	15.7	16.9	24.6	+12.7

[18] Very similar results are obtained when technological externalities are zero, as shown in Table 1.A1 in the Appendix.

In line with Hanson and McIntosh (2016) or with Docquier and Machado (2007), future migration pressures mainly affect European countries, and are mostly due to rising migration flows from developing countries. To illustrate this, we use the same *Max-Sum Submatrix* algorithm as in the previous section, and apply it to the matrix of total migration net flows from developing countries to the 27 members of the European Union between 2010 and 2060; projections for subsequent years are more uncertain and scenario-sensitive. For each socio-demographic scenario, we identify the sub-matrix with a fixed dimension of 25×10 that maximizes the total migration net flows.

Under the SSP2 scenario, we obtain the following results (in alphabetical order):

- Main destination countries: *Belgium, France, Germany*, Ireland, *Italy, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.*
- Main countries of origin: *Afghanistan, Algeria, Angola, Bangladesh*, Cameroon, *Dem. Rep. of Congo, Cote d'Ivoire, Ghana, India*, Iran, *Iraq, Kenya, Madagascar, Mali, Morocco*, Mozambique, *Nigeria, Pakistan, Philippines, Senegal, Somalia*, Tanzania, *Turkey, Uganda*, and Zimbabwe.

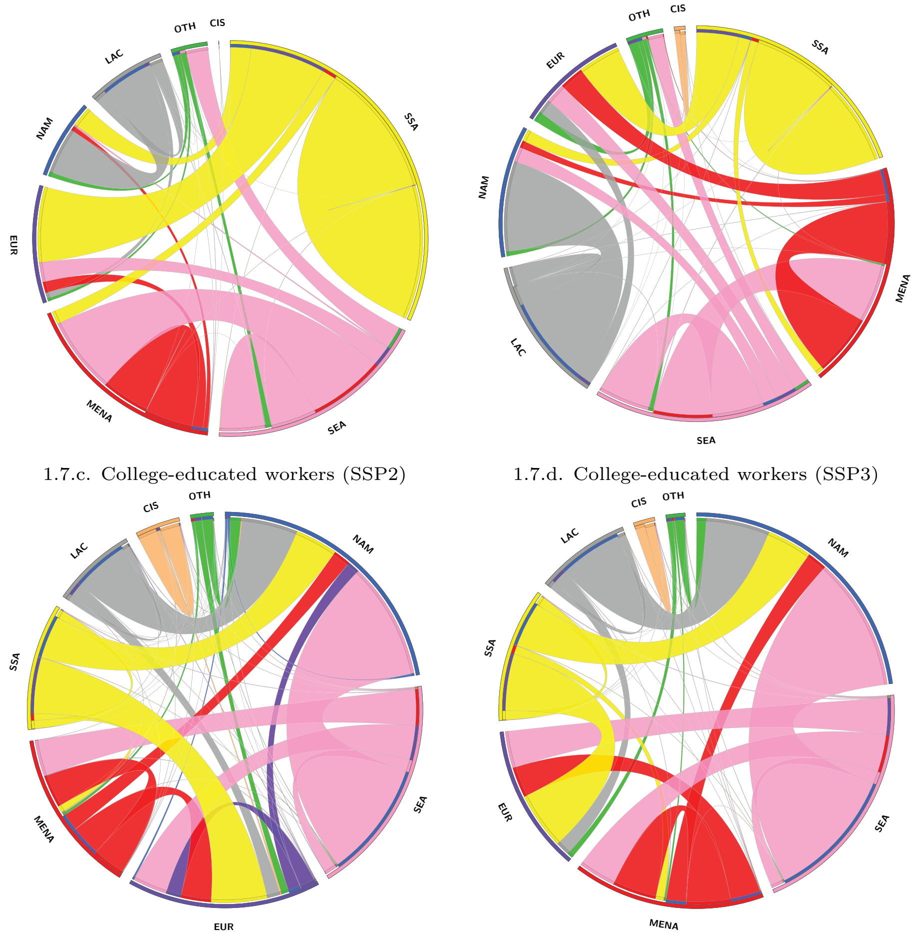
And under the SSP3 scenario, we have (by alphabetical order):

- Main destination countries: Austria, *Belgium, France, Germany, Italy, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.*
- Main countries of origin: *Afghanistan, Algeria, Angola, Bangladesh*, Bolivia, Colombia, *Dem. Rep. of Congo, Cote d'Ivoire*, Ecuador, *Ghana, India, Iraq*, Kazakhstan, *Kenya, Madagascar, Mali, Morocco, Nigeria, Pakistan*, Peru, *Philippines, Senegal, Somalia, Turkey, and Uganda.*

Under SSP2, migration flows from sub-Saharan Africa and from the MENA play a key role, as well as the flows from a few Asian countries with large populations. As the majority of African migrants go to Europe, the EU15 experience greater migration pressures. Under SSP3, this change is mostly due to immigration from Africa, although the magnitude of this phenomenon is smaller than under SSP2. However, migration pressures from Asia, from MENA, and from some Latin American countries are stronger. Clearly, there is a large intersection of 9 destination countries (see countries in italics above) that are all member states of the EU15, and for which future migration pressures are expected to be strong, whatever the socio-demographic scenario for the coming half century. And there is large intersection of 20 developing countries (in italics above) that are responsible for such migration pressures, including sub-Saharan African countries, the MENA countries, and a few Asian countries.

Figure 1.7: Global migration net flows, 2010-2100

(Technological variant with $\sigma = 2$ and with technological externalities)



1.7.a. Less educated workers (SSP2)

1.7.b. Less educated workers (SSP3)

1.7.c. College-educated workers (SSP2)

1.7.d. College-educated workers (SSP3)

The case for Migration Compacts. – In line with the Sustainable Development Goals and the New York Declaration for Refugees and Migrants (United Nations, 2016), the European Commission has outlined a general line of action to cope with the global challenge of future migration (see the European Agenda on Migration and the new Partnership Framework on Migration). Migration Compacts have been designed for Jordan, Lebanon, Nigeria, Niger, Mali, Senegal, Morocco, Tunisia, Libya and Ethiopia as of 2017; they can also be implemented in other partner countries. They include a set of measures to be implemented in the home country, targeting the reinforcement of border controls, the readmission of migrants who have been denied entry, or a higher level of economic development. Readmission and border control strategies are difficult to implement in fragile states. Under the European Migration Compacts, an investment plan has also been proposed to stimulate employment opportunities and income in Africa, in the hope of reducing migration pressures. The effectiveness of these Migration Compacts depends on the resources allocated to their implementation (in comparison to the development targets to be reached), and on the effectiveness of the measures undertaken.

To illustrate the difficulty curbing future migration pressure, we consider the intersection of 20 developing countries emerging from our *Max-Sum Submatrix* problem (referred to as *Compact 1*),[19] or the combined region of sub-Saharan African and the MENA countries (referred to as *Compact 2*). We consider these sets of countries as potential partners of a Migration Compact, and we quantify the homothetic change in TFP (above normal trend) and derive the consequent GDP annual growth rates required to keep their total emigration stocks to Europe at their levels of 2010. Our simulations account for all general equilibrium effects.

Table 1.4 provides the results of these policy experiments, taking the population size and structure as given. Our discussion mainly focuses on net migration flows in the next two decades, the period for which socio-demographic variations between SPP2 and SPP3 are smaller and less likely to be affected by the TFP changes. In other words, this consideration partially mitigates the issue that fertility and human capital are endogenously affected by income, which our model does not account for. Indeed, if TFP and GDP start increasing from 2010 onwards, population growth rates and the skill composition of the labor force will be gradually impacted. Results obtained for 2030 and after (essentially beyond one generation) are likely to overestimate the requested changes and should be treated with more caution.

Under the SSP2 socio-demographic scenario, keeping the stock of the 20 main origin countries (*Compact 1*) at its level of 2010 requires TFP to increase by 58% in 2020 and by 128% in 2030, compared to the baseline. Under the SSP3 scenario, the required TFP changes amount to 49% in 2020 and by 99% in 2030. Overall, this means multiplying GDP per capita by 2 above the normal trend over the next two decades. Equivalently, this requires a TFP growth rate of 5% per year under SPP2 (instead of 1.5% a year in the baseline), and a TFP growth rate of 4.2% a year under SPP3. In terms of GDP growth, the required levels are on average twice as high as the baseline levels; in all variants, the requested annual GDP growth rate is close to 10%. Implementing Migration Compacts with all sub-Saharan African and MENA countries (*Compact 2*) requires similar changes in TFP and gives rise to similar effects.[20]

[19]These include Afghanistan, Algeria, Angola, Bangladesh, Dem. Rep. of Congo, Cote d'Ivoire, Ghana, India, Iraq, Kenya, Madagascar, Mali, Morocco, Nigeria, Pakistan, Philippines, Senegal, Somalia, Turkey, and Uganda.

[20]We have also conducted another set of simulations (*Compact 3*) keeping constant the total emigration stocks of sub-Saharan African countries only. The resulting required TFP growth rates are much higher than the ones in *Compact 2* where growth is fostered in both the MENA and SSA regions. This shows the capacity of the MENA countries to absorb migrants from SSA. Thus smaller but simultaneous investment in both regions is recommended to keep immigration rates in Europe at constant levels.

Takeoffs of this nature have rarely been observed in the course of history.[21] They basically require all SSA and MENA countries to enter the "modern growth club" during the 21st century. Based on facts from the 19th and 20th centuries, Benetrix et al. (2015) estimate that joining the club requires an annual GDP growth rate above 5% over a period of ten years; Jones and Romer (2010) argue that higher threshold growth rates are needed in the current period. Still, "explosive-growth" episodes were indeed recently observed in emerging countries. Taiwan multiplied its income per capita by 5 between 1980 and 2000, and South Korea multiplied it by 7.5 over the same period; China has increased its income level tenfold since 1990 with an average GDP growth rate of 8% per year. Similar takeoffs have not been observed in sub-Saharan Africa. However, Rwanda, which is usually seen as one of the fastest growing economies in Africa, has increased its income per capita threefold since the genocide.

Table 1.4: Development policies to limit migration pressures

	2010	2020	2030	2040	2050	2060	2100
	I. Socio-demographic scenario: SSP2						
Baseline immigration rate to EU15	14.6	16.8	19.3	22.2	24.7	26.8	35.8
Compacts 1	**I.a. 20 main origin countries**						
TFP change: $A_{j,t}/A_{j,t}^{Base}$	1.00	1.58	2.28	3.19	4.18	5.24	9.73
New immigration rate EU15	14.6	15.6	16.9	18.5	19.5	20.4	24.9
Mean annual GDP growth over decade *(Base)*		5.17	5.00	4.82	4.58	4.33	3.48
Mean annual GDP growth over decade		10.28	9.59	9.11	8.54	7.99	6.25
Compacts 2	**I.b. All sub-Saharan Africa and MENA**						
TFP change: $A_{j,t}/A_{j,t}^{Base}$	1.00	1.58	2.28	3.24	4.30	5.51	11.81
New immigration rate EU15	14.6	15.6	16.9	18.3	19.3	20.0	22.6
Mean annual GDP growth over decade *(Base)*		5.06	4.85	4.67	4.42	4.16	3.34
Mean annual GDP growth over decade		10.22	9.47	9.05	8.48	7.95	6.37
	II. Socio-demographic scenario: SSP3						
Baseline immigration rate to EU15	14.6	16.4	18.4	20.7	22.8	25.3	38.9
Compacts 1	**II.a. 20 main origin countries**						
TFP change: $A_{j,t}/A_{j,t}^{Base}$	1.00	1.49	1.99	2.51	3.06	3.67	6.40
New immigration rate EU15	14.6	15.4	16.5	17.7	18.8	20.1	28.1
Mean annual GDP growth over decade *(Base)*		4.54	4.36	4.17	4.01	3.86	3.3
Mean annual GDP growth over decade		8.95	8.15	7.53	7.05	6.68	5.51
Compacts 2	**II.b. All sub-Saharan Africa and MENA**						
TFP change: $A_{j,t}/A_{j,t}^{Base}$	1.00	1.49	1.97	2.48	2.99	3.54	5.89
New immigration rate EU15	14.6	15.4	16.5	17.7	18.8	20.2	28.8
Mean annual GDP growth over decade *(Base)*		4.51	4.25	4.05	3.85	3.67	3.1
Mean annual GDP growth over decade		8.95	8	7.38	6.84	6.42	5.22

Sustaining TFP growth rates of 4 to 5% or real GDP growth rates of 8 to 10% per year on the spatial scale of a continent and over several decades is unprecedented. So far, development policies have not triggered such resounding and generalized economic booms. Hence, dramatic changes in the effectiveness of aid are needed if policymakers want to use development tools to reduce migration pressures (Berthelemy et al. 2009; Berthelemy and Maurel 2010; Gary and Maurel 2015). In addition, generating these booms in SSA and MENA would only attenuate migration pressures to Europe, but would not eliminate them since migration pressures from other countries and regions would still be observed. Table 1.4 shows that the EU15 immigration rate in 2060 would be around 20% in all scenarios, compared to 14.6% in 2010. Reinforcing immigration restrictions is another complementary policy avenue. However, it is a

[21] This was even the case during the Industrial Revolution. Between 1820 and 1900, GDP per capita rose 2.5 times in Western Europe, and 3.3 fold in the United States (Maddison, 2007). In other words, growth rates were 1.2 and 1.5% a year, respectively.

priori unclear whether changes in laws and policies can significantly affect the size of immigration flows. Past restrictions on migration have not prevented third-country nationals from moving in past decades (it may be recalled that our backcasts with constant $V_{ij,s,t}$ fit well past migration flows), and have caused displacements and increasing flows of irregular migrants. Over the 21st century, increasing migration seems to be an inevitable phenomenon, which raises important challenges in terms of policy coherence for most industrialized countries.

1.5 Conclusion

The number of asylum applications lodged in 2015 in EU Member States exceeded 1.3 million, putting migration policy in the forefront of the global policy debate. While the proximate cause of the current crisis is the conflict and political unrest in the Middle East and Africa, the recent trends and forecasts for the world economy strongly suggest that there may be further episodes of large-scale migration in the near future, in Europe and in other OECD countries. Specifically, the underlying root causes of increased migration (demographic imbalances, economic inequality, increased globalization, political instability, climatic changes) are all projected to exert a stronger influence in the coming decades.

Relying on socio-demographic and technological scenarios, this paper produces integrated backcasts and forecasts of income and bilateral migration stocks for all pairs of countries. Our model fits very well the trends in international migration of the last 40 years, and demonstrates that historical trends were mostly governed by demographic changes. Turning to the migration prospects for the 21st century, we also find that world migration prospects are mainly governed by socio-demographic changes; they are virtually insensitive to the technological environment. We predict a highly robust increase in immigration pressures in general, and in European immigration in particular. These migration pressures are mostly explained by the demographic changes in sub-Saharan Africa and in the MENA countries. Curbing them with development policies requires triggering unprecedented economic booms in many developing countries. More than ever, improving the management of migration flows and the coherence between development and migration policies will represent major challenges for European countries in the 21st century.

1.6 Appendix

Table 1.A1: Proportion of working-age immigrants by main destination

(Scenario with $\sigma = 2$ and no technological externality)

	2010	2020	2030	2040	2050	2100	Δ
	SSP2, $\sigma = 2$, no externality						
EU15	14.5	16.7	19.1	21.9	24.2	34.8	+20.2
France	14.7	17.8	20.6	23.2	25.2	34.8	+20.1
Germany	15.9	17.3	19.2	21.2	22.0	25.1	+9.2
Italy	10.5	11.7	12.9	14.6	15.6	18.2	+7.7
Spain	14.9	16.7	18.9	21.4	24.4	28.8	+13.9
United Kingdom	16.5	19.8	24.0	28.4	32.2	51.0	+34.6
Switzerland	31.4	33.3	35.7	38.8	40.8	50.9	+19.5
United States	17.7	20.6	23.6	25.6	27.4	33.5	+15.9
Canada	24.5	29.4	35.2	40.0	44.1	60.5	+36.0
Australia	28.7	31.1	33.7	36.1	38.2	47.9	+19.2
OECD	11.9	13.7	15.5	14.4	19.2	27.8	+15.8
	SSP3, $\sigma = 2$, no externality						
EU15	14.5	16.3	18.3	20.5	22.6	38.6	+24.0
France	14.7	17.4	19.4	21.2	22.7	36.3	+21.6
Germany	15.9	17.3	19.2	21.4	23.1	40.2	+24.3
Italy	10.5	11.8	13.2	15.3	17.3	32.1	+21.6
Spain	14.9	16.5	18.6	21.3	25.1	41.9	+27.0
United Kingdom	16.5	18.6	21.1	23.3	25.2	42.7	+26.2
Switzerland	31.4	32.6	34.2	36.2	37.4	49.6	+18.3
United States	17.7	20.0	22.4	23.7	25.5	40.4	+22.7
Canada	24.5	27.4	31.3	33.6	35.8	54.1	+29.7
Australia	28.7	29.9	31.4	32.4	33.4	46.6	+17.9
OECD	11.9	13.3	14.6	15.7	17.0	24.6	+12.7

Chapter 2

Migration and Development: Dissecting the Anatomy of the Mobility Transition

Abstract[1]

Emigration first increases and then decreases as a country experiences economic development. This inverted U-shaped, cross-sectional relationship between emigration and development was first hypothesized by Zelinsky's theory of the *mobility transition.* Although several mechanisms have been proposed to explain the upward segment of the curve (the most common being the existence of financial constraints), they have not been examined in a systematic way. In this paper, we propose two decomposition methods to disentangle the main drivers of the mobility transition curve to OECD destination countries. Our simple decompositions shed light on the role of both *microeconomic* drivers (i.e., financial incentives and constraints) and *macroeconomic* drivers, as well as the skill composition of the population. Our double decomposition further distinguishes between migration aspirations and realization rates by education level. Overall, we provide consistent evidence that the role of financial constraints, while relevant for the poorest countries, is limited. Rather, a large fraction of the increasing segment is explained by the skill composition and by *macroeconomic* drivers (i.e., by factors that do not change in the short-run).

JEL codes: F22, O15.

Keywords: Migration, Development, Human Capital, Credit Constraints.

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2.1 Introduction

Traditional neoclassical models of migration posit that narrowing wage gaps between country pairs monotonically reduce migration along specific corridors. In reality, we instead observe an inverted-U shaped relationship between migration and development in cross-sectional data. Since the seminal work of Zelinsky (1971), this is most commonly referred to as the *mobility transition* curve. Contrary to the neoclassical predictions therefore, economic development seems to produce additional emigration from origin countries in early stages of development (see de Haas 2007, 2010a, 2010b) as shown in Figure 2.a.[2] Adults' emigration rates to the OECD destination countries increase with economic development up to a level of income per capita around \$6,000 and decrease thereafter. Figure 2.b shows the density of the world population according to income per capita. Approximately two thirds of the world population reside in countries with income per capita levels below \$6,000. Taken at face value therefore, the *mobility transition curve* suggests that further global economic development will result in higher volumes of international migration from the poorest regions of the world. It is no surprise that co-development policies, those founded on neoclassical principles, have largely proven unsuccessful (see Clemens 2014; Parsons and Winters 2014).

While various explanations of the observed relationship have been conjectured in specific contexts — the most common being the existence of credit constraints preventing potential migrants in poorer countries from realizing their aspirations — they have not been examined in a systematic way. Our understanding of the underlying mechanisms at play therefore, in addition to the potential consequences of changes in policies or in the distribution of world income on international migration remains limited. As argued by Clemens (2014), *"We do not know enough about the mechanisms that create this observed pattern. Theories of the transition are well-developed, though they could benefit from more formalization and unification in a single framework that can explain patterns observed at both the macro- and micro-levels."*

This paper focuses on migration flows to OECD countries, which host about 50% of the worldwide adult migrant stock (Artuç et al. 2015); the destination countries for which the dyadic and skill structures of migration are measured with the greatest precision.[3] We propose a simple methodology to evaluate the competing theories that are hypothesized to underpin the upward segment of the observed inverted-U relationship, which consists of three steps. *In the first step*, we decompose average emigration rates into several additive components and investigate the correlations between them and income per capita. We begin with a simple decomposition that identifies the role of education, to shed light

[2]Net emigration rates are proxied by changes in emigrant stocks between 2000 and 2010 as a percentage of the resident population in 2000.

[3]In Appendix A, Figure 2.A1 shows that the inverted-U mobility transition curve also holds when considering 70 destination countries (33 OECD member states and 37 non-OECD destination countries) for which data by education level are available in the years 2000 and 2010.

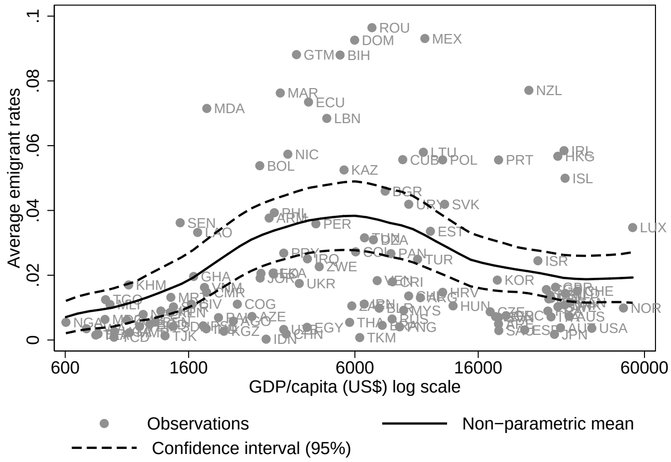
on the correlation between income per capita, the skill structure of the population and skill-specific emigration rates. We subsequently propose a double decomposition that instead distinguishes between bilateral migration aspirations and realization rates by education level. *In the second step*, we estimate regressions to disentangle the effects of both *microeconomic and macroeconomic* drivers of each additive component. Our microeconomic determinants capture the private incentives to migrate, as well as financial constraints that curb migration decisions. Our macroeconomic determinants comprise origin-specific and dyadic migration determinants as identified in the existing literature (i.e., socio-demographic and gravity variables as well as migrant networks). Controlling for *macroeconomic* drivers, we consider the residual effect of income to reasonably provide an upper-bound of the roles of financial incentives and constraints. *In the third step*, we bring together our previous findings and quantify the role of each driver in explaining the changing slope of the mobility transition curve at differing levels of income.

Our paper contributes to a 45 year-old literature on the link between migration and development. Wilbur Zelinsky in his seminal paper (Zelinsky, 1971), developed the theory of the *mobility transition.* This descriptive theory, combining insights from modernization theory and demographic transition analysis, hypothesizes that societies pass through five distinct phases of development, from pre-modern traditional societies to future super-advanced societies, which are accompanied by various forms of internal and international migration. The theory predicts an inverted U-shaped relationship between average emigrate rates and levels of income per capita. This relationship, which we term the *mobility transition curve*, has since been established empirically in differing contexts and variously referred to as: *migration curve* (Akerman, 1976)), *migration transition* (Gould, 1979), *migration hump* (Martin, 1993), and *emigration life cycle* (Hatton and Williamson, 1994). The mobility transition curve has most recently been identified in panel data. Using *aggregate* stock data for the years 1960 to 2000, Clemens (2014) shows that emigration increases with economic development at origin until a level of development commensurate with a per capita income of around \$5,000 in PPP terms, while falling thereafter.[4]

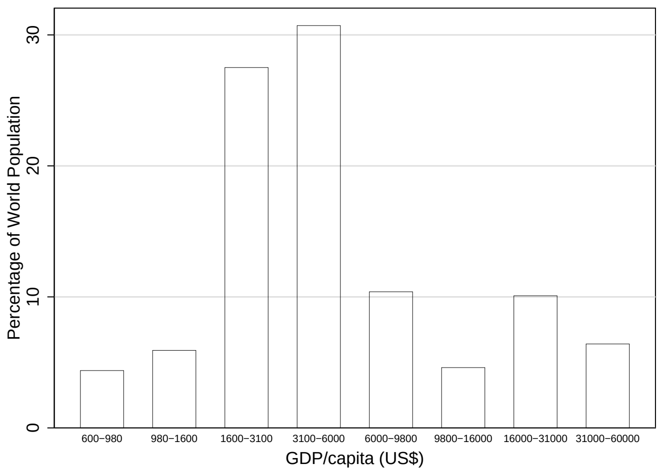
[4]Clemens (2014) investigates emigration to all destinations, including non-OECD countries. Comparisons between decades reveal that the \$5,000 turning point has only slightly increased over time. In Appendix A, Figure 2.A1 shows that the turning point corresponds to a greater level of income when restricting the set of destinations to the OECD member states.

Figure 2.1: Emigration rates and development

2.1.a. Nonparametric regressions of emigration rates on income per capita



2.1.b. Density of the world population by income per capita level



Notes: Non-parametric regressions using Epanechnikov kernel (see Epanechnikov, 1969), local-mean smoothing, bandwidth 0.5. Our sample includes 123 countries with populations above 2.5 million. We omit small states that typically exhibit unusually large emigration rates, countries in conflict, country pairs with negative net flows, and country pairs with realization rates equal to 0 or 1 (see Section 2.3). Average migration rates are calculated as the difference between migrant stocks in 2000 and 2010, normalized by the population at origin. The migration data derive from the *OECD-DIOC database*. Data on GDP per capita at PPP in 2000 are taken from the *Penn World Tables 7.0*. Population data in 2000 are provided by the *UN-DESA World Population Prospects 2012*.

The inverted U-shaped relationship between emigration and development as identified in the data, is not predicted by neoclassical models of migration. Building upon Sjaastad (1962), this class of models places wage or income differentials at the heart of rational agents' decision as to whether to remain at home or migrate elsewhere. Neoclassical models of migration therefore unambiguously predict that narrowing income differentials between origins and destinations will (monotonically) reduce the intensity of international migration. In the neoclassical *tradition* however, the interplay between incentives to emigrate and financial constraints, which we term *microeconomic* drivers henceforth, can give rise to the mobility transition curve. Increases in personal income make migration more affordable, while simultaneously reducing individual's willingness to migrate. Credit constraints have therefore been proposed as an explanation to the paradox wherein emigration from low-income regions, those in which many citizens would benefit the most from emigrating to higher-income regions, is limited.[5] There is ample historical evidence of the role of financial constraints in the 18th and 19th centuries (Hatton and Williamson, 1994; Hatton and Williamson, 1998; Faini and Venturini, 2010; Covarrubias et al., 2015). More recently, Bazzi (2013) provides evidence that financial constraints limit international labor mobility, such that positive agricultural income shocks result in significant increases in international migration, particularly among villages with higher numbers of small landholders. Both mechanisms, emigration incentives and constraints (or aspirations and capabilities), are correlated with income however and are therefore difficult to disentangle from each other.

Aside from *microeconomic* drivers, economists and geographers have, for almost half a century, proposed a number of complementary theories aimed at explaining the observed relationship between emigration and economic development. A recent survey (Clemens, 2014), lists five alternative classes of theory. (i) Demographic transitions may result in more youthful and economically-active populations, which might result in more emigration should they fail to be absorbed locally into the labor force (see Lee, 2003). (ii) Immigration barriers abroad, for example visas, are typically lower for citizens of wealthier nations and for high-skilled workers, meaning that they are more migratory than their lower-skilled compatriots. Education may stimulate migration aspirations of potential migrants, while selective immigration policies at destination favor educated migrants. The impact of development on the skill composition of migration remains ambiguous however. At early stages of development, improvements in education likely increase the success rate of potential migrants. Since education quality is endogenous with economic development however, further educational improvements likely reduce potential migrants' willingness to move, an effect that is likely compounded by the narrowing educational gaps between origins and potential destinations. (iii) Within-country income inequality, since during initial stages of development that are characterized by

[5]Similarly, de Haas (2010b), proposes to incorporate the notions of agency and individual aspirations into transition theory, by conceptualizing migration at the microeconomic level as a function of aspirations (as characterized by an inverted U-shaped relationship) and capabilities (that increase monotonically with development).

rising inequality, worse-off individuals feel relatively deprived and seek alternative 'reference' frames. (iv) Structural transformation due to for example trade linkages that emerge in parallel with the formation of transportation and communication networks that may facilitate mobility (see Massey et al., 1993; Martin and Taylor, 1996; Faini and Venturini, 2010). (v) Information asymmetry whereby migrants for example, having settled, may provide information and send remittances to potential migrants thereby reducing migration costs (see Beine et al., 2010 and 2011).

Another plausible theoretical underpinning for the mobility transition curve arises from 'gravity' or geographic variables that may capture both economic development and migration costs. Such a mechanism has been understudied in the literature in this context. Distance from the equator is correlated both with levels of development (lowest for countries near the equator) and with the ease of migrating to rich countries (mostly located at the higher latitudes of each hemisphere). Thus gravity may explain why emigration rates and economic development are positively correlated, without implying a causal effect of development on emigration. Importantly therefore, the roles of both geography and culture, which jointly affect both migration costs and economic development need to be accounted for (see Gallup et al., 1999).

This paper is the first to quantify the competing mechanisms that underpin the mobility transition. We dissect the anatomy of the mobility transition by simultaneously incorporating all relevant *macroeconomic* and *microeconomic* mechanisms into our empirical model. Distinguishing between skill groups proves key, since emigration rates differ enormously between skill groups and many of the underlying mechanisms affect individuals of various educational attainments differently.[6] Our simple and double decomposition exercises reveal consistent results. In particular, we find that *microeconomic* drivers, while relevant for the poorest countries, have only limited power in explaining the upward sloping part of the transition curve. In countries with income per capita levels below \$1,500, financial constraints are the major mechanism preventing low-skilled workers from realizing their migration aspirations. Nevertheless, these countries exhibit low emigration rates and only account for less than 10% of the world labor force. In countries with income per capita levels between \$1,500 and \$6,000 (representing about 60% of the world population), the effect of financial constraints is much smaller. The upward segment of the mobility transition curve is mostly explained by the changing skill composition of working-age populations at origin in addition to *macroeconomic* drivers (i.e., network size and gravity drivers) that are constant or else adjust very slowly. In other words, by factors that do not change in the short-run. This suggests that a rise in income is unlikely to induce large emigration pressures in the short term (i.e., for a given size and skill structure of the population, and for a given socio-demographic environment). In the long-run however, a permanent

[6]For example, greater inequality in less developed nations, strongly affects the incentives and financial capabilities of less educated individuals. Alternatively, the effect of migrant networks on migration costs has been shown to be greater for the low-skilled (as shown in Beine et al., 2010 and 2011).

rise in income, relaxes other financial constraints and affects other behaviors. In particular, it increases the share of college graduates and reduces population growth. Hence, an increase in permanent income induces uncertain effects with regards the magnitude of emigration stocks, but unambiguously increases the education level of future migrants.

The remainder of the paper is organized as follows. Section 2.2 describes our data and provides aggregate stylized facts on various components of the mobility transition. In Section 2.3, we describe our simple decomposition method and highlight the roles of skill-specific emigration rates and of the skill composition of the working-age population. In Section 2.4, we use a double decomposition method, relying on proxies for migration aspirations and realization rates by education level. Finally, Section 2.5 concludes.

2.2 Data and stylized facts

To disentangle the various potential drivers of the mobility transition curve (as detailed in the previous section), we construct measures of migration intensity to OECD member states, by education level, from 123 origin countries, over the 2000-2010 period. We further distinguish between actual and potential migration intensities. Actual migrants are those who have left their country of origin. Potential migrants include those who have left (i.e., actual migrants) in addition to those who have not yet migrated but express a desire to do so. We consider potential migration intensity as a proxy for migration aspirations. The ratio of actual to potential migration, which we term the realization rate, is used as proxy for the capacity of potential migrants to realize their aspirations. In this section we describe the data sources used to compute our migration intensity measures, provide some aggregate stylized facts and discuss some limitations of the data.

2.2.1 Migration by education level

Data on actual migration flows over the 2000-2010 period are derived from the Database on Immigrants in OECD Countries (*DIOC*), for the 2000 and 2010 census rounds. The *DIOC* database documents bilateral migration stocks by education level from all countries of origin ($i = 1, ..., I$) to OECD destinations ($j = 1, ..., J$). Data from the 2010 census round are described in Arslan et al. (2014), while the corresponding data for 2000 are presented in OECD (2008).[7]

We only consider migrants aged 25 and above (as a proxy for the working-age

[7]It is not possible to conduct our analysis using panel data due to the lack of an education dimension in the available migration data. Using data on population by skill level would result in difficulties separating out compositional effects (whereby more educated individuals are more able to migrate) from incentive effects (in which potential migrants' desire to move are a function of the prevailing level of development at origin). Furthermore, any panel study would need to account for the endogeneity between acquiring education and the prospect of migration, what is known as the *brain gain* effect.

population) and distinguish between migrants with college education (denoted by h and referred to as the highly skilled) and those with lower levels of education (denoted by l and referred to as the low-skilled). For each country pair, net migration flows are proxied as the difference between the bilateral migrant stocks in 2000 and 2010. We denote the net flow of migrants from country i to country j of education level $s = (h, l)$ as M_{ij}^s. Aggregating these numbers across OECD destinations allows us to characterize the size and structure of net emigration flows to the OECD from all the countries of the world i.e. $\overline{M}_i^s = \sum_j M_{ij}^s$.

To compute actual migration *intensities*, we divide our net migration flows by the resident population at origin in 2000. This requires data on the number and average education levels of working-age residents (proxied by the resident population aged 25 and above, which corresponds with our migration data) in each sending country in our sample. This variable, denoted by N_i^s, is taken from Artuç et al. (2015), which proxies the size of the native population in country i from which we can extract the proportion of college graduates (σ_i^l) and less educated natives (σ_i^l). By definition, we have $\sigma_i^l + \sigma_i^h = 1$. Actual migration intensities can be measured as $m_{ij}^s \equiv M_{ij}^s / N_i^s$ at the bilateral level, and as $\overline{m}_i^s \equiv \overline{M}_i^s / N_i^s$ on the aggregate. It follows that the average emigration rate of each sending country is defined as:

$$\overline{m}_i \equiv \sigma_i^h \overline{m}_i^h + \sigma_i^l \overline{m}_i^l. \tag{2.1}$$

Existing studies of the mobility transition curve have identified the cross-sectional relationship between $\overline{m}_i$ and the level of development at origin, proxied by the log of income per capita (y_i). Figures 2.2.a and 2.2.b show the relationships between each component of Eq. (2.1) and the log level of GDP per capita in US dollars (y). We consider a sample of 123 countries, excluding small states with populations below 2.5 million inhabitants, as well as those experiencing episodes of conflict. The results are obtained using the non-parametric Epanechnikov kernel density estimation (see Epanechnikov, 1969).

The skill composition of the population (σ^s) varies with economic development, possibly reflecting the existence of credit constraints that go beyond the capacity of individuals to finance migration costs. As shown in Figure 2.2.a., the share of college graduates in the native population σ^h rises constantly with development. This share is 20 times larger in the richest relative to the poorest countries. In addition, migration rates are always greater among college graduates $(\overline{m}^h)$ than among the less educated $(\overline{m}^l)$, as depicted in Figure 2.2.b. At low levels of income per capita, positive selection is strong $(\overline{m}^h \simeq 30\overline{m}^l)$. In the richest countries, positive selection is much weaker $(\overline{m}^h \simeq 3\overline{m}^l)$. Hence, education levels, taken in isolation, likely prove crucial in understanding the foundations of the mobility transition curve, since the hypothesized drivers likely affect the mobility of low-skilled and high-skilled individuals differently. Overall, the college-educated emigration rates $\left(\overline{m}^h\right)$ decrease with development, while those of the less-educated $\left(\overline{m}^l\right)$ follow an inverted U-shape.

2.2.2 Aspirations and realization rates

Our simple decomposition by education level allows us to examine how the skill composition of the native population affects the mobility transition curve. In a complementary double-decomposition analysis, we further distinguish between actual and potential migrants, which enables us to identify the effect of economic development on migration aspirations and realization rates. We rely upon the *Gallup World Poll surveys*, which identify the proportion of non-migrants expressing a desire to emigrate to another country. The Gallup survey has been canvassing opinions annually in more than 150 countries over the last ten years. As well as documenting various individual characteristics (such as age, gender and education), these surveys also include two relevant questions on emigration intentions. These questions, posed in 142 countries that represent about 97% of the world population, were: (i) *Ideally, if you had the opportunity, would you like to move to another country, or would you prefer to continue living in this country?* (ii) *To which country would you like to move?*

In line with our migration and population data, we only consider Gallup respondents aged 25 and above and distinguish between individuals with college education or otherwise. We aggregate four waves of the Gallup survey (i.e., the years 2007 to 2010) and consider that these four waves represent a single observation period. Using (year-specific) sample weights, we compute the weighted number of respondents to question (i) and the weighted number of respondents who answered positively to the same question. We then compute the stock of aspiring migrants by multiplying the 2010 population aged 25 and over, in origin countries, by the average proportion of individuals answering in the affirmative to question (i). These aspiring migrants would have increased the 2000-2010 net flow of actual migrants should they had been given the opportunity to emigrate therefore (as in Docquier et al. 2014, and Docquier et al. 2015). We then use responses to question (ii) to disaggregate the number of desiring migrants by country of destination. About 10 percent of desiring migrants failed to mention a desired destination however and these are ignored then we compute our dyadic shares.

Adding aspiring migrants to actual migration flows, we define the concept of potential migration flows P_{ij}^s, i.e. the total migration flows that would have been observed between 2000 and 2010 if all aspiring migrants had been able or allowed to emigrate. Aggregating bilateral stocks give $\overline{P}_i^s = \sum_j P_{ij}^s$. Thus, potential migration intensities, which captures emigration aspirations, can be measured as $p_{ij}^s \equiv P_{ij}^s / N_i^s$ at the bilateral level and as $\overline{p}_i^s \equiv \overline{P}_i^s / N_i^s$ on the aggregate. For reasons that will be explored later, aspiring migrants can fail to realize their aspirations, such that we define bilateral and aggregate realization rates as $r_{ij}^s \equiv m_{ij}^s / p_{ij}^s$ and $\overline{r}_i^s \equiv \overline{m}_i^s / \overline{p}_i^s$. Our decomposition of emigration rates by skill level, allows us to investigate whether the effect of economic development on emigration is skill specific and whether it is driven by migration aspirations or else by realization rates.

The databases described above allow us to differentiate emigration rates by skill level and to further distinguish between migration aspirations and realization rates. The average emigration rate of country i ($i = 1, ..., I$) can be decomposed as:

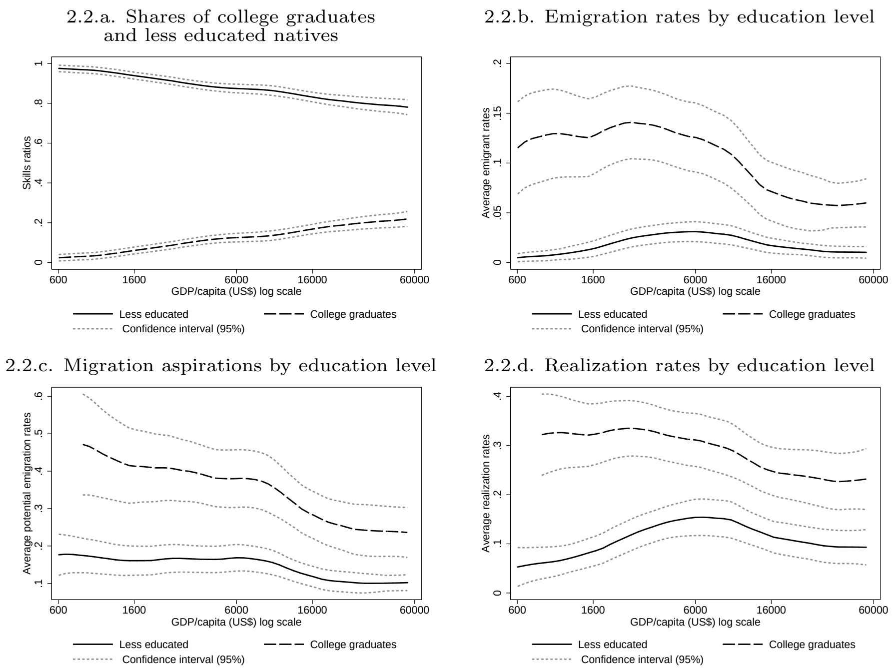
$$\overline{m}_i = \sigma_i^h \overline{p}_i^h \overline{r}_i^h + \sigma_i^l \overline{p}_i^l \overline{r}_i^l \quad (2.2)$$

where $\overline{p}_i^s$ is the proportion of potential migrants in the skill-s population and $\overline{r}_i^s$ is the average realization rate. The product of these two variables gives the proportion of natives who have realized their migration aspirations (i.e., $\overline{m}_i^s$). This corresponds to the observed migration rates by skill groups in Eq. (2.1).

Figures 2.2.c and 2.2.d show the relationships between $\overline{p}^s$, $\overline{r}^s$, and the log of GDP per capita in US dollars (y); when considering the same sample of 123 countries and implementing non-parametric Epanechnikov kernel density estimations (see Epanechnikov, 1969). Figure 2.2.c. shows that migration aspirations decrease with development for both college-educated and less educated individuals.[8] We observe a positive selection in migration aspirations, but this selection is much weaker when compared to actual migration. At low levels of development, the average willingness to migrate among the highly-educated is greater by a factor of four, when compared to the lower-skilled $\left(\overline{p}^h \simeq 4\overline{p}^l\right)$. In the richest countries, the ratio falls to one and a half $\left(\overline{p}^h \simeq 1.5\overline{p}^l\right)$. Figure 2.2.d. describes the relationship between income per capita and the realization rates of college graduates $\left(\overline{r}_i^h\right)$ and the less-educated $\left(\overline{r}_i^l\right)$. Overall, the realization rate of the high-skilled slightly decreases with development. Its slope is not as sharp as that of the $\overline{p}^h$ curve. The realization rate of the less educated however, is the only inverted-U shaped component of the decomposition equation (2.1). At low levels of income per capita, the high-skilled are eight times more likely to realize their migration aspirations compared to the low-skilled $\left(\overline{r}^h \simeq 8\overline{r}^l\right)$. This ratio falls to 2 at intermediate income levels (around US $5,000) and reaches 3 in the richest countries. Economic development therefore has a greater impact on realization rates than on migration aspirations.

[8] Total potential migration, is equal to the sum of those potential migrants expressing a willingness to migrate (from the Gallup data) and the actual migrants who effectively migrated between 2000 and 2010.

Figure 2.2: Nonparametric regressions of the aggregate components of emigration on income per capita



Notes: Non-parametric regression using Epanechnikov kernel, local-mean smoothing, bandwidth 0.5. The migration rates delineated by skill levels are the differences between migrant stocks in 2000 and 2010, normalized by the skill population of the origin countries. Migration aspirations rates are calculated as the sum of the number of non-migrants expressing a willingness to emigrate and the actual migration flows between 2000-2010, normalized by the origin country populations. Realization rates are obtained by dividing the 2000-2010 migration flows by the total number of potential migrants. The sample consists of 123 countries. We omit small states that typically exhibit unusually large emigration rates, countries in conflict, country pairs with negative net flows, and country pairs with realization rates equal to 0 or 1 (see Section 2.3). Data on GDP per capita at PPP in 2000 are taken from the *Penn World Tables 7.0.*

2.2.3 Data compatibility and sample selection

The Gallup database is a unique and relevant source of information about migration aspirations. First, it is the only comprehensive source of data on migration aspirations worldwide or at the global scale. Secondly, empirical studies reveal that the reported aspirations are correlated with the traditional drivers of migration.[9] Thirdly, there is a high correlation between migration

[9]Dustmann and Okatenko (2014) show that internal migration intentions depend on individual wealth as well as contentment with local amenities. The role of local amenities is

aspirations at year t and actual migration flows at year $t + 1$ (Bertoli and Ruyssen, 2017), although actual flows are smaller. Nevertheless, the interpretation of the Gallup questions as well as the combination of data on actual net flows of migrants and on desired migration raise a number of concerns. This section discusses five problems associated with the double decomposition and their implications in terms of sample selection for our analyses in Sections 2.3 and 2.4.

- First, actual migration data capture the net dyadic *flow* of migrants between 2000 and 2010, while aspiring migration data are meant to represent the dyadic *stock* of individuals who would like to migrate if they had the opportunity around the year 2010. We consider that the latter stock also represents the additional flow of migrants that would have been observed if the opportunity to migrate had been given to each individual. Hence, the flow of potential migrants P^s_{ij} corresponds to the total migration flows that would have been observed between 2000 and 2010 if all aspiring migrants had been able or allowed to emigrate during that decade (as in Docquier et al. 2014, and Docquier et al. 2015).

- Secondly, aspiring migrants are asked to provide their first-best destination. Actual migrants however, may have instead migrated to a second-best location (think about refugees and forcibly displaced persons), something we ignore by aggregating the two numbers. In particular, the database includes 3,600 values of realization rates that are equal to one (2,040 for the high-skilled and 1,560 for the low-skilled). This is equivalent to realizing migration aspirations with certainty, due to the total absence of sedentary individuals expressing a desire to emigrate in the Gallup World Polls; while concurrently some migrants actually moved to that destination. These dyadic observations can be considered atypical or inconsistent and their reliability is highly questionable. This is because the absence of aspiring migrants to these countries can arise due to the small sample sizes used in the Gallup World Polls. Moreover, these dyads may also comprise small numbers of actual migrants that are inaccurately measured in the *DIOC* database. Due to statistical disclosure rules, small corridors are usually aggregated in regions of origin that are split out using simple rules. The influence of these atypical observations on the mobility transition curve is limited. These dyads only represent 3.9% and 9.5% of the low-skilled and high-skilled migrant stocks, respectively.

- Thirdly, our database includes a smaller number of realization rates equal to zero (73 and 106 dyads for college graduates and the less educated,

confirmed in Manchin et al. (2014), who also find large effects of social networks on the desire to migrate internationally and locally. Docquier et al. (2014) find that the size of the network of previous migrants and the average income per person at destination are crucial determinants of potential migration and that college graduates exhibit greater actual emigration rates mainly because of better chances in realizing their immigration potentials, rather than because of a higher willingness to migrate.

respectively). These result from the total absence of actual migrants recorded in the desired destination countries. Most of these cases concern Germany, a destination country for which there is an important lack of information about the country of origin of immigrants in the *DIOC* database. Again, the reliability of these dyadic observations remains questionable.

- Fourthly, the database includes a number of corridors with zero potential migrants (i.e., zero values for p_{ij}^s). In particular, the potential bilateral rate variables p_{ij}^s contain 7.25% of zero values for college graduates and 8.8% for the less educated. The presence of these zeroes may lead to biased and inconsistent OLS results.[10] In addition, realization rates cannot be computed when $p_{ij}^s = 0$, as they basically boil down to 0/0.

- Fifthly, the use of contingent valuation surveys to assess migration preferences is open to criticism (see Clemens and Pritchett 2016). One might indeed argue that some respondents do not express a desire to emigrate because they interpret "opportunity" in light of the possibilities currently available to them. These might be limited to a life-threatening trip with the prospect of a life in the shadow economy at destination.

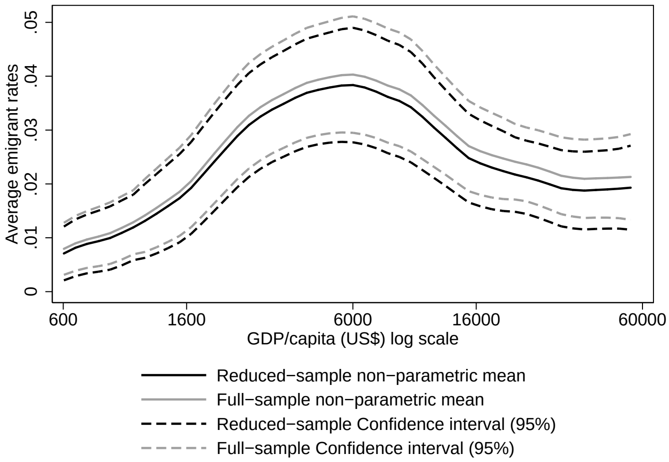
In the decomposition and empirical analyses below, we limit our sample to dyads with positive potential migration flows and realization rates strictly comprises between 0 and 1 (in line with Docquier et al. 2014, or Grogger and Hanson 2011). Although we eliminate a large number of inconsistent observations,[11] the influence of these dyads on the mobility transition curve is negligible. Figure 2.3 shows that the mobility transition curve is almost completely explained by those dyads included in our sample, i.e. 1,409 dyads for low-skilled migration, and 1,067 dyads for high-skilled migration. In addition, restricting our sample allows us to use OLS explorative regressions. For comparability reasons, we will use the same reduced sample throughout the rest of the paper. As developed in Appendix F, the alternative option to keep atypical/inconsistent observations requires using other estimation techniques (due to the large concentration of zeroes and ones) and leads to many counterintuitive results.[12]

[10] An alternative is to estimate potential bilateral emigration rates with the Poisson pseudo-maximum likelihood estimator (PPML) described in Santos Silva and Tenreyro (2006 and 2011). PPML corrects for the fact that the variance of the error in gravity equations, which is non-linear, varies across country-pairs (heteroskedasticity); it is consistent in the presence of fixed effects; it does not exclude these zeroes and thus eliminates sample selection bias. However, PPML does not apply to realization rates, which exhibit a number of 0/0 and a concentration of ones.

[11] Figure 2.A2 in Appendix B compares the distribution of realization rates in the full sample with that of the reduced sample.

[12] In Appendix F, PPML regression results are provided. We include observations with realization rates of 1 and potential migration rates of 0 in Tables 2.A4 and 2.A5.

Figure 2.3: Mobility transition curve under the full and restricted samples



Notes: The full sample consists of 3,359 corridors of positive total migration flows between 123 origin and 33 destination countries. The restricted sample consists of 1,409 corridors with realization rates strictly between 0 and 1. Data on GDP per capita at PPP in 2000 are taken from the Penn World Tables 7.0.

2.3 Simple decomposition: Education levels

Starting from the simple decomposition by education level provided in Eq. (2.1), we compute the total derivative with respect to income per capita. Given $\sigma_i^l = 1 - \sigma_i^h$, this gives:

$$\frac{d\overline{m}_i}{dy_i} \equiv \underbrace{\frac{d\sigma_i^h}{dy_i}\left(\overline{m}_i^h - \overline{m}_i^l\right)}_{\text{Skill Composition}} + \underbrace{\sigma_i^h \frac{d\overline{m}_i^h}{dy_i}}_{\text{HS Migration}} + \underbrace{\sigma_i^l \frac{d\overline{m}_i^l}{dy_i}}_{\text{LS Migration}} . \tag{2.3}$$

The total derivative can be expressed as the sum of three additive components, labeled as *Skill Composition*, *HS Migration*, and *LS Migration*. In line with the stylized facts of the previous section, the magnitude of each of these components is strongly correlated with the level of economic development at origin (see Figure 2.2). Each positive component can result in the upward segment of the mobility transition curve, while each negative component is in line with the neoclassical theory. In particular, the *Skill Composition* component is always positive. As income per capita increases, the share of college graduates increases and this mechanically increases the average emigration rate.[13]

[13]Note that the literature on migration and development has also identified an effect of emigration prospects on human capital formation (Mountford 1997). This implies that

Remember $\overline{m}^h \simeq 30\overline{m}^l$ in the bottom countries, and $\overline{m}^h \simeq 3\overline{m}^l$ in industrialized countries. An upward segment of the mobility transition curve could be observed when the effect of the first term dominates, even if the emigration rates of each skill group decreased with development (i.e., $d\overline{m}^s/dy$ are jointly negative). Given Figure 2.2.b, we expect the *HS Migration* component to be zero or negative, since the high-skilled emigration rate always decreases with development. The size of this component is limited at low levels of development however since σ^h is small. It becomes non negligible in countries where income per capita exceeds \$6,000. Conversely, the *LS Migration* component has an ambiguous sign since $\overline{m}^l$ is an inverted U-shaped function of income per capita.

The size of the three components of Eq. (2.3) is illustrated in Figure 2.4.a, which provides the results of non-parametric Epanechnikov kernel regressions of all three components with respect to the log of income per capita (y). It typically shows that the *Skill Composition* and *LS Migration* components explain approximately half of the positive slope of the mobility transition curve at levels of income per capita below \$1,000 or else between \$4,000 and \$6,000. At higher income levels however (i.e., between \$2,500 and \$3,000), those income levels corresponding to the highest values of the slope of the mobility transition curve, the *LS Migration* component accounts for around 3/4 of the gradient, while the *Skill Composition* component accounts for only 1/4. Figure 2.A3.a in the Appendix shows that estimating the derivatives of σ^h, $\overline{m}^h$ and $\overline{m}^l$ with respect to y separately and aggregating the three components as in (2.1) almost perfectly fits the (one-step) non-parametric Epanechnikov kernel regression of $\overline{m}$ on y.

Macroeconomic versus microeconomic drivers. – As an additional step in dissecting the anatomy of the mobility transition curve, we now identify the fractions of $\frac{d\overline{m}^s}{dy}$ that are due to *microeconomic* drivers (i.e. financial incentives and constraints) and *macroeconomic* drivers (denoted by a vector X_{ij} that includes socio-demographic variables, gravity determinants and existing migrant networks). We implement simple OLS regressions to estimate (and subsequently quantify) the relative contributions of all factors that the literature has highlighted as being potential explanations of the mobility transition. Importantly, we separately evaluate the impact of all these variables on both high-skilled and low-skilled emigration rates. Identifying the influence of gravity drivers and network effects requires our analysis to be conducted at the dyadic level, as well as controlling for absolute geography, culture and other exogenous determinants of migration flows. Using a quadratic function of income per capita (in logs), we allow the *microeconomic drivers* to induce non-monotonic effects on skill-specific emigration rates. Our regression model can be written as:

$$m_{ij}^s = \gamma_m^s X_{ij} + a_m^s y_i + b_m^s y_i^2 + \varepsilon_{ij}^s \tag{2.4}$$

$(\overline{m}_i^h - \overline{m}_i^l)$ may influence σ_i^h. Beine et al. (2008) empirically demonstrate that this effect is positive and significant in developing countries, whatever the level of income per capita at origin. Hence, we assume that this *brain gain* mechanism does not distort the size of $d\sigma_i^h/dy_i$.

which implicitly assumes that income per capita is a good proxy for the financial incentives and constraints of both types of workers. This is in line with Clemens et al (2008) who demonstrate that the income/productivity of all types of workers is mostly determined by the locality in which they are employed. Nevertheless, we also recognize that within-country inequality depends upon levels of development. In Appendix E, we use within-country inequality data from Hendriks (2004) to construct proxies for low-skilled and high-skilled income levels (y_i^s) and re-estimate Eq. (2.4). The results are presented in Table 2.A1.

Once estimated, the model implies that:

$$\overline{m}_i^s \equiv \sum_{j=1}^{J^s} m_{ij}^s = \gamma_m^s \sum_{j=1}^{J^s} X_{ij} + J^s a_m^s y_i + J^s b_m^s y_i^2 \tag{2.5}$$

where J^s stands for the average number of destinations with positive migrant flows from each origin.

We can therefore compute the partial derivatives of skill-specific emigration rates with respect to income, $\frac{\partial \overline{m}_i^s}{\partial y_i}$, which clearly differ from the total derivatives that appeared in Eq. (2.1) since most *macroeconomic* drivers (X_{ij}) are correlated with income:

$$\frac{\partial \overline{m}_i^s}{\partial y_i} \equiv J^s a_m^s + 2J^s b_m^s y_i \quad \neq \quad \frac{d\overline{m}_i^s}{dy_i} \equiv \frac{\partial \overline{m}_i^s}{\partial y_i} + \gamma_m^s \sum_{j=1}^{J^s} \frac{dX_{ij}}{dy_i}$$

Having controlled for *macroeconomic* drivers (i.e., all the relevant, origin-specific mechanisms identified in the existing literature), we consider the residual effect of income to reasonably provide an upper-bound for the effect of *microeconomic* drivers (i.e. an upper-bound for financial incentives and constraints).

Finally, to illustrate the role of *microeconomic* drivers and compare it with that of the *Skill Composition* component, the derivative of the mobility transition curve in Eq. (2.3) can be rewritten as:

$$\frac{d\overline{m}_i}{dy_i} = \underbrace{\frac{d\sigma_i^h}{dy_i}\left(\overline{m}_i^h - \overline{m}_i^l\right)}_{\text{Skill Composition}} + \underbrace{\sigma_i^h \frac{d\overline{m}_i^h}{dy_i}}_{\text{HS Migration}} + \underbrace{\sigma_i^l \frac{d\overline{m}_i^l}{dy_i}}_{\text{LS Migration}} + \underbrace{\frac{dO_i}{dy_i}}_{Others}, \tag{2.6}$$

where $\frac{\partial \overline{m}_i^s}{\partial y_i}$ is computed as the partial derivative of Eq. (2.5) with respect to y_i.

The total derivative can now be expressed as the sum of four additive components. The skill-specific partial derivatives (referred to as *HS Micro* and *LS Micro*) proxy financial incentives and constraints for high-skilled and low-skilled natives, respectively. The last term $\frac{dO_i^s}{dy_i} = \sigma_i^h \gamma_m^h \sum_{j=1}^{J^h} \frac{dX_{ij}}{dy_i} + \sigma_i^l \gamma_m^l \sum_{j=1}^{J^l} \frac{dX_{ij}}{dy_i}$

captures the residual effect of macroeconomic and gravity drivers (referred to as *Others*).

Empirical results. – We proceed by estimating Eq. (2.4) using GDP per capita data (PPP in 2005) international USD (Chain series) in 2000 (y_i) from the *Penn World Tables 7.0*. The set of explanatory variables (X_{ij}) includes the following variables:[14]

- Gravity drivers includes the log of geographic distance between sending and receiving countries and a set of dummy variables that equal one should the sending and receiving countries by contiguous, speak a common language or share a colonial heritage after 1945. These variables are obtained from the *CEPII Dyadic Distance Database* described in Mayer and Zignago (2011). We also include a measure of genetic diversity provided in Spolaore and Wacziarg (2015) as a proxy for cultural distance.[15] In addition, we also include a dyadic variable that captures the changes in the restrictiveness of the migration policy of a destination country j towards an origin country i between 2000 and 2010. The restrictiveness index is taken from the *Demig* database (DEMIG 2015).

- To account for pre-existing migrant networks, we use the total stock of bilateral migrants from i to j in the year 2000, divided by the native population of country i in the same year. This variable captures the probability that a native from country i has a friend or relative in country j at the beginning of the period. Given the endogeneity of this variable, we instrument it with its 10-year lag.

- Socio-demographic drivers include: the log of the population size, the share of the population in country i aged between 15 and 24 in 2000, as a proxy for the adult population in the age of migration between 2000 and 2010, average weighted import tariffs, as proxies for the degree of openness of country i and an index of education quality. The shares of the population aged 15-24 are obtained from the *UN-DESA World Population Prospects 2012*. Information on weighted import tariffs derive from the *World Integrated Trade Solution (WITS)* as of the year 2000. This variable is constructed using the average of all effectively applied import tariffs, weighted by their corresponding trade value.[16] The lower

[14]Figure 2.A4 in Appendix C depicts the cross-sectional relationships between the main potential drivers of emigration rates and the log-level of income per capita in the origin country. Descriptive statistics are provided in Appendix G (see Table 2.A6).

[15]We use the probability that two alleles (a particular form taken by a gene) at a given locus selected at random from two populations are different (as a proxy for time since isolation) from Spolaore and Wacziarg (2009). Genetic distance is based on blood samples and proxies the time since the two populations shared common ancestors. Spolaore and Wacziarg (2015) find a pattern of positive and significant relationships between genetic distance and various measures of cultural distance, including language, religion, values, and norms.

[16]Data for 12 European countries (Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and the United Kingdom) are unavailable. Under the common trade policy, the EU15 (plus Austria, Finland, Sweden) apply the same

the import tariffs, the more open a country. Data on education quality are proxied by the test score results of high school students in maths, science and reading skills, which are taken from Angrist et al. (2013).

- Each regression includes a full set of destination fixed effects. These capture the relative attractiveness of all destinations as well as accounting for immigration policies that do not discriminate between origins. Finally, the gravity regressions that we estimate, although not formally derived from an underlying random utility model, nevertheless manifest similarly. One particular concern in this regard is the potential role of multilateral resistance to migration (MRM) (see Bertoli and Fernandez-Huertas Moraga, 2013), which is the observation that the attractiveness of a particular destination country for potential migrants at origin will likely also depend upon the relative attractiveness of alternative destinations. To account for any potential bias that might arise from the existence of MRM, we follow the approach of Baier and Bergstrand (2009), one adapted to the case of migration as in Gröschl (2012) and control for MRM with the inclusion of an additional term capturing the average distance and contiguity of country i and j with respect to all other migration partners.

Regression results for actual migration rates are presented in Table 2.1. The standard errors are clustered by country of origin. Columns (L1) and (H1) include the full set of controls and the log of income per capita (linear specification). Columns (L2) and (H2) add the squared level of the log of income per capita (quadratic specification). Finally, columns (L3) and (H3) represent our parsimonious specifications comprising significant controls only, in addition to the log level of income. We run a horse race between several competing theories underpinning the mobility transition curve. Hence, our parsimonious specifications are obtained after running backward stepwise regressions starting from the most complete model. Our decision as to whether include a variable or not, is based on its p-value (i.e., the variable should be significantly different from zero at the 5% threshold) and on the global fit of the model before and after eliminating that variable. The correlations between the log of income per capita, its square, gravity and socio-demographic determinants prove important. In our subsequent counterfactual simulations, we use the estimates of the parsimonious regressions to minimize concerns of collinearity.[17]

Our parsimonious model explains 60.5% of the overall variation in low-skilled migration rates. The only significant variables are network size, the log of income per capita and its square. A rise in income increases the low-skilled emigration rate when income per capita is below $1,400. Above this level,

tariff rates to all their imports. The weighted tariffs are therefore not equivalent due to the differences in import volumes. For the sake of simplicity and given the difficulty of working with 6-digit commodity lines in order to calculate the exact weighted tariffs for each country however, we decided to use the average value of the European Union, which is available, for those 12 countries.

[17] In each regression, we instrument the network variable in 2000 by its 10-year lag. Partial R-squared and F-statistics of the first stage IV regressions show a high correlation between the migration stocks of these two periods.

low-skilled emigration decreases with development. Our parsimonious model rather explains 45.2% of the overall variability in high-skilled emigration rates. On the one hand, the high-skilled emigration rate increases with network size, linguistic proximity, colonial links and genetic distance. On the other hand, it decreases with contiguity and with income per capita.[18] As further robustness checks, we run similar regressions in the Appendix (i) with proxies of skill-specific wages instead of aggregate income per capita (see Table 2.A1), (ii) when using the full sample and the PPML regression technique (see Tables 2.A4 and 2.A5). The effect of income per capita becomes insignificant when using a proxy for high-skilled income levels. Using alternative regression techniques yields qualitatively similar results, confirming the robustness of our benchmark estimates.

Table 2.1: Determinants of migration rates by dyad

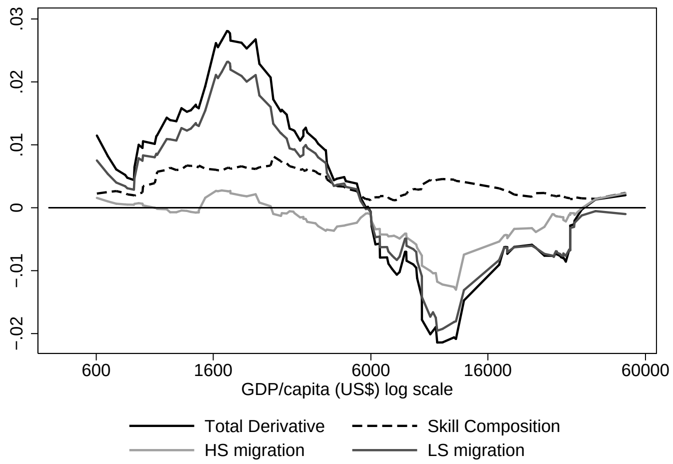
	Less educated			College Graduates		
	(L1)	(L2)	(L3)	(H1)	(H2)	(H3)
Network (% pop.)	0.4535***	0.4511***	0.4504***	0.8648***	0.8616***	0.8806***
	(0.07)	(0.07)	(0.07)	(0.18)	(0.18)	(0.18)
Geo. Dist. (log)	-0.0005*	-0.0005*		-0.0037***	-0.0036***	-0.0036***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Contiguity	-0.0018	-0.0014		-0.0123***	-0.0119***	-0.0136***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Com. Lang.	0.0003	0.0005		0.0122***	0.0126***	0.0127***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Colonial Link	-0.0023**	-0.0020**		0.0486***	0.0490***	0.0484***
	(0.00)	(0.00)		(0.01)	(0.01)	(0.01)
Genetic Dist.	-0.0001	0.0001		0.0081***	0.0083***	0.0075***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Population (log)	-0.0000	-0.0000		-0.0013*	-0.0013*	
	(0.00)	(0.00)		(0.00)	(0.00)	
Pop 15-24 (% pop.)	0.0000	-0.0000		-0.0000	-0.0002	
	(0.00)	(0.00)		(0.00)	(0.00)	
Import Tariff	-0.0000	-0.0000		0.0005*	0.0005*	
	(0.00)	(0.00)		(0.00)	(0.00)	
Educ. Quality	-0.0000	-0.0000*		-0.0001	-0.0001	
	(0.00)	(0.00)		(0.00)	(0.00)	
Pol. restr.	-0.0004	-0.0003		0.0017	0.0018	
	(0.00)	(0.00)		(0.00)	(0.00)	
GDP/cap	-0.0003	0.0063***	0.0058***	-0.0007	0.0129	-0.0025**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
GDP/cap Sq.		-0.0004***	-0.0004***		-0.0008	
		(0.00)	(0.00)		(0.00)	
Constant	0.0095	-0.0166**	-0.0256***	0.0492	-0.0039	0.0258
	(0.01)	(0.01)	(0.01)	(0.04)	(0.10)	(0.02)
Dest. FE	Yes	Yes	Yes	Yes	Yes	Yes
MRM	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.6072	0.6105	0.6050	0.4571	0.4576	0.4516
N. of obs	1409	1409	1409	1067	1067	1067
Partial R-squared	0.8725	0.8725	0.8828	0.8854	0.8859	0.8864
F-stat	377.4963	376.6303	396.9139	163.1120	166.1433	160.3231

Notes: Standard errors are in parentheses. $^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$. OLS regressions estimted on the restricted sample of dyads with realization rates of strictly between 0 and 1 (see Section 2.3). The sample consists of 1,409 observations for low-skilled migration rates and 1,067 observations for high-skilled migration rates. All regressions include destination fixed effects and variables to control for multilateral resistance to migration. Our network variable is instrumented using its 10-year lag. Standard errors are clustered by country of origin.

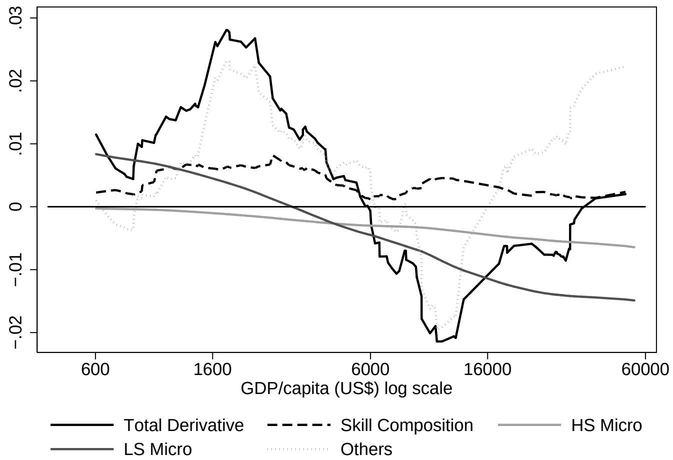
[18] The counterintuitive sign of the effect of being contiguous may be due to the fact that our set of destination countries only includes OECD member states and contiguity captures low income differentials between origin and destination countries. Alternatively, this result could be interpreted as a border effect when geographic distance is small.

Figure 2.4: Simple decomposition: education levels

2.4.a. Total derivative with respect to income (as in Eq. (2.3))



2.4.b. Proxying financial constraints and incentives (as in Eq. (2.6))



Simple decomposition: a synthesis. – Figures 2.4.b describes the results of our simple decomposition as in Eq. (2.6). The magnitudes of the *Skill Composition* (by construction) and *HS Micro* (due to the low level of σ^h at low income levels) effects are very much in line with those of Figure 2.3.a. Conversely, dissecting the *macroeconomic* and *microeconomic* drivers of the *LS Migration* curve reveals that a large portion of the curve can be explained by gravity and network effects. In addition, for origin countries below \$1,000, the *LS Micro* component effect is larger than that of the *Skill Composition.* Remember countries below \$1,000 account for less than 5% of the world population. For origin countries between \$1,000 and \$6,000 however (i.e., in countries accounting for more than 60% of the world population), the *Skill Composition* effect exceeds that of the *LS Micro*. Overall, this means that financial constraints, while relevant for the very poorest countries, only have a limited effect on the upward segment of the mobility transition curve. As far as policy implications are concerned, our results suggest that in the short run (i.e., for a given skill structure, σ^s and for a given set of macroeconomic determinants, O), a rise in income induces only small effects on low-skilled and average emigration rates. In the long-run, a rise in income increases σ^s (i.e., increasing the number of more mobile high-skilled workers) and affects O (e.g., lower population growth), which increases the share of college graduates among emigrants as well as the average emigration rate. Nevertheless O has an uncertain effect on the emigration stock, since increasing the mobility of workers can be offset by smaller populations.

2.4 Double decomposition: aspirations and realization

In this section, we check whether the limited effect of financial constraints is confirmed when using the Gallup proxies for migration aspirations and realization rates. We hypothesize that the role of financial constraints is reflected by the effect of income per capita on the capacity to realize migration aspirations. We proceed as in the previous section, but now exploit the double decomposition in Eq. (2.2) and compute its total derivative with respect to the log of income per capita. This gives:

$$\frac{d\overline{m}_i}{dy_i} = \underbrace{\frac{d\sigma_i^h}{dy_i}\left(\overline{m}_i^h - \overline{m}_i^l\right)}_{\text{Skill Composition}} + \underbrace{\sigma_i^h \overline{r}_i^h \frac{d\overline{p}_i^h}{dy_i}}_{\text{HS Aspiration}} + \underbrace{\sigma_i^h \overline{p}_i^h \frac{d\overline{r}_i^h}{dy_i}}_{\text{HS Realization}} + \underbrace{\sigma_i^l \overline{r}_i^l \frac{d\overline{p}_i^l}{dy_i}}_{\text{LS Aspiration}} + \underbrace{\sigma_i^l \overline{p}_i^l \frac{d\overline{r}_i^l}{dy_i}}_{\text{LS Realization}} . \tag{2.7}$$

The total derivative can be expressed as the sum of five additive components, labeled as *Skill Composition*, *HS Aspiration*, *HS Realization, LS Aspiration* and *LS Realization.* Using non-parametric Epanechnikov kernel regressions, we estimate the relationship between the log of income per capita and the size of each of these five components. The results are depicted in Figure 2.5.a. In line with our intuition and with Figure 2.5.a, it shows that the *Skill Composition* and *LS Realization* components explain approximately half of the positive slope of the mobility transition curve at levels of income per capita below \$6,000, although the *LS Realization* component slightly dominates between \$2,000 and \$3,500. As far as migration aspirations of low-skilled and high-skilled workers are concerned, they have negligible effects on the slope of the mobility transition curve at lower levels of development (i.e. below \$6,000).

To identify the roles of *microeconomic* and *macroeconomic* drivers, we implement simple OLS regressions of dyadic potential migration rates and realization rates using the same determinants as in the previous section. Our regression models can be written as:

$$p_{ij}^s = \gamma_p^s X_{ij} + a_p^s y_i + b_p^s y_i^2 + \varepsilon_{ij}^s, \tag{2.8}$$

$$r_{ij}^s = \gamma_r^s X_{ij} + a_r^s y_i + b_r^s y_i^2 + \varepsilon_{ij}^s, \tag{2.9}$$

assuming that income per capita is a good proxy for the financial incentives and constraints of both types of workers. In Appendix E, we re-estimate the regression models (2.8) and (2.9) using separate proxies for low-skilled and high-skilled income levels (y_i^s). The results are provided in Tables 2.A2 and 2.A3.

Once estimated, the model implies that:

$$\overline{p}_i^s \equiv \sum_{j=1}^{J^s} p_{ij}^s = \gamma_p^s \sum_{j=1}^{J^s} X_{ij} + J^s a_p^s y_i + J^s b_p^s y_i^2, \tag{2.10}$$

$$\overline{r}_i^s = \sum_{j=1}^{J^s} \frac{p_{ij}^s r_{ij}^s}{\overline{p}_i^s} = \gamma_r^s \sum_{j=1}^{J^s} \frac{X_{ij} p_{ij}^s}{\overline{p}_i^s} + a_r^s y_i + b_r^s y_i^2, \tag{2.11}$$

where J^s stands for the average number of destinations with positive migrant flows from each origin country.

To illustrate the role of *microeconomic* drivers, the derivative of the mobility transition curve in Eq. (2.7) can now be rewritten as:

$$\frac{d\overline{m}_i}{dy_i} = \underbrace{\frac{d\sigma_i^h}{dy_i}\left(\overline{m}_i^h - \overline{m}_i^l\right)}_{\text{Skill Composition}} + \underbrace{\sigma_i^h \overline{r}_i^h \frac{d\overline{p}_i^h}{dy_i}}_{\text{HS Aspiration}} + \underbrace{\sigma_i^h \overline{p}_i^h \frac{d\overline{r}_i^h}{dy_i}}_{\text{HS Realization}} + \underbrace{\sigma_i^l \overline{r}_i^l \frac{d\overline{p}_i^l}{dy_i}}_{\text{LS Aspiration}} + \underbrace{\sigma_i^l \overline{p}_i^l \frac{d\overline{r}_i^l}{dy_i}}_{\text{LS Realization}} + \underbrace{\frac{dO_i}{dy_i}}_{Others}, \tag{2.12}$$

where $\frac{\partial \overline{p}_i^s}{\partial y_i}$ and $\frac{\partial \overline{r}_i^s}{\partial y_i}$ can be replaced by the analytical expressions of the partial derivatives of Eqs. (2.10) and (2.11) with respect to y_i.

The total derivative can now be rewritten as the sum of six additive components. The skill-specific partial derivatives of the potential migration rates (referred to as *HS Incentive* and *LS Incentive*) proxies for the financial incentives to emigrate; the skill-specific partial derivatives of the realization rates (referred to as *HS Constraint* and *LS Constraint*), proxies for the financial constraints for high-skilled and low-skilled natives, respectively. The residual term captures the effect of *macroeconomic drivers* (referred to as *Others*).

Empirical results. – Regression results for migration aspirations and realization rates are presented in Tables 2.2 and 1.3. As in Table 2.1, all estimations include both destination fixed effects and variables controlling for multilateral resistance to migration. The standard errors are clustered by country of origin. Columns (L1) and (H1) include the full set of controls and the linear specification in income. Columns (L2) and (H2) present the results obtained with the quadratic specification. Columns (L3) and (H3) represent our parsimonious specifications comprising significant controls only (in addition to the log level of income) and minimizing collinearity issues.[19]

Table 2.2: Determinants of migration aspirations by dyad

	Less educated			College Graduates		
	(L1)	(L2)	(L3)	(H1)	(H2)	(H3)
Network (% pop.)	1.3483***	1.3477***	1.3482***	1.2354***	1.2599***	1.2516***
	(0.17)	(0.17)	(0.16)	(0.37)	(0.38)	(0.37)
Geo. Dist. (log)	-0.0034***	-0.0034***	-0.0027***	-0.0125***	-0.0125***	-0.0112***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Contiguity	-0.0125***	-0.0124***	-0.0119***	-0.0291***	-0.0322***	-0.0296***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Com. Lang.	0.0135***	0.0135***	0.0152***	0.0360***	0.0328***	0.0380***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Colonial Link	0.0050	0.0051		0.0811***	0.0773***	0.0821***
	(0.00)	(0.00)		(0.03)	(0.03)	(0.03)
Genetic Dist.	0.0013	0.0013		0.0180***	0.0165***	0.0175***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.01)
Population (log)	0.0004	0.0004		-0.0004	-0.0001	
	(0.00)	(0.00)		(0.00)	(0.00)	
Pop 15-24 (% pop.)	-0.0003	-0.0003		0.0005	0.0017	
	(0.00)	(0.00)		(0.00)	(0.00)	
Import Tariff	0.0001	0.0001		0.0007	0.0008	
	(0.00)	(0.00)		(0.00)	(0.00)	
Educ. Quality	-0.0003**	-0.0003**		-0.0006	-0.0005	
	(0.00)	(0.00)		(0.00)	(0.00)	
Pol. restr.	-0.0012	-0.0012		0.0006	-0.0006	
	(0.00)	(0.00)		(0.00)	(0.00)	
GDP/cap	-0.0009	0.0007	-0.0028***	-0.0043	-0.1093**	-0.0109***
	(0.00)	(0.01)	(0.00)	(0.00)	(0.05)	(0.00)
GDP/cap Sq.		-0.0001			0.0061**	
		(0.00)			(0.00)	
Constant	0.0360	0.0297	0.0363*	0.1164	0.5260**	0.1358**
	(0.04)	(0.05)	(0.02)	(0.13)	(0.26)	(0.06)
Dest. FE	Yes	Yes	Yes	Yes	Yes	Yes
MRM	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.5681	0.5680	0.5632	0.4422	0.4504	0.4368
N. of obs	1409	1409	1409	1067	1067	1067
Partial R-squared	0.8725	0.8725	0.8751	0.8854	0.8859	0.8864
F-stat	377.4963	376.6303	382.0562	163.1120	166.1433	160.3231

Notes: Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. OLS regressions estimted on the restricted sample of dyads with realization rates of strictly between 0 and 1 (see Section 2.3). The sample consists of 1,409 observations for low-skilled migration rates and 1,067 observations for high-skilled migration rates. All regressions include destination fixed effects and variables to control for multilateral resistance to migration. Our network variable is instrumented using its 10-year lag. Standard errors are clustered by country of origin.

Focusing first upon migration aspirations, Table 2.2 reveals that migration aspirations of the low-skilled monotonically decrease with the log of income per capita and the magnitude of the coefficient is small.[20] In addition, $\overline{p}_i^l$ increases with the size of the network and with linguistic proximity and decreases with geographic distance and contiguity (see footnote 17 above). Our parsimonious model explains 56.3% of the overall variability in potential low-skilled migration. As for college graduates, their aspirations to emigrate monotonically decrease with the log of income per capita and this effect is larger than for the low-skilled.[21] The aspirations of the high-skilled increase with the size of

[19]In each regression, we instrument the network variable in 2000 by its ten-year lag. Partial R-squared and F-statistics of the first stage IV regressions show a high correlation between the migration stocks of these two periods.

[20]Similar results are obtained when using proxies for the income level of the low-skilled (see Table 2.A2).

[21]When using proxies for the income level of the high-skilled, migration aspirations become independent of income (see Table 2.A2). This is in line with the results of the simple

the network, with linguistic proximity, colonial links and with genetic distance and they decrease with geographic distance and contiguity. The results on population size are negative, which might be indicative of the fact that larger countries usually exhibit lower (international) emigration rates since their citizens have access to better opportunities at home. Our parsimonious model explains 43.7% of the overall variability in the migration aspirations of the highly skilled.

Table 2.3: Determinants of realization rates by dyad

	Less educated			College Graduates		
	(L1)	(L2)	(L3)	(H1)	(H2)	(H3)
Network (% pop.)	2.5594***	2.4139***	2.4921***	2.8480***	2.7494***	2.7874***
	(0.450)	(0.467)	(0.443)	(0.507)	(0.470)	(0.487)
Geo. Dist. (log)	-0.0152**	-0.0156**	-0.0218***	-0.0287***	-0.0285***	-0.0365***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.009)
Contiguity	-0.0131	0.0076		0.0193	0.0319	
	(0.028)	(0.026)		(0.028)	(0.028)	
Com. Lang.	0.0050	0.0178		0.0807***	0.0937***	0.0866***
	(0.013)	(0.012)		(0.021)	(0.021)	(0.023)
Colonial Link	0.0067	0.0212		0.1390***	0.1543***	0.1459***
	(0.023)	(0.022)		(0.041)	(0.040)	(0.040)
Genetic Dist.	-0.0263**	-0.0146		-0.0065	-0.0004	
	(0.011)	(0.010)		(0.018)	(0.017)	
Population (log)	-0.0142***	-0.0152***	-0.0168***	-0.0311***	-0.0322***	-0.0315***
	(0.005)	(0.005)	(0.005)	(0.008)	(0.008)	(0.008)
Pop 15-24 (% pop.)	0.0028	-0.0030		-0.0049	-0.0098	
	(0.003)	(0.004)		(0.006)	(0.006)	
Import Tariff	-0.0014	-0.0013		0.0033	0.0031	
	(0.001)	(0.001)		(0.002)	(0.002)	
Educ. Quality	0.0017	0.0016		0.0033*	0.0028	
	(0.001)	(0.001)		(0.002)	(0.002)	
Pol. restr.	0.0120	0.0161		0.0048	0.0095	
	(0.012)	(0.012)		(0.016)	(0.016)	
GDP/cap	-0.0186*	0.3826***	0.3529***	-0.0448**	0.3788***	0.3383***
	(0.010)	(0.090)	(0.082)	(0.018)	(0.146)	(0.123)
GDP/cap Sq.		-0.0237***	-0.0209***		-0.0245***	-0.0207***
		(0.005)	(0.005)		(0.008)	(0.007)
Constant	1.0946***	-0.4917	-0.2464	1.5606***	-0.0916	0.3783
	(0.315)	(0.415)	(0.370)	(0.398)	(0.764)	(0.665)
Dest. FE	Yes	Yes	Yes	Yes	Yes	Yes
MRM	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.2167	0.2494	0.2345	0.3715	0.3879	0.3733
N. of obs	1409	1409	1409	1067	1067	1067
Partial R-squared	0.8725	0.8725	0.8778	0.8854	0.8859	0.8886
F-stat	377.4963	376.6303	384.7583	163.1120	166.1433	163.0592

Notes: Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. OLS regressions estimted on the restricted sample of dyads with realization rates of strictly between 0 and 1 (see Section 2.3). The sample consists of 1,409 observations for low-skilled migration rates and 1,067 observations for high-skilled migration rates. All regressions include destination fixed effects and variables to control for multilateral resistance to migration. Our network variable is instrumented using its 10-year lag. Standard errors are clustered by country of origin.

The determinants of realization rates are presented in Table 2.3. Interestingly, both the linear and squared terms of the log of income per capita are now highly significant for both low-skilled and high-skilled workers. The relationship between realizing migration and financial capacity is non-linear, implying that economic progress is likely to increase the capacity of workers to financially meet the cost of international movement during early stages of development. After computing the turning points of these quadratic relationships, we find that low-skilled realization rates tend to increase with development in countries

decomposition in Table 2.A1.

where income per capita is below \$4,640;[22] high-skilled realization rates increase with development when income per capita is below \$3,540.[23] In addition, low-skilled realization rates increase with the network size and decrease with distance and population size. As for the highly skilled, their realization rates respond to the same determinants, as well as to linguistic proximity and colonial links. Overall, the gravity channels play an important role in determining the realization of migration. Migrant networks mitigate these costs related to long-distance movement and have sizable effects on the success of migration. The magnitude of network effects is globally similar across skill groups. Our parsimonious models explain 23.5% and 37.3% of the overall variability in the realization rates of the low-skilled and high-skilled, respectively.

Double decomposition: a synthesis. – Figures 2.5.b describes the results of our double decomposition Eq. (2.12). The *HS Incentive* and *HS Constraint* components are always zero or negative and of low amplitude (due to the low level of σ^h at low income levels). Globally, the *LS Incentive* component is also negative, meaning that migration aspirations of the low-skilled are decreasing with income after controlling for the *macroeconomic drivers*. Conversely, the *LS Constraint* component is positive when income per capita is smaller than \$5,000. Below \$1,500, the *LS Constraint* component effect is the largest positive component. For income levels between \$1,500 and \$6,000 however, the *LS Constraint* component is smaller than the *Skill Composition* one. These results are very much in line with those of the simple decomposition. As before, a large portion of this curve is explained by the *macroeconomic* drivers (i.e. predominantly by gravity and network effects) and by the skill composition of the population.

2.5 Conclusion

In his seminal paper, Zelinsky (1971) was the first to hypothesize an inverted U-shaped relationship between emigration and development, a relationship that he termed the *mobility transition*; which has subsequently been observed in a variety of settings. Neo-classical explanations have been unable to explain the upward segment of the curve wherein migration increases with development at origin for countries at low or intermediate levels of income per capita. The existence of this upward sloping segment of the curve has therefore constituted a decades-old puzzle for which several potential explanations have been proposed in numerous geographical and historical contexts. Overall, the most common explanation is the existence of financial constraints that prevents the poorer workers from poor countries to realize their migration aspirations. If the existence of financial constraints is the major explanation, improving the economic situation of the bottom million is likely to result in large migration pressures

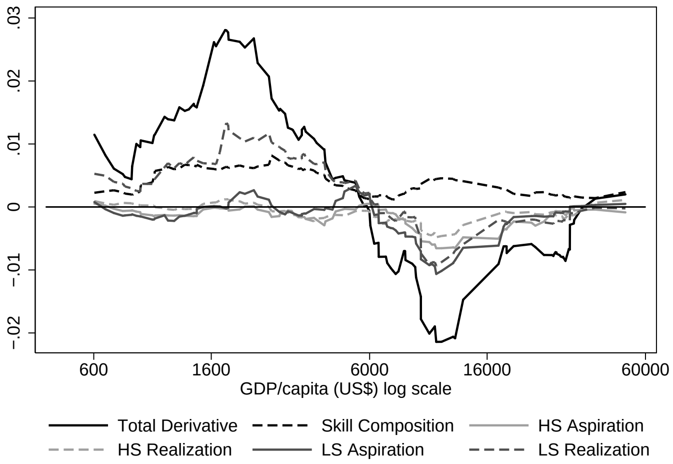
[22] When using proxies for the income level of the low-skilled, the turning point equals \$5,120 (see Table 2.A3).

[23] When using proxies for the income level of the high-skilled, the realization rate monotonically decreases with income (see Table 2.A3).

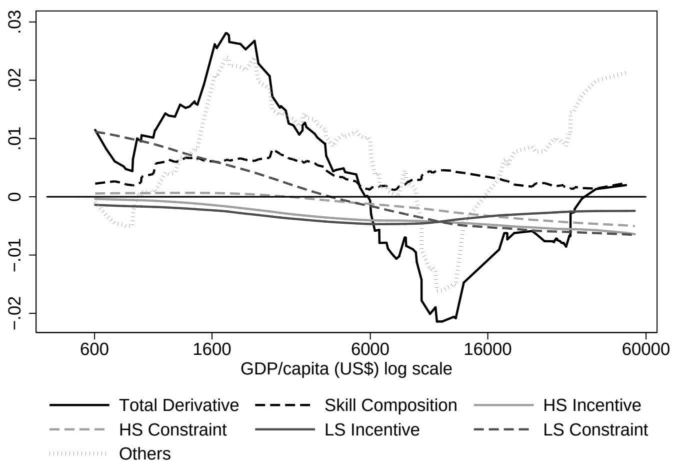
towards industrialized countries.

Figure 2.5: Double decomposition: aspirations and realization rates

2.5.a. Total derivative with respect to income (as in Eq. (2.7))



2.5.b. Proxying financial constraints and incentives (as in Eq. (2.12))



In this paper we analyze rich aggregated micro-data on individual's aspirations and realization rates in a decompositon framework with two skill groups. Having confirmed the existence of the *mobility transition* non-parametrically, we subsequently decompose it into migration rates of more and less skilled and their proportions in the population. We then use regression analyses to run a horse race between several competing theories underpinning the observed relationship for the first time. Having identified statistically significant variables from this analysis, we explore the roles of *microeconomic* drivers (i.e., financial incentives and constraints), skill composition and *macroeconomic* drivers in generating the upward segment of the mobility transition curve.

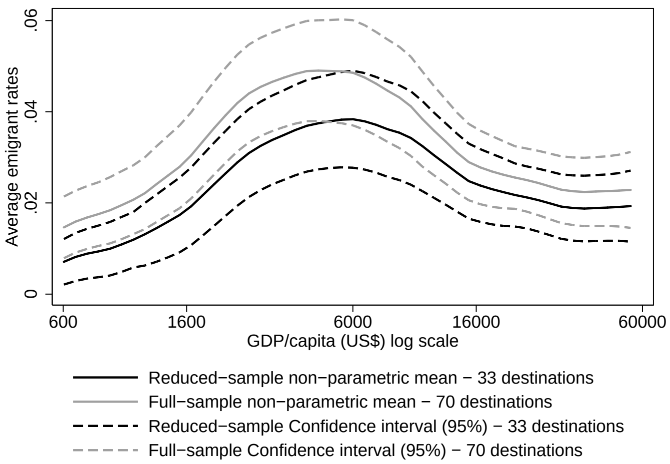
Our key result is that the contributions of *microeconomic* drivers are limited. With the exception of the poorest countries (representing less than 10% of the world population), a large fraction of the increasing segment is explained by *macroeconomic* drivers and by the skill composition of the population. The latter effect is particularly important in countries where GDP per capita in PPP value is between $1,500 and $6,000. While our conclusion is somewhat at odds with many pre-existing explanations, it is rather intuitive. Emigration increases with development, because the proportion of college graduates in the native population increases and it is precisely this group that has highest propensity to emigrate abroad. Hence, our results suggest that in the short term, a rise in income induces small effects on low-skilled and average emigration rates. In the long-run, a rise in income may increase the share of college graduates among emigrants and the average emigration rate. Nevertheless, the effect on emigration stocks is uncertain since the increasing mobility of workers can be offset by smaller populations.

2.6 Appendix

A. OECD vs non-OECD destination countries

Our paper focuses solely upon OECD destinations. It relies on the DIOC data, which documents skill-specific emigration stocks and rates to OECD member states in 2000 and 2010. On Figure 2.1.a, we identify a turning point around \$6,000. Clemens (2014) includes all destination countries of the world and finds a turning point around \$5,000. His database does not include information on the educational level of migrants however. The DIOC-E database provides information on skill-specific emigration stocks to 70 destination countries (i.e., 33 OECD member states and 37 non-OECD countries) by education level for the years 2000 and 2010. Figure 2.A1 compares the mobility transition curves obtained when the set of destination countries includes OECD member states only, or else 70 destination countries.

Figure 2.A1: Development and emigration to OECD versus non-OECD countries



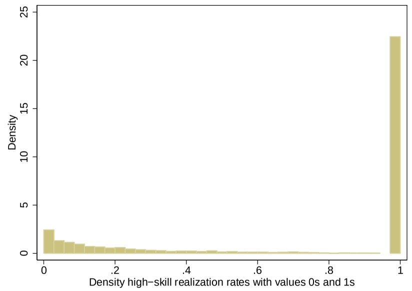
Notes: The reduced sample consists of 1,409 observations for the low-skilled, and 1,067 observations for the high-skilled populations from 123 origin to 33 OECD destination countries. The detailed sample choice is explained in section 2.3. The larger sample consists of all corridors between 123 origin and 70 destination countries available in the OECD-DIOC-E data set.

B. Distribution of realization rates

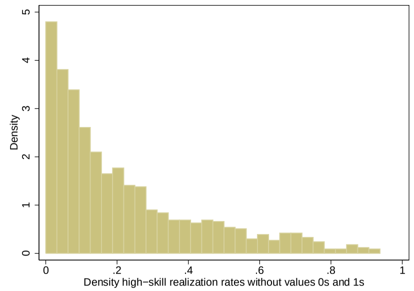
Figure 2.A2 compares the distribution of realization rates in the full sample (including values of 0 and 1) and in the restricted sample (excluding values of 0 and 1).

Figure 2.A2: Histograms of realization rates by education level

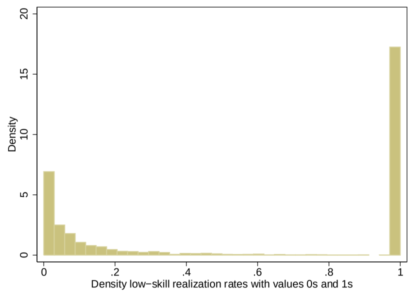
2.A2.a. College graduates - Full sample



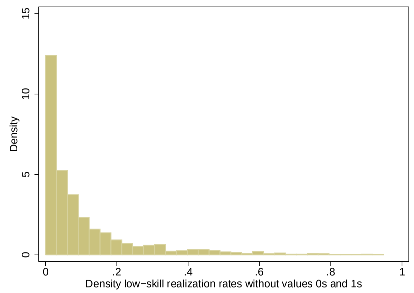
2.A2.b. College graduates - Restricted sample



2.A2.c. Less educated - Full sample



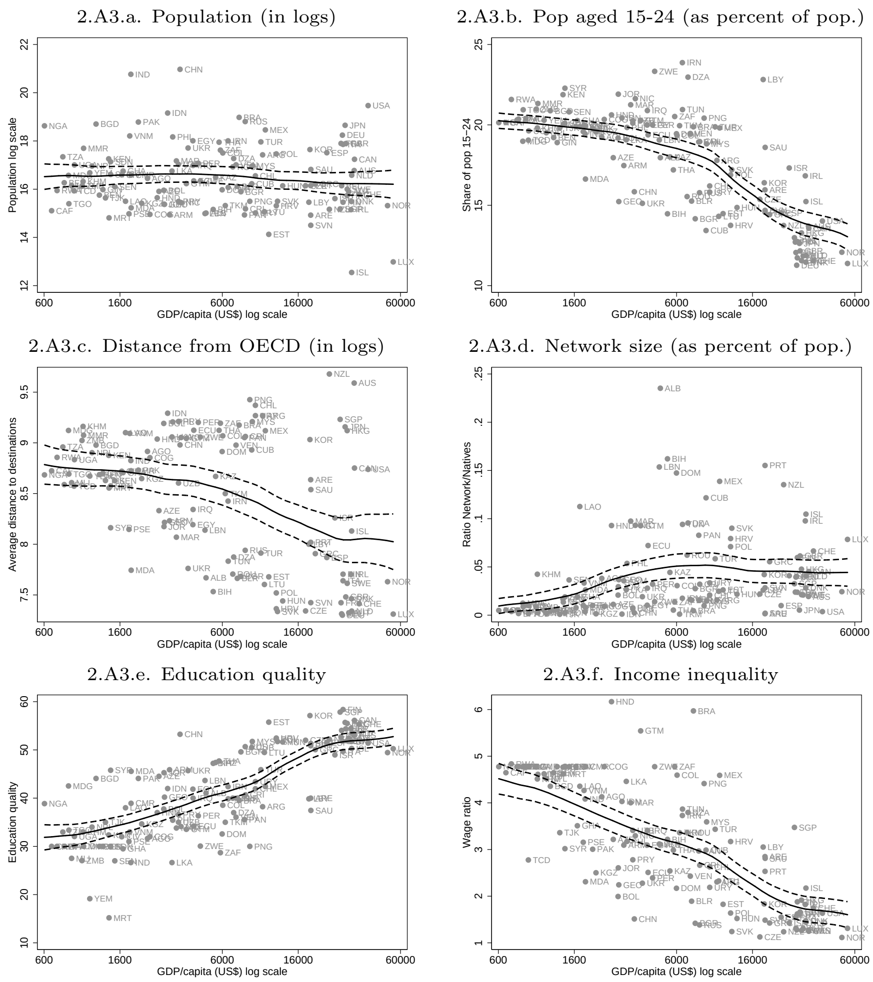
2.A2.d. Less educated - Restricted sample



C. Macroeconomic drivers and income

Figure 2.A3 depicts the cross-sectional relationships between the main potential drivers of emigration rates and the level of income per capita in origin countries. These relationships are obtained using the non-parametric Epanechnikov kernel density estimation (see Epanechnikov, 1969). On average, population size is poorly correlated with development (fig. 2.A3.a). Conversely, the share of the population aged 15 to 24 (fig. 2.A3.b), the average geographic distance from the nearest OECD country (fig. 2.A3.c) and the level of income inequality in the origin country (fig. 2.A3.f) are all negatively correlated with income per capita. As far as the network size (fig. 2.A3.d) is concerned, it first increases with development before decreasing when income per capita exceeds $7,000. Finally, education quality (fig. 2.A3.e) is positively correlated with development.

Figure 2.A3: Nonparametric regressions of main drivers on income per capita

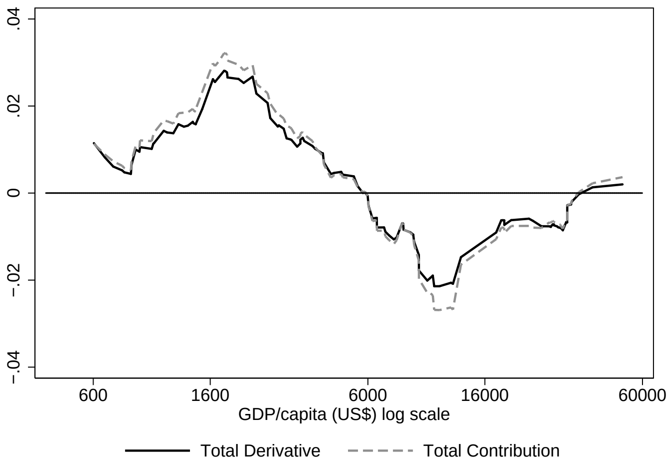


D. Validity of the decomposition methods

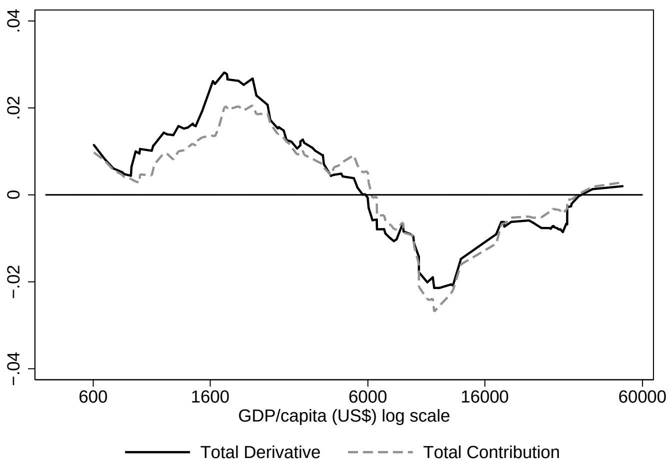
Figure 2.A4 compares the total derivative of $\overline{m}$ on y (estimated using the non-parametric Epanechnikov kernel regression), with the sum of the three components in Eq. (2.3) for the simple decomposition (Fig A4.a), or with the sum of the five components in Eq. (2.7) for the double decomposition (Fig A4.b).

Figure 2.A4: Total derivative and sum of all components

2.A4.a. Simple decomposition



2.A4.b. Double decomposition



E. Regressions with skill-specific wage proxies

In supplementary regressions, we replace income per capita by proxies for skill-specific levels of income, y_i^h and y_i^l and include their logged levels and their squares. Our measures of income proxy for income inequality. We use GDP per capita data at destination (PPP in 2005) international USD (Chain series) in 2000 (y_i) from the *Penn World Tables 7.0* and data on the wage ratio between college educated and less educated workers (ω_i) from Hendricks (2004). We combine these values with the proportions of high-skilled and low-skilled workers from Artuç et al. (2015). Skill-specific income levels are computed as $y_i^l = y_i / \left(\sigma_i^h \omega_i + \sigma_i^l\right)$ and $y_i^h = \omega_i y_i / \left(\sigma_i^h \omega_i + \sigma_i^l\right)$.

Table 2.A1: Determinants of migration rates with skill-specific wage proxies

	Less educated			College Graduates		
	(L1)	(L2)	(L3)	(H1)	(H2)	(H3)
Network (% pop.)	0.4537***	0.4508***	0.4505***	0.8553***	0.8519***	0.8596***
	(0.07)	(0.07)	(0.07)	(0.18)	(0.18)	(0.18)
Geo. Dist. (log)	-0.0005*	-0.0005**		-0.0038***	-0.0037***	-0.0036***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Contiguity	-0.0017	-0.0014		-0.0125***	-0.0122***	-0.0127***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Com. Lang.	0.0003	0.0005		0.0117***	0.0121***	0.0120***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Colonial Link	-0.0023**	-0.0020**		0.0489***	0.0493***	0.0490***
	(0.00)	(0.00)		(0.01)	(0.01)	(0.01)
Genetic Dist.	-0.0001	0.0000		0.0084***	0.0085***	0.0086***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Population (log)	-0.0000	-0.0000		-0.0013*	-0.0014**	-0.0014**
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Pop 15-24 (% pop.)	0.0000	-0.0000		0.0002	0.0001	
	(0.00)	(0.00)		(0.00)	(0.00)	
Import Tariff	-0.0000	-0.0000		0.0006**	0.0005**	0.0006***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Educ. Quality	-0.0000	-0.0000*		-0.0001	-0.0001	
	(0.00)	(0.00)		(0.00)	(0.00)	
Pol. restr.	-0.0004	-0.0003		0.0020	0.0021	
	(0.00)	(0.00)		(0.00)	(0.00)	
Low-Skill Wage	-0.0004*	0.0071***	0.0065***			
	(0.00)	(0.00)	(0.00)			
Low-Skill Wage Sq.		-0.0004***	-0.0004***			
		(0.00)	(0.00)			
High-Skill Wage				0.0015	0.0469	
				(0.00)	(0.04)	
High-Skill Wage Sq.					-0.0023	
					(0.00)	
Constant	0.0104	-0.0207**	-0.0297***	0.0349	-0.1759	0.0340
	(0.01)	(0.01)	(0.01)	(0.05)	(0.19)	(0.04)
Dest. FE	Yes	Yes	Yes	Yes	Yes	Yes
MRM	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.6075	0.6103	0.6048	0.4572	0.4583	0.4560
N. of obs	1409	1409	1409	1067	1067	1067
Partial R-squared	0.8727	0.8724	0.8827	0.8852	0.8855	0.8868
F-stat	376.1988	376.0130	397.1648	162.9635	164.5837	162.3549

Notes: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. OLS regressions are estimate on the restricted sample of dyads with realization rates strictly between 0 and 1 (see Section 2.3). The sample consists of 1,409 observations for the low-skilled migration rates, and 1,067 observations for high-skilled migration rates. All regressions include destination fixed effects and variables to control for multilateral resistance to migration. The network variable is instrumented using its 10-year lag. Standard errors are clustered by country of origin.

Table 2.A2: Determinants of migration aspirations with skill-specific wage proxies

	Less educated			College Graduates		
	(L1)	(L2)	(L3)	(H1)	(H2)	(H3)
Network (% pop.)	1.3479***	1.3477***	1.3463***	1.2088***	1.2179***	1.1824***
	(0.17)	(0.17)	(0.16)	(0.37)	(0.37)	(0.38)
Geo. Dist. (log)	-0.0034***	-0.0034***	-0.0027***	-0.0129***	-0.0131***	-0.0127***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Contiguity	-0.0124***	-0.0124***	-0.0118***	-0.0298***	-0.0308***	-0.0301***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Com. Lang.	0.0135***	0.0135***	0.0153***	0.0347***	0.0337***	0.0358***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Colonial Link	0.0050	0.0050		0.0822***	0.0810***	0.0841***
	(0.00)	(0.00)		(0.03)	(0.03)	(0.03)
Genetic Dist.	0.0013	0.0013		0.0192***	0.0188***	0.0194***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.01)
Population (log)	0.0004	0.0004		-0.0004	0.0001	
	(0.00)	(0.00)		(0.00)	(0.00)	
Pop 15-24 (% pop.)	-0.0003	-0.0003		0.0012	0.0015	0.0036***
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Import Tariff	0.0001	0.0001		0.0008	0.0008	
	(0.00)	(0.00)		(0.00)	(0.00)	
Educ. Quality	-0.0003***	-0.0003**		-0.0009**	-0.0009**	
	(0.00)	(0.00)		(0.00)	(0.00)	
Pol. restr.	-0.0012	-0.0012		0.0017	0.0015	
	(0.00)	(0.00)		(0.00)	(0.00)	
Low-Skill Wage	-0.0010	-0.0005	-0.0030***			
	(0.00)	(0.01)	(0.00)			
Low-Skill Wage Sq.		-0.0000				
		(0.00)				
High-Skill Wage				0.0019	-0.1181	
				(0.00)	(0.09)	
High-Skill Wage Sq.					0.0060	
					(0.00)	
Constant	0.0374	0.0356	0.0370*	0.0757	0.6323	0.0360
	(0.04)	(0.06)	(0.02)	(0.13)	(0.47)	(0.05)
Dest. FE	Yes	Yes	Yes	Yes	Yes	Yes
MRM	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.5680	0.5680	0.5627	0.4410	0.4428	0.4345
N. of obs	1409	1409	1409	1067	1067	1067
Partial R-squared	0.8727	0.8724	0.8753	0.8852	0.8855	0.8871
F-stat	376.1988	376.0130	382.1835	162.9635	164.5837	160.2113

Notes: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. OLS regressions are estimate on the restricted sample of dyads with realization rates strictly between 0 and 1 (see Section 2.3). The sample consists of 1,409 observations for the low-skilled migration rates, and 1,067 observations for high-skilled migration rates. All regressions include destination fixed effects and variables to control for multilateral resistance to migration. The network variable is instrumented using its 10-year lag. Standard errors are clustered by country of origin.

Table 2.A3: Determinants of realization rates with skill-specific wage proxies

	Less educated			College Graduates		
	(L1)	(L2)	(L3)	(H1)	(H2)	(H3)
Network (% pop.)	2.5739***	2.4086***	2.5024***	2.7941***	2.7496***	2.9001***
	(0.451)	(0.466)	(0.438)	(0.515)	(0.496)	(0.529)
Geo. Dist. (log)	-0.0152**	-0.0164**	-0.0208***	-0.0309***	-0.0300***	-0.0322***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
Contiguity	-0.0100	0.0087		0.0165	0.0213	
	(0.028)	(0.026)		(0.028)	(0.028)	
Com. Lang.	0.0066	0.0172		0.0786***	0.0839***	0.0782***
	(0.013)	(0.013)		(0.021)	(0.021)	(0.023)
Colonial Link	0.0057	0.0195		0.1449***	0.1508***	0.1410***
	(0.023)	(0.022)		(0.041)	(0.040)	(0.040)
Genetic Dist.	-0.0262**	-0.0177*		0.0019	0.0038	
	(0.011)	(0.010)		(0.016)	(0.016)	
Population (log)	-0.0147***	-0.0156***	-0.0176***	-0.0308***	-0.0329***	-0.0284***
	(0.005)	(0.005)	(0.005)	(0.008)	(0.008)	(0.008)
Pop 15-24 (% pop.)	0.0020	-0.0030		-0.0014	-0.0026	
	(0.003)	(0.004)		(0.006)	(0.006)	
Import Tariff	-0.0013	-0.0012		0.0037*	0.0035	
	(0.001)	(0.001)		(0.002)	(0.002)	
Educ. Quality	0.0019*	0.0016	0.0023**	0.0019	0.0020	
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	
Pol. restr.	0.0119	0.0166		0.0086	0.0093	
	(0.012)	(0.012)		(0.016)	(0.017)	
Low-Skill Wage	-0.0251**	0.4068***	0.3775***			
	(0.011)	(0.106)	(0.093)			
Low-Skill Wage Sq.		-0.0242***	-0.0221***			
		(0.006)	(0.005)			
High-Skill Wage				-0.0308*	0.5550	-0.0289**
				(0.018)	(0.421)	(0.013)
High-Skill Wage Sq.					-0.0293	
					(0.021)	
Constant	1.1656***	-0.6447	-0.5424	1.4725***	-1.2447	1.7170***
	(0.319)	(0.481)	(0.433)	(0.400)	(2.035)	(0.378)
Dest. FE	Yes	Yes	Yes	Yes	Yes	Yes
MRM	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.2207	0.2473	0.2377	0.3627	0.3677	0.3565
N. of obs	1409	1409	1409	1067	1067	1067
Partial R-squared	0.8727	0.8724	0.8781	0.8852	0.8855	0.8876
F-stat	376.1988	376.0130	388.3746	162.9635	164.5837	160.1732

Notes: Standard errors in parentheses. $^{*}p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.OLS regressions are estimate on the restricted sample of dyads with realization rates strictly between 0 and 1 (see Section 2.3). The sample consists of 1,409 observations for the low-skilled migration rates, and 1,067 observations for high-skilled migration rates. All regressions include destination fixed effects and variables to control for multilateral resistance to migration. The network variable is instrumented using its 10-year lag. Standard errors are clustered by country of origin.

F. Alternative regression techniques

In a last set of supplementary regressions, we use the full sample (including realization rates equal to 0 or 1) and alternative regression techniques. Table 2.A4 revisits the determinants of dyadic migration rates using IV Poisson regressions. Table 2.A5 further examines the determinants of dyadic migration aspirations using IV Poisson regressions.

Table 2.A4: Determinants of migration rates IV-PPML (full sample)

	Less educated			College Graduates		
	(L1)	(L2)	(L3)	(H1)	(H2)	(H3)
Network (% pop.)	28.7631***	25.5574***	25.4243***	12.3577***	12.3069***	10.8831***
	(2.63)	(2.75)	(2.56)	(2.49)	(2.18)	(2.57)
Geo. Dist. (log)	-0.7083***	-0.7147***	-0.7191***	-0.4938***	-0.4655***	-0.4155***
	(0.13)	(0.13)	(0.12)	(0.11)	(0.10)	(0.10)
Contiguity	-0.5810**	-0.0559		-0.5034	-0.1324	
	(0.29)	(0.26)		(0.33)	(0.31)	
Com. Lang.	1.0039***	1.2745***	1.3244***	0.8192***	0.9928***	0.9326***
	(0.22)	(0.20)	(0.18)	(0.15)	(0.17)	(0.16)
Colonial Link	0.4160*	0.3351		1.5410***	1.4900***	1.5557***
	(0.25)	(0.25)		(0.19)	(0.19)	(0.19)
Genetic Dist.	-0.1553	0.0628		0.2619*	0.3234**	
	(0.16)	(0.14)		(0.15)	(0.13)	
Population (log)	-0.2341***	-0.2692***	-0.2567***	-0.2360***	-0.2812***	-0.2323***
	(0.08)	(0.09)	(0.08)	(0.07)	(0.07)	(0.07)
Pop 15-24 (% pop.)	0.0725	-0.0086		0.0219	-0.0297	
	(0.05)	(0.05)		(0.05)	(0.04)	
Import Tariff	-0.0330*	-0.0311*	-0.0342**	0.0331*	0.0344*	0.0346**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Educ. Quality	0.0228	0.0151		0.0141	0.0166	
	(0.02)	(0.02)		(0.01)	(0.01)	
Pol. restr.	-0.2557	-0.1952		-0.0413	-0.0194	
	(0.22)	(0.20)		(0.18)	(0.17)	
GDP/cap	-0.3038***	7.7822***	7.6574***	-0.1801	3.2276**	-0.2164**
	(0.11)	(1.30)	(1.14)	(0.15)	(1.30)	(0.10)
GDP/cap Sq.		-0.4729***	-0.4606***		-0.2075***	
		(0.08)	(0.07)		(0.07)	
Constant	7.7415	-25.5742***	-23.5825***	-4.3917	-15.4041**	-7.7513
	(6.38)	(9.01)	(7.98)	(7.82)	(7.15)	(9.65)
Dest. FE	Yes	Yes	Yes	Yes	Yes	Yes
MRM	Yes	Yes	Yes	Yes	Yes	Yes
N. of obs	3359	3359	3359	3522	3522	3522

Notes: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.IV-PPML regressions (equivalent IV Poisson GMM) regressions are used on the full sample of dyads with positive total migration flows. The sample consists of 3,359 observations for low-skilled migration rates and 3,522 observations for the high-skilled migration rates. All regressions include destination fixed effects and variables to control for multilateral resistance to migration. The network variable is instrumented using its 10-year lag. Standard errors are clustered by country of origin.

Table 2.A5: Determinants of migration aspirations with IV-PPML (full sample)

	Less educated			College Graduates		
	(L1)	(L2)	(L3)	(H1)	(H2)	(H3)
Network (% pop.)	17.4628***	16.8709***	17.5941***	8.2830***	8.2215***	8.4859***
	(2.19)	(2.17)	(2.21)	(2.26)	(2.19)	(2.23)
Geo. Dist. (log)	-0.5454***	-0.5526***	-0.5695***	-0.4868***	-0.4849***	-0.4971***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Contiguity	-0.5619**	-0.4597**	-0.6133**	-0.6280**	-0.5519**	-0.7454***
	(0.23)	(0.22)	(0.24)	(0.27)	(0.26)	(0.27)
Com. Lang.	1.1278***	1.1700***	1.1268***	0.7990***	0.8345***	0.8430***
	(0.13)	(0.13)	(0.12)	(0.14)	(0.15)	(0.14)
Colonial Link	0.3087**	0.3101**	0.2896**	0.9102***	0.9044***	0.9174***
	(0.13)	(0.13)	(0.14)	(0.21)	(0.21)	(0.22)
Genetic Dist.	-0.0045	0.0306		0.0662	0.0818	
	(0.08)	(0.08)		(0.09)	(0.09)	
Population (log)	-0.0827	-0.0909*		-0.0672	-0.0746	
	(0.05)	(0.05)		(0.05)	(0.05)	
Pop 15-24 (% pop.)	-0.0112	-0.0307		0.0331	0.0206	
	(0.03)	(0.03)		(0.04)	(0.04)	
Import Tariff	0.0082	0.0091		0.0123	0.0128	
	(0.01)	(0.01)		(0.01)	(0.01)	
Educ. Quality	-0.0069	-0.0066		-0.0015	-0.0008	
	(0.01)	(0.01)		(0.01)	(0.01)	
Pol. restr.	-0.2324	-0.2256		-0.2172	-0.2085	
	(0.14)	(0.14)		(0.13)	(0.13)	
GDP/cap	-0.2209***	1.0742	-0.2306***	-0.1497**	0.6288	-0.2309***
	(0.08)	(0.75)	(0.05)	(0.07)	(0.77)	(0.06)
GDP/cap Sq.		-0.0780*			-0.0472	
		(0.04)			(0.05)	
Constant	0.5316	-4.2474	-3.2832	-0.8241	-3.6088	-2.5789
	(4.37)	(5.11)	(2.60)	(4.10)	(4.86)	(2.73)
Dest. FE	Yes	Yes	Yes	Yes	Yes	Yes
MRM	Yes	Yes	Yes	Yes	Yes	Yes
N. of obs	3359	3359	3359	3522	3522	3522

Notes: Standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, *** $p < 0.01$.IV-PPML regressions (equivalent IV Poisson GMM) regressions are used on the full sample of dyads with positive total migration flows. The sample consists of 3,359 observations for low-skilled migration rates and 3,522 observations for the high-skilled migration rates. All regressions include destination fixed effects and variables to control for multilateral resistance to migration. The network variable is instrumented using its 10-year lag. Standard errors are clustered by country of origin.

G. Sample structure and descriptive statistics

The sample structure is decribed as following:

- Our 33 OECD destinations are: Australia, Austria, Belgium, Canada, Switzerland, Chile, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, United Kingdom, Greece, Hungary, Ireland, Iceland, Israel, Italy, Japan, Luxembourg, Mexico, Netherlands, Norway, New Zealand, Poland, Portugal, Slovakia, Slovenia, Sweden, Turkey, United States.
- Our 123 countries of origin are: Angola, Albania, United Arab Emirates, Argentina, Armenia, Australia, Austria, Azerbaijan, Belgium, Benin, Burkina Faso, Bangladesh, Bulgaria, Bosnia and Herzegovina, Belarus, Bolivia, Brazil, Central African Republic, Canada, Switzerland, Chile, China, Cote d'Ivoire, Cameroon, Congo. Rep. of the, Colombia, Costa Rica, Cuba, Czech Republic, Germany, Denmark, Dominican Republic, Algeria, Ecuador, Egypt, Spain, Estonia, Finland, France, United Kingdom, Georgia, Ghana, Guinea, Greece, Guatemala, China. Hong Kong SAR, Honduras, Croatia, Hungary, Indonesia, India, Ireland, Iran, Iraq, Iceland, Israel, Italy, Jordan, Japan, Kazakhstan, Kenya, Kyrgyzstan, Cambodia, Korea, Laos, Lebanon, Libya, Sri Lanka, Lithuania, Luxembourg, Morocco, Moldova, Madagascar, Mexico, Mali, Burma (Myanmar), Mauritania, Malaysia, Nigeria, Nicaragua, Netherlands, Norway, Nepal, New Zealand, Pakistan, Panama, Peru, Philippines, Papua New Guinea, Poland, Portugal, Paraguay, Occupied Palestinian Territory, Romania, Russia, Rwanda, Saudi Arabia, Sudan, Senegal, Singapore, Slovakia, Slovenia, Sweden, Syria, Chad, Togo, Thailand, Tajikistan, Turkmenistan, Tunisia, Turkey, Tanzania, Uganda, Ukraine, Uruguay, United States, Uzbekistan, Venezuela, Vietnam, Yemen, South Africa, Zambia, Zimbabwe.
- The 37 non-OECD destination countries included in Figure 2.A1 (Appendix A) are: Albania, Argentina, Armenia, Burkina Faso, Belarus, Brazil, Cameroon, Colombia, Costa Rica, Dominican Republic, Ecuador, Egypt, Hong Kong, China, Croatia, Indonesia, Iran, Kazakhstan, Kenya, Cambodia, Lithuania, Mali, Malaysia, Nicaragua, Panama, Peru, Philippines, Paraguay, Romania, Rwanda, Sudan, Togo, Thailand, Tajikistan, Tanzania, Uruguay, South Africa, Zambia.

Table 2.A6 provides descriptive statistics on migration intensity variables and explanatory variables.

Table 2.A6: Descriptive statistics

	Full sample					Low-skilled realization rates restricted between 0 and 1					High-skilled realization rates restricted between 0 and 1				
Variable	Obs	Mean	Sd	Min	Max	Obs	Mean	Sd	Min	Max	Obs	Mean	Sd	Min	Max
Mig. Rates LS	3359	0.001	0.005	0.000	0.128	1409	0.002	0.007	0.000	0.128	/	0.002	0.009	0.000	0.128
Mig. Rates HS	3522	0.005	0.021	0.000	0.546	/	0.011	0.031	0.000	0.546	1067	0.012	0.034	0.000	0.546
Mig. Aspir LS	3359	0.006	0.021	0.000	0.394	1409	0.013	0.030	0.000	0.394	/	0.016	0.035	0.000	0.394
Mig. Aspir HS	3522	0.013	0.046	0.000	0.929	/	0.030	0.069	0.000	0.929	1067	0.038	0.076	0.001	0.929
Mig. Realiz LS	3075	0.558	0.460	0.000	1.000	1409	0.110	0.149	0.001	0.948	/	0.206	0.309	0.001	1.000
Mig. Realiz HS	3180	0.715	0.402	0.000	1.000	/	0.519	0.406	0.000	1.000	1067	0.219	0.210	0.000	0.938
Geo. Dist. (log)	4026	8.473	0.932	4.088	9.883	1409	8.368	0.983	4.088	9.866	1067	8.349	1.022	4.088	9.883
Contiguity	4026	0.026	0.159	0.000	1.000	1409	0.034	0.182	0.000	1.000	1067	0.053	0.223	0.000	1.000
Com. Lang.	4026	0.082	0.274	0.000	1.000	1409	0.143	0.351	0.000	1.000	1067	0.157	0.364	0.000	1.000
Colonial Link	4026	0.012	0.110	0.000	1.000	1409	0.029	0.168	0.000	1.000	1067	0.031	0.173	0.000	1.000
Genetic Dist.	4026	0.819	0.709	0.000	2.793	1409	0.698	0.715	0.000	2.760	1067	0.573	0.644	0.000	2.793
Network (%) 2000	4026	0.001	0.008	0.000	0.213	1409	0.003	0.011	0.000	0.148	1067	0.004	0.014	0.000	0.213
Network (%) 1990	4026	0.001	0.007	0.000	0.243	1409	0.002	0.009	0.000	0.143	1067	0.003	0.013	0.000	0.243
Population (log)	4026	16.47	1.35	12.54	20.97	1409	16.60	1.37	12.55	20.97	1067	16.63	1.44	12.55	20.97
Pop 15-24 (%)	4026	17.77	3.22	11.27	23.87	1409	17.39	3.25	11.27	23.87	1067	16.80	3.28	11.27	23.87
Import Tariff	4026	8.91	6.39	0.00	30.73	1409	8.65	6.14	0.00	30.73	1067	7.77	5.95	0.000	30.73
Educ. Quality	4026	41.44	9.41	15.19	58.36	1409	42.74	9.04	15.1875	58.37	1067	44.21	8.81	15.19	58.37
Pol. restr.	4026	-0.047	0.352	-4.000	2.000	1409	-0.073	0.324	-3.000	2.000	1067	-0.095	0.369	-4.000	1.000
GDP/cap	4026	8.600	1.213	6.402	10.91	1409	8.700	1.179	6.402	10.908	1067	8.920	1.135	6.40	10.91

Chapter 3

Forecasting future migration and the potential impact of policy intervention: insights from a micro-founded behavioral model

Abstract[1]

This study proposes a theoretical framework to forecast future migration in the dynamic context of development. It takes into consideration three factors affecting migration, including income, population size, and skill composition. In particular, I built a micro-founded model to characterize the effects of income on migration based on the theory of the mobility transition, distinguishing between the effects on migration incentives and constraints. This framework further allows to envision the potential outcomes of two types of policy intending to govern migration that are border restriction at destination and fostering development at origin. An illustrative exercise is conducted to foresee future migration flows to OECD countries in the upcoming decade. The results indicate a large increase in the future number of potential migrants from sub-Saharan Africa (SSA) to OECD countries. However, the number of effective migrants will be much more limited due to the fact that slow growth in SSA will retain the capacity of potential migrants to realize their migration plan. Border restriction will affect the world migration both in size and direction. Moreover, only substantial growth in SSA could succeed to reduce future outmigration intensity from the region.

JEL codes: F22, O15

Keywords: Migration, Development, Aspirations, Credit constraints

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3.1 Introduction

Forecasting migration could be considered to be the most difficult component of population projection. The multitude of factors influencing migration makes this task particularly complex. To date, existing official projections have been criticized to not rely on any transition theory to predict migration (Sander et al., 2017). The methodology often relies on simplified and ad hoc assumptions. For instance, the UN world population prospects only assume constant future migration flows. The Wittgenstein database uses constant migration rates of the period of 2005-2010 estimated from a bi-regional model to project migration for the entire 21st century (Lutz et al., 2014). They also do not provide prediction of bilateral migration. While at the same time, the public has increasing interest in knowing whether future development will foster or reduce migration, and whether policies intending to govern migration could be effective. Answering to these questions requires a projection methodology that accounts for the bilateral structure of migration, for economic and demographic characteristics, and for the ambiguous effect of income on migration. This paper provides such methodology that can be used to project future country-to-country migration under different socio-politico-economic scenarios.

The methodology consists of simultaneously plugging in three exogenous factors including income, demographic growth, and skill composition of the population into a partial equilibrium behavioral model of migration. In particular, in order to model the impact of income on migration behavior, the paper relies on the theory of the hump-shaped relationship between emigration and development. Until now, no study has considered this well-established theory to forecast future migration. More precisely, the micro-founded model builds upon the findings of Dao et al. (2016) which is the most recent analysis on the determinants of the migration hump. The model endogenizes two steps of migration decision. First, individuals develop the willingness to migrate based on income differentials as well as their relative positions in each society. Once decided to migrate, individuals prepare for migration by saving part of their earnings to pay for the migration costs. The migration response to income differs between skill groups.

The theoretical model developed in this paper relates to two previous studies by Lopez and Schiff (1998) and Djajic and Vinogradova (2014). The first one is a static model while the second one is dynamic. Both consider income differentials as a motive to migrate. Fixed migration cost and financial constraints explain the rise of emigration in low-income countries when economies develop. Lopez and Schiff (1998)'s model uses linear utility function and two separate equations of migration incentives and constraints. However, it does not allow the generation of a smooth inverted-U shape relationship between migration and income. It also can only explain the downward slope of the inverted U by allowing migration incentives to decrease with the squeezing wage gaps, but not due to the rising opportunity costs of migration preparation. While Djajic and Vinogradova (2014) develop a dynamic model endogenizing the age at which migration takes place and the opportunity cost of migration that depends on the amount of time of preparation for migration. Nevertheless, these models are purely theoretical and have not been confronted with empirical findings.

For the sake of simplicity, the micro-founded model of this study is chosen to be static like the one by Lopez and Schiff (1998). However, the utility function is refined to accommodate facts drawn from real data. It is augmented by using a non-linear specification, accounting for relative deprivation, and explicitly modeling the time cost of preparing for migration. The model identifies a clear first step where individuals develop a desire to migrate and a second step where they realize this intention. The paper defines "potential migrants" as those who express a desire to migrate and, among which, "effective migrants" as those who actually manage to do so.[2] For this model, migration aspirations depend on the absolute level of income and the relative position that people have in each society. The realization of migration is a function of the capacity of financing migration, which depends on income at origin country and the cost of migration. One of the noticeable contributions of this paper relies on the fact that the cost of migration is modeled to vary with income in the origin country. The common assumption of fixed migration cost in the majority of existing studies does not help to explain why with higher financial capacity the realization of migration, already conditional on the declining incentive to migrate, decrease. The choice of having migration cost dependent on income within this model is compatible with the empirical finding that migration realization rate diminishes with higher level of development found in Dao et al. (2016).

In the illustrative exercise, the model is calibrated to fit the bilateral patterns of potential and effective migration from 175 countries to 33 OECD destinations in 2010. It is then used to predict the indirect and direct migration *pressure*[3] on OECD countries between 2010 and 2020. The indirect *pressure* refers to the volume of potential migrants who desire and attempt to migrate. Among these would-be migrants, those who have the capacity to turn their migration project into reality represent the direct migration *pressure*. The calibration makes use of the Gallup database that provides the information on individuals' willingness for migration for a large majority of countries in the world. It also employs the backsolving technique developed by Docquier et al. (2015) to quantify the cost of migration, which is assumed to be the gap between potential and effective migration.

The results of simulation suggest that between 2010 and 2020 immigration volume to OECD countries will rise by 18.69%. This predicted number corresponds to the 1.7% yearly increase observed between 2010 and 2015. The combination of demographic transition, income evolution and human capital growth gives rise to numerous patterns of future migration around the world. Declining migration due to aging population and higher income will be experienced in China, Eastern Europe and Mexico. Population boom coupled with

[2] "Potential", "desiring" and "intending" can be used interchangeably. "Effective" and "actual" can be used interchangeably.

[3] This word simply refers to the high intensity of immigration.

high economic growth weighing down credit constraint will stimulate migration from South Asia. While in SSA, youth bulge and persistently large income differentials between that region and OECD destinations will enlarge the pool of potential migrants (those who would like to migrate). This represents a rising indirect migration *pressure* on OECD countries. However the slow economic growth in SSA could not lift up the problem of credit constraint therefore the volume of effective migrants (i.e. the direct *pressure*) will still be limited.

The results of this study could be compared to the most recent papers by Hatton and Williamson (2003), Hanson and McIntosh (2016), Docquier and Machado (2017) and Dao et al. (2017). All the four papers provide projections of future migration in the 21st century and come to the same conclusion of a high migration *pressure* from SSA. Hanson and McIntosh (2016) call the Mediterranean sea the "new" Rio Grande. The authors predict a fall of immigration to the US because of demographic stagnation in Mexico, while Europe would face high migration *pressure* from the neighboring SSA and Middle East and North Africa (MENA) because of their bulging population and low growth prospect. In comparison with these four papers, this study provides a short-term projection of the period 2010-2020 due to the lack of accurate prediction of income of a longer period. Even though the considered period of time is short, the conclusion of this paper is somewhat in line with those studies. By the end of this decade, migration volumes from Mexico and Latin America and the Caribbean (LAC) to the US are still high however the sign of sluggishness is apparent. Migration *pressure* from SSA and MENA will be on the rise at very high speed. In addition, one extra element developed in this study will help to refine this conclusion in the existing literature. The four aforementioned papers only consider the wage gap as the main driver of migration and consequently reach the conclusion that migration *pressure* from SSA will be the most intensive. This paper however also brings into play the capacity to realize migration. Due to the fact that population growth will not go hand in hand with economic growth in SSA, the volume of its people who would like to emigrate will increase but at the same time these individuals will continue to face high financial constraint to realize their migration intention. Therefore, the *direct* migration *pressure* (i.e. the volume of effective migrants) will be lower than the *indirect* migration *pressure* (i.e. the volume of potential migrants) from SSA at least in the short and medium terms when its economy does not show any sign of taking off.[4]

After determining where migration *pressure* will arise and the destinations on which the *pressure* will exert under the "business-as-usual" scenario, this paper also projects migration under another plausible scenario of rising protectionism and stricter border control. It is inspired by the most recent political events. The first one is Brexit where Britain voted to leave the European Union. The second one is the victory of Donald Trump in the 2017 US presidential election. Both events could have consequences on migration. Based on these events, we

[4]It could possibly mean that the intensity of irregular migration from Africa will be more pronounced.

expect that migration to the United Kingdom (UK) and the United States (US) will be more restricted in the next coming years. With the technique used in this paper, it is possible to estimate how the world migration will be hypothetically affected by a border closing in these two major destinations. This scenario is called the "Brexit-Trumpism" scenario. The results indicate that border restrictions have various implications on the world migration. The world volume of migrants would be more than halved and Mexican migrants would be mostly affected. Migration would intensify in other OECD countries, especially in Canada.

Additionally, the microfounded model of this paper can serve as a tool to simulate the effect of development policies on migration flows. The attempt to manage migration flows has always been a major concern of governments. Examples of policies aiming at reducing migration can be easily found in many international cooperation agendas, from the biggest trade deal such as NAFTA[5] to the world's largest workfare program India's National Rural Employment Guarantee Act intending to reduce rural-urban migration (Imbert and Papp, 2016). Very recently the European Union has initiated a New Migration Partnership framework that tailors compacts of development aid, trade and other economic areas to lower-income peripheral countries.[6] The purpose of these "EU compacts" is to help bordering low- and middle-income countries develop in order to address the root causes of irregular migration. The measures are stimulating employment, bringing in private investors and innovative financing mechanisms. The budget is estimated up to 62 billion Euros. The question raised in this study would be whether these developmental measures will be effective in limiting migration. Using the model developed, this paper estimates the levels of economic growth in SSA and MENA countries that are required to suppress emigration flows from these regions to the EU15.[7] The result of this simulation exercise suggests that developmental measures intending to limit migration could fail to prove their effectiveness. Because of the current low development levels in the targeted countries, rising income in the medium run would only free up potential migrants from financial constraint and further intensify out-migration.

The paper is organized as follows. Section two presents the literature on the developmental determinants of migration and the assumptions to build the behavioral model of migration in section three. Section four describes the calibration strategies. From the benchmark scenario, results on future potential and effective migration will be commented in section five. It later presents the predictions on the consequences of the "Brexit-Trumpism" scenario and estimation of the development levels in developing countries that are required to reduce migration intensity. Finally section six concludes the study.

[5]At the wake of which the former Mexican President Carlos Salinas de Gortari made a clear statement: "Mexico wants to export goods, not people."

[6]The countries are Jordan, Lebanon, Nigeria, Niger, Mali, Senegal, Morocco, Tunisia, Libya and Ethiopia.

[7]The EU15 comprised the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

3.2 Development and migration: Review and empirical facts

In order to predict future migration, one must address two questions: (i) why do people migrate? and (ii) under which conditions? The first question refers to the causes that drive individuals to migrate. The second question refers to the constraints that retain people from moving and the favorable conditions that allow migration to take place. These are the two basic elements contained in the majority of migration models. This section will first review the literature on the developmental determinants of migration and presents the empirical facts that will be used to develop the micro-founded model in the next section.

Studies on the causes of labor mobility constitutes the building block of research on migration (e.g. Lewis, 1954; Ranis and Fei, 1961; Sjaastad, 1962; Lee, 1966; Todaro, 1969; Harris and Todaro, 1970; Stark and Bloom, 1985). According to the neoclassical theory, migration is driven by income differentials between places. Migration therefore linearly decreases with lower income gap. This gives rise to a common belief among policy makers that combating poverty in less-developed countries would reduce migration *pressure*. Real data however reveal a paradox that emigration intensity in poor countries is rather low and the relationship between migration and income is hump-shaped. Thus, income differentials may well determine the desire or intention to migrate, but migration is also affected by a set of conditioning factors that may constrain or facilitate migration. These factors are mostly attributed to the existence of migration cost (Carrington et al., 1996) and liquidity constraints especially among the very poor (Dustmann and Okatenko, 2014; Hatton and Williamson, 2003; Massey et al., 1993; Phan and Coxhead, 2010), which are barriers to migration. The interplay between migration incentives and constraints helps to explain the rise and fall of the migration hump characterizing the relationship between development and emigration (Zelinsky, 1971). Emigration first rises with development because greater income relaxes financial constraints limiting migration. When the economy reaches a certain level of development, the willingness to migrate falls because the opportunity cost of migrating increases. Besides these two factors characterizing the response of migration to income, the literature also identifies other macroeconomic drivers of the migration hump, which are demographic transition, economic structural change, accumulation of migrant network, education, policy and geography. A complete literature review can be found in Clemens et al. (2014).

This current paper is built on the new empirical findings found in Dao et al. (2016) on the mechanisms that govern the effects of income on migration willingness and realization.[8] It also uses the same conceptual framework by

[8] The authors collect the information on individuals' willingness to migrate from the Gallup World Poll survey available for the majority of countries in the world. Until now, a number of studies rely on this dataset to investigate the patterns and determinants of migration intentions. Specifically, Docquier et al. (2014) study the determinants of potential and actual migration; Manchin et al. (2014) analyze the effect of life satisfaction on the desire to migrate; Dustmann and Okatenko (2014) provide evidence of the relationship between the

considering two migration variables that are potential migration and effective migration. Potential migrants are the ones who desire to migrate and prepare to do so. However, not all potential migrants can succeed. Those who can actually migrate are called effective migrants. The basic theoretical framework and empirical facts are presented in the following paragraphs. They will subsequently be used throughout the rest of the paper.

Bilateral effective or actual migration stock is denoted by n_{ijs} from country of origin $(i = 1, ..., I)$ to destination country $(j = 1, ..., J)$. We distinguish between two types of migrants by their skill groups s, one with college education (denoted by h, which stands for the high skill), and the other with less education (denoted by l, which stands for the low skill). The aggregated numbers of emigrants from each country of origin i to all destinations is the aggregated $\overline{M}_{is} = \sum_j n_{ijs}$. To compute actual migration *intensities* we divide the number of actual migration by the origin resident population N_{is}. Actual migration intensities can be measured as $m_{ijs} \equiv n_{ijs}/N_{is}$ at the bilateral level, and as $\overline{m}_{is} \equiv \overline{M}_{is}/N_{is}$ on the aggregate.

The number of bilateral potential migrants is denoted by N_{ijs}. The total potential emigrants of each origin country is therefore $\overline{N}_{is} = \sum_j N_{ijs}$. Additionally, the intensity of potential migration can be measured as $p_{ijs} \equiv N_{ijs}/N_{is}$ at the bilateral level and as $\overline{p}_{is} \equiv \overline{N}_{is}/N_{is}$ on the aggregate. Potential migrants can unsuccessfully realize their migration intention, therefore bilateral and aggregate realization rates are defined as the share of effective migration over potential migration $r_{ijs} \equiv m_{ijs}/p_{ijs}$ and $\overline{r}_{is} \equiv \overline{m}_{is}/\overline{p}_{is}$.

Dao et al. (2016) use a decomposition equation of actual emigration rates to investigate whether the effect of economic development on emigration is driven by the skill composition, migration aspirations or realization. The decomposition equation of average emigration rate of each sending country writes as follows:

$$\overline{m}_i \equiv \delta_{ih}\overline{m}_{ih} + \delta_{il}\overline{m}_{il}, \tag{3.1}$$

with δ_{ih} the proportion of college educated and (δ_{il}) the proportion of low-skilled in the population. By definition, $\delta_{il} + \delta_{ih} = 1$. According to the formula, the average emigration rate is the sum of the emigration rates of the two skill groups weighted by the share of each skill groups in the population. It can then be decomposed as:

$$\overline{m}_i = \delta_{ih}\overline{p}_{ih}\overline{r}_{ih} + \delta_{il}\overline{p}_{il}\overline{r}_{il}. \tag{3.2}$$

The actual migration rate of each skill group is equal to the product of the potential migration rate and realization rate. In other words, the probability of a person being a migrant is equal to the probability of this person belonging to the pool of potential migrants multiplied by the probability that he can realize his migration plan.

intention to move and satisfaction with amenities; Docquier et al. (2015) and Delogu et al. (2014) use the proportion of individuals who intend to move to analyze the efficiency gains of a removal of the legal restrictions to migration.

Using cross-sectional data on effective and potential migration flows between 2000 and 2010 from 123 countries to 33 OECD destinations, Dao et al. (2016) find that the observed average effective emigration intensity follows a inverted-U relationship with development. They subsequently quantify relative contributions of all potential drivers that could affect migration willingness and realization for the two skill groups. The explanatory variables represent all the channels that are hypothesized to shape the migration transition curve, namely, the gravity drivers (proxied by geographic, genetic, and linguistic distances), migrant networks, macroeconomic drivers (share of young population, economic openness, and education quality), income inequality, change in restrictiveness of migration policies, skill-specific wages and destination fixed effects. Once controlled for all other non-behavioral drivers, the coefficients of the skill-specific wages, linear and quadratic, give the upper bounds of individual's behavioral responses to income.[9] They will later be used to calibrate the model developed in this paper.

Dao et al. (2016)'s results suggest that potential migration is negatively affected by geographical distance. Skill-specific income linearly decreases the willingness to migrate among the less-educated. While the aspirations of college-graduates do not seem to be affected by absolute income but instead by relative status. As for the results of migration realization, both linear and quadratic terms of income have significant impacts among the less-educated. The linear terms is positive while the quadratic one is negative. This suggests that during early stages of development, economic progress increases the capacity of the less-educated to financially meet the cost of international movement. The effect of income on migration realization of the highly-skilled is significantly negative. This can be explained by the fact that the highly-skilled face more increasing opportunity cost of migration when income rises.

These results provide important bases to build the microfounded model to predict future migration in development process. To summarize, the behavioral model of migration is designed to match 4 findings in Dao et al. (2016):

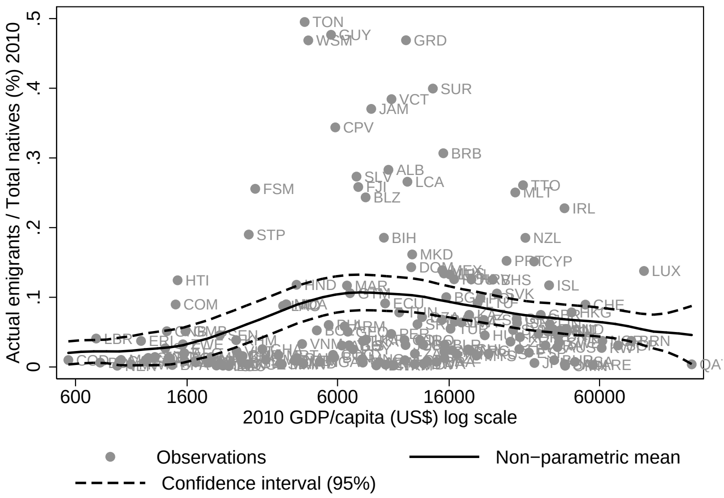
- F1: The migration aspirations of the college graduates do not vary with development.
- F2: The migration aspirations of the less-educated decrease with development.
- F3: The realization rates of the college graduates decrease with development.
- F4: The realization rates of the less-educated follow an inverted-U relationship with development.

From the data used in this paper, Figure 3.1 illustrates the non-parametric

[9]These coefficients should be considered as upper bounds because the endogeneity bias could not be properly removed from the estimations.

trend of the current emigration rates we observe in 2010 over the full range of income level proxied by GDP/worker. The relationship between emigration and development follows an inverted-U curve. The same pattern is found in Dao et al. (2016).

Figure 3.1: Nonparametric regressions of aggregate emigration rates on GDP per worker



Notes: Non-parametric regression using Epanechnikov kernel, local-mean smoothing, bandwidth 0.5.

3.3 Micro-foundations of aspirations and realization rates

To predict the impact of future development on migration prospects, a partial equilibrium behavioral model is developed based on the findings presented in the previous section. The model highlights major economic mechanisms underlying migration aspirations and realization. The willingness to migrate of an individual depends on the wage differentials between countries, his relative position in each society, and a random component that captures the heterogeneity of individuals' preferences. The realization of migration is determined by the cost of migration netted from the help of social network and other favorable conditions;[10] and the capacity of an individual to afford this cost of migration. The migration cost is estimated as the gap between the number of people who want to migrate and those who can actually do so.

[10]The favorable conditions facilitating migration are for example the skill attraction policies in destination countries such as the EU Blue Card, the point-based systems in Canada, Australia and New Zealand.

3.3.1 General structure of the model

Each country is characterized by a representative individual of type-s who lives two periods of unequal length. This two-period structure is developed in order to identify two clear steps in the migration process. They are assumed to correspond to the distinction between migration aspirations and realization in the data. Existing studies using Gallup (Docquier et al., 2015, 2017) show that aspirations are likely to reflect after-migration net utility gains when living in destination country. These gains and costs are reflected in the utility of the second period. The first period corresponds to the one in which moving costs are incurred without inducing benefits. During the first period of life, the individual lives in his country of birth i, decides to migrate or not to country j and prepares for the move if he wishes to leave. Migration happens at the end of the first period. In the second period or in the mature stage of life, individual lives in the destination country if he manages to realize his migration plan. Those who stay in origin country in the second period are the sum of the number of people who initially did not want to migrate and the potential migrants who did not succeed in migrating. The unsuccessful migrants are individuals whose ex-ante realization costs exceed the ex-post net benefits. The instantaneous random utility function of our representative individual born in country i writes as:

$$U_{ijs} = \rho u^1_{ijs} + u^2_{ijs} + \varepsilon^2_{ijs}, \tag{3.3}$$

where u^1_{ijs} is the utility in the early stage of the working life when the individual prepares to migrate, weighed by a preference parameter ρ, which captures impatience and the relative length of the first period. u^2_{ijs} is the utility in the mature stage of life and ε^2_{ijs} is the random component of utility. The latter varies among individuals, capturing the heterogeneity of preferences. If the individual decides not to migrate, his utility in his first period is u^1_{iis} and in the second period is u^2_{iis}. The utilities of a potential migration are u^1_{ijs} in the early stage and u^2_{ijs} in the mature stage of life.

The probability that a type-s individual born in country i will develop a willingness to migrate to country j is given by:

$$\frac{N_{ijs}}{N_{is}} = Pr\left[u^2_{ijs} + \varepsilon^2_{ijs} = \underset{k}{max} u^2_{iks} + \varepsilon^2_{iks}\right], \tag{3.4}$$

where N_{is} is the native population of type s of country i and N_{ijs} is the number of potential migrants from country i to country j. N_{iis} denotes the potential number of non-migrants or natives staying in i. The formula states that the probability that an individual is willing to move from his origin country i to destination j is the probability that he perceives that country j would offer him the highest utility among all possible destinations k including his own country i. We use the McFadden theorem (McFadden, 1984) to analytically solve this problem. According to the theorem where the random term ε_{ijs} is assumed to follow an i.i.d. extreme-value distribution of type I of mean 0 and standard deviation 1, the probability that a type-s individual born in country i will develop a desire to move to country j is given by the following logit expression:

$$Pr\left[u_{ijs}^2 + \varepsilon_{ijs}^2 = \underset{k}{max} u_{iks}^2 + \varepsilon_{iks}^2\right] = \frac{exp\left[u_{ijs}^2\right]}{\sum_k exp\left[u_{iks}^2\right]}$$

.

We then derive the log ratio of desiring emigrants from country i to country j to total desiring stayers expressed by the following linear expression:

$$ln\left[\frac{N_{ijs}}{N_{iis}}\right] = u_{ijs}^2 - u_{iis}^2 \equiv B_{ijs}. \tag{3.5}$$

In this expression, we define B_{ijs} as the net utility differential in the second period of life that drives the individual's willingness to migrate.

In the same manner, the probability that a type-s individual born in country i will move to country j is given by:

$$\frac{n_{ijs}}{N_{is}} = Pr\left[U_{ijs} = \underset{k}{max} U_{iks}\right], \tag{3.6}$$

where N_{is} is the native population of type s originates from country i and n_{ijs} is the number of migrants from country i to country j. n_{iis} denotes the number of non-migrants or natives staying in i. As previously mentioned, the random term ε_{ijs} is assumed to follow a Type I Extreme Value Distribution. The probability that a type-s individual born in country i will move to country j is given by the following logit expression:

$$Pr\left[U_{ijs} = \underset{k}{max} U_{iks}\right] = \frac{exp\left[\rho u_{ijs}^1 + u_{ijs}^2\right]}{\sum_k exp\left[\rho u_{iks}^1 + u_{iks}^2\right]}$$

.

We can thus equate the log-ratio of the number of actual emigrants n_{ijs} and actual stayers n_{iis} to the net utility gain from realizing migration b_{ijs}:

$$ln\left[\frac{n_{ijs}}{n_{iis}}\right] = \left[\rho u_{ijs}^1 + u_{ijs}^2\right] - \left[\rho u_{iis}^1 + u_{iis}^2\right] \equiv b_{ijs}. \tag{3.7}$$

As illustrated, the individual's actual migration decision is governed by the difference in lifetime utilities of moving and not moving.

The proportion of actual migrants among the total potential migrants defines our concept of realization rate, which is:

$$R_{ijs} = \frac{n_{ijs}}{N_{ijs}}. \tag{3.8}$$

A less-than-unity bilateral realization rate could be explained by two potential reasons: either people change to other foreign destinations or they remain at origin.

The total number of natives of each country is:

$$N_{is} = \sum_j n_{ijs} = n_{iis} + \sum_{j \neq i} n_{ijs} = \sum_j N_{ijs} = N_{iis} + \sum_{j \neq i} N_{ijs}.$$

In order to generate the observed U-shape patterns, u^1_{ijs} and u^2_{ijs} must belong to a family of utility function that is increasing in its first order $(u'(.) > 0)$ and decreasing in its second order $(u''(.) < 0)$ of its argument. The utility of our representative individual can take the form of a simple log-utility function.

3.3.2 Aspirations for migration

In line with the interpretation of Dao et al. (2016), I introduce relative utility concept and the log-specification for u^2_{ijs}. The mature-stage utility levels are dependent on the absolute income gain and the relative position gain of an individual in a society:

$$\begin{cases} u^2_{ijs} & = lny_{js} - \alpha lny_{jm} - ln(1 + d_{ijs}), i \neq j \\ u^2_{iis} & = lny_{is} - \alpha lny_{im} \\ d_{iis} = 0 \end{cases}$$

If the individual chooses to migrate, he also takes into account in his utility d_{ijs}, which is the disutility of living abroad. The latter could be emotional cost, assimilation cost that potential migrants expect to face once being at destination. The parameter α represents the intensity of utility or disutility related to the individual's relative position in the society. We assume that the individual compares his living standard to the average one in the society he lives in. This assumption is common in the macroeconomic literature on social comparison (Clemens, 2004, 2006; Fershtman et al., 1996; Boskin and Sheshinski, 1978). Relative status is assumed to only affect utility in the second stage of life when the individual reach a certain level of maturity. They are also assumed to be fully aware of the income distribution in their own countries as well as in destination countries.

In the Gallup World Poll, individuals were asked whether *ideally* they want to migrate. We can thus assume that when answered to this question individuals disregard the preparation burden of migration and only consider the net benefits of emigrating after crossing the border. I.e. in the mature stage of their working life, emigrating induces an average net utility gain that is:

$$B_{ijs} \equiv u^2_{ijs} - u^2_{iis} = [lny_{js} - lny_{is}] - \alpha\,[lny_{jm} - lny_{im}] - ln(1 + d_{ijs}). \quad (3.9)$$

The first term $[lny_{js} - lny_{is}]$ reflects the absolute gain in income after migrating to higher-income country. It corresponds to the well-known income differential that effects negatively migration in neoclassical models. This subfunction increases with the average income at destination y_{js}, and decreases with that at origin y_{is}. While the second component $\alpha\,[lny_{jm} - lny_{im}]$ shows the individual' relative utility loss from living in richer surroundings. This status function increases with income of reference group at destination y_{jm}, and decreases with that at origin y_{im}. This specification is common in the existing literature on social comparisons (Clark and Oswald, 1998). In all countries in our sample, the average-income individual belongs to the low-skill group,[11] thus $y_{im} = y_{il}$ and $y_{jm} = y_{jl}$ later in the numerical exercise. The parameter α will be chosen such that the model will be compatible with the findings F1 and F2, according to which absolute income only negatively affects the willingness to migrate of the low-skilled and relative income matters more for the migration decision of the highly-skilled. We define the country-specific skill premium σ_i which is the ratio of high- over low-skill wages $\sigma_i = \frac{y_{jh}}{y_{jl}}$. Proposition 1 in the Appendix describes how aspirations for migration will change with the average incomes per worker at origin and/or destination.

3.3.3 Realization of migration

Once decided to migrate, the would-be migrant will prepare for the move. He takes into account the bilateral pecuniary cost of moving c_{ijs}, which is totally incurred in the early stage of the working life. Individual cannot borrow to finance the cost. In order to successfully realize migration, he needs to save up to the amount of this migration cost c_{ijs}, which is assumed to be discovered only when the individual starts preparing for migration, and not to influence his willingness to migrate. The early-stage utility levels in log-specification are given by:

$$\begin{cases} u^1_{ijs} & = ln(y_{is} - c_{ijs}), i \neq j \\ u^1_{iis} & = lny_{is} \\ c_{iis} = 0 \end{cases}$$

Following Equation 3.7, the net lifetime utility can be re-written as:

$$b_{ijs} = B_{ijs} + \rho G_{ijs}, \quad (3.10)$$

where $G_{ijs} = ln(y_{is} - c_{ijs}) - lny_{is}$. Since G_{ijs} is always equal to zero or negative, the net utility gained when realizing migration b_{ijs} is lower than or equal to the utility that potential migrants expected B_{ijs}.

[11] In fact, the low-skill group accounts for more than 90% of the population in developing and less-developed countries (see for example Figure 3.2.a in Dao et al. (2016)).

A common practice in migration studies to estimate the migration cost c_{ijs} is to use variables that affect migration negatively such as geographical distance, cultural distance, mobility restrictions, or positively such as migrant network, etc. It is worth noting that these migration costs have, in most of the case, been estimated as fixed. This induces that migration will always increase with higher income. Therefore, a fixed cost of moving does not allow us to replicate the findings F3 and F4 according to which the realization of migration decreases with higher level of development.

To clearly illustrate this point, the following paragraphs develop the argument in mathematical terms. Starting with the college graduates, the two empirical facts are that their realization rate decreases with income or, in other words, the net utility gain from realizing migration declines with income $\frac{\partial b_{ijh}}{\partial lny_{ih}} < 0$ (F3), while income does not have significant impact of their aspirattions for migration $\frac{\partial B_{ijh}}{\partial lny_{ih}} = 0$ (F1). Since $b_{ijh} = B_{ijh} + \rho G_{ijh}$ where $G_{ijh} = ln(y_{ih} - c_{ijh}) - lny_{ih}$, taking derivative of both sides of b_{ijh}, we should obtain that $\frac{\partial G_{ijh}}{\partial y_{ih}} < 0$:

$$\underbrace{\frac{\partial b_{ijh}}{\partial y_{ih}}}_{<0} = \underbrace{\frac{\partial B_{ijh}}{\partial y_{ih}}}_{=0} + \underbrace{\rho}_{>0} \underbrace{\frac{\partial G_{ijh}}{\partial y_{ih}}}_{\Rightarrow <0}.$$

However, if c_{ijh} is fixed, the derivative of G_{ijh} with respect to y_{ih} should be positive rather than negative:

$$\frac{\partial G_{ijh}}{\partial y_{ih}} = \frac{+c_{ijh}}{y_{ih}\left(y_{ih} - c_{ijh}\right)} \geq 0.$$

Therefore the migration cost should vary with income and the elasticity should be higher than unity:

$$\frac{\partial G_{ijh}}{\partial y_{ih}} = \frac{1 - \frac{\partial c_{ijh}}{\partial y_{ih}}}{y_{ih} - c_{ijh}} - \frac{1}{y_{ih}} < 0 \Leftrightarrow \frac{\partial lnc_{ijh}}{\partial lny_{ih}} > 1.$$

For the less educated, income decreases significantly their aspirations to migrate $\frac{\partial B_{ijl}}{\partial y_{il}} < 0$ (F2), while their realization rate first increases then decreases with income (F4) $\frac{\partial b_{ijl}}{\partial lny_{il}} > 0$ and $\frac{\partial^2 b_{ijl}}{\partial (lny_{il})^2} < 0$. The critical point z can always be determined as:

$$\frac{\partial b_{ijl}}{\partial y_{il}} = \frac{\partial B_{ijl}}{\partial y_{il}} + \rho \frac{\partial G_{ijl}}{\partial y_{il}} = \frac{-\left(1-\alpha\right)}{y_{il}} + \rho \left[\frac{1 - \frac{\partial c_{ijl}}{\partial y_{il}}}{y_{il} - c_{ijl}} - \frac{1}{y_{il}}\right] = 0$$

$$\frac{\partial lnc_{ijl}}{\partial lny_{il}} = 1 + \frac{\left(\alpha - 1\right)\left(y_{il} - c_{ijl}\right)}{\rho c_{ijl}}$$

As the result of these facts, I adopt the choice of modeling that makes c_{ijs} explicitly dependent on y_{is}. With this strategy, we can obtain the pattern that when c_{ijs} increases at lower rate than y_{is} migration will rise and when c_{ijs} increases at faster rate, migration will decline. More specifically to be compatible with F3 and F4, the migration cost will take the following form:

$$c_{ijs} = k_{ijs}y_{is} + v_{ijs}, \tag{3.11}$$

in which k_{ijs} represents the time cost. And $k_{ijs}y_{is}$ represents the forgone consumption or the opportunity cost that potential migrant needs to sacrifice in order to prepare to migrate. The residual v_{ijs} could be interpreted as a fixed cost or benefit of migration that would-be migrants do not spend time to prepare for.[12] If the individual stays in his country of origin i he faces no migration cost $c_{ijs} = 0$. Note that because of the use of log-utility function, the migration cost cannot be equal to or exceeds the level of home income, i.e. c_{ijs} must satisfy that $c_{ijs} < y_{is}$.

In Docquier et al. (2015), the gap between desired and actual migration rates is the cost of migration and it is totally attributed to the cost induced by visa restrictions. Based on this model setting I can identify the functional form of the migration gap g_{ijs} as follows:

$$g_{ijs} = B_{ijs} - b_{ijs} = \rho\left(lny_{is} - ln(y_{is} - c_{ijs})\right). \tag{3.12}$$

This migration gap is the difference between the potential migration rate and the actual migration rate. If the migration gap is equal to zero, all individuals who desire to migrate can effectively realize it. It has positive correlation with the pecuniary migration cost c_{ijs}. Its derivative with respect to income of group s in country i is $\frac{dg_{ijs}}{dy_{is}} = \rho\left[\frac{-v_{ijs}}{y_{is}(y_{is}-c_{ijs})}\right]$. It thus decreases with income at origin if $v_{ijs} > 0$ and increases if $v_{ijs} < 0$. Since $b_{ijs} = B_{ijs} - g_{ijs}$, we can differentiate 6 scenarios for the future migration realization where B_{ijs} and g_{ijs} evolve differently with changes in incomes at origin and destination. Proposition 2 in the Appendix details how migration will respond to convergence or divergence of development between countries. On the one hand, increasing income relaxes the budget constraint and allows migration to take place. On the other hand, spending time preparing migration when income increases also means foregoing better opportunities in the current location, migration willingness will therefore decrease.

3.3.4 Data and parameter identifications

To illustrate the functionality of the developed model, in this subsection I first calibrate it using data of the year 2010 available for 175 countries. The following paragraphs explain how I identify the common, country-specific and bilateral parameters of the model.

[12] c_{ijs} embeds migration costs related to policy, for example migration quotas, which are equivalents to monetary and non-monetary costs in the utility function (similar to tariff equivalent of non-tariff barriers in trade (Facchini and Willmann, 2005)).

Actual migration is measured by taking the data on effective migration stocks in 2010 from OECD-DIOC database (OECD, 2014).[13] The DIOC database provides bilateral migration stocks n_{ij}^s by education level s from all countries of origin i to 33 OECD destination countries j. I only consider working-age population with age from 25 and above. The data are sorted into two skill groups, college-educated (h) and less-educated (l). These data have been recorded before the start of the refugee crisis in 2015, therefore mostly capture economic migrants who are the subject of this study. To compute actual migration intensities in 2010, I divide the migration stocks by the origin resident population aged 25 and above N_i^s in 2010. Data on N_i^s is taken from Artuç et al. (2015). The log-ratio of migrants to stayers is then computed as $ln\left[\frac{n_{ijs}}{n_{iis}}\right]$.

For the information on potential migration, I first consider the same variable used in Docquier et al. (2014) that is collected from the *Gallup World Poll* surveys. Available in 142 countries representing 97 percent of the world population, the question that identifies the proportion of non-migrants expressing a desire to emigrate is (i) *Ideally, if you had the opportunity, would you like to move to another country, or would you prefer to continue living in this country?*.[14] The bilateral migration intention is captured by the next following question (ii) *To which country would you like to move?*. In line with actual migration and population data, I only consider respondents aged 25 and above and distinguish between individuals with college education or and less educated. Since observations are not available for all 175 countries in 2010, the variable is aggregated over four waves of poll, i.e. from 2007 to 2010, and considered as one unified observation in 2010. Next, adding this stock of desiring migrants from the Gallup World Poll to actual migrants, I obtain an approximation of the number of potential migrants N_{ijs}. This number represents the migration stocks that would have been observed in 2010 if all desiring migrants had been able to emigrate. Once having the number of potential migrants of each country-pair, I obtain the log-ratio of potential migrants to potential stayers $ln\left[\frac{N_{ijs}}{N_{iis}}\right]$. Albeit many critics about the small sample sizes[15] and the reliability in capturing migration willingness, the Gallup dataset is a unique source of information that allows comprehensive cross-country comparison. Empirical

[13]In fact, the findings from Dao et al. (2016) are drawn from empirical analyses that use net migration flows. While here I use these findings to predict variation in migration stocks. Supposing that the relationship between net migration flows and development is stable over time, the same relationship should be reflected in the migration stocks, which by definition are the accumulated flows. In addition, migration processes are heterogeneous in terms of duration of stay, entry track, etc. The OECD-DIOC database however does not contain such details of migration. These migration stock data are assumed to reflect the aggregate long-run migration equilibrium.

[14]This question does not exactly capture the number of people who actually take an action to realize migration. The *Gallup World Poll* also asks two other relevant questions about the preparation for migration that are (i) *Are you planning to move permanently to another country in the next 12 months, or not?* and (ii) *Have you done any preparation for this move? For example, have you applied for residency or a visa, purchased the ticket, etc.?*. These questions however contain very few observations that do not allow to conduct robust analyses.

[15]The sample size is about 1000 individuals in each surveyed country.

studies also prove that it offers relevant information about migration aspirations as it permits to obtain intuitive results. Its migration intention variable is found to be significantly affected by individuals' wealth level and contentment with local amenities (Dustmann and Okatenko, 2014), by social networks (Manchin et al., 2014); and there is a high correlation between migration aspirations at year t and actual migration flows at year t+1 (Bertoli and Ruyssen, 2017).

In order to identify the relative length of the first period ρ, I use the statistics on the age of first-time immigrants in major receiving countries.[16] The median age of new immigrants to the EU-28 in 2013 was 28 years (Eurostat, 2015). In Canada, the median age of newcomers in 2011 was 31.7 years (Chui et al., 2014). Age increases the likelihood of an individual migrating to the US until age 32.5, after which point age decreases the likelihood (Quinn, 2006). Based on these facts, I set the age at which individuals migrate abroad is 30 years old. From the beginning of adulthood at age 18 to the retirement age of 65, successful migrant lives 12 years in his country of origin, and 35 years in country of destination. The discount factor of a quarter is set to 0.99. Thus the relative weight of the first period is $\rho = \sum_{t=1}^{12} 0.99^{4t} / \sum_{t=13}^{65} 0.99^{4t}$ equal to 0.8.

Based on the fact found in Dao et al. (2016) according to which the effect of income on aspirations is not significant for the highly-skilled, the parameter of relative income α is calibrated such that the derivative of B_{ijh} with respect to income is equal to zero. In developing countries, the average income is close to the one of the less-educated group, y_{jm} is therefore proxied by y_{jl}. Replacing y_{jl} in Equation 3.9 by $\frac{y_{ih}}{\sigma_i}$ and taking the derivative of B_{ijh} with respect to income, we obtain a relationship between α and the elasticity of skill premium relative to high-skill wages $\frac{\alpha-1}{\alpha} = \frac{dln\sigma}{dlny_h}$. The latter is estimated to be equal to -0.22. α is thus equal to 0.82. This value of α is close to the estimated coefficient attached to average income variable in the utility function in the existing empirical literature. The common regression is typically $H = \beta_Y Y + \beta_{\overline{Y}} \overline{Y} + controls$ where H is happiness or life satisfaction, Y is absolute income/consumption and $\overline{Y}$ is the average income/consumption of the reference group. For the US, using the 1987-88 and the 1992-94 waves of the National Survey of Families and Households Luttmer (2005) found $\beta_{\overline{Y}}$ equal to -0.24; while Layard et al. (2009) using the General Social Survey of the period 1972-2006 found $\beta_{\overline{Y}}$ equal to -0.69, and a $\beta_{\overline{Y}}$ of -1.552 if H is financial satisfaction. They also found that in West Germany the elasticity of life satisfaction on average income is equal to -0.648 based on the longitudinal German Socio-Economic Panel beginning in 1984.

Next, I compute the emotional cost d_{ijs} as a residual of (9). This variable is specific to each corridor. Estimations reveal that it is strongly correlated with bilateral distance.

[16] Many requests have been sent to main statistical offices such as Eurostat, Statistics Canada in order to obtain skill-specific ages of new immigrants. Unfortunately, none of these agencies are able to provide such data.

The two parameters k_{ijs} and v_{ijs} are calibrated in order to match two moments: first, the real level of aspirations rates and actual migration rates in Equation 3.10 and second, the change in realization rate with respect to income. From Equations 3.5, 3.7, 3.8, 3.9, 3.10, 3.11 the function of the realization rate is derived as:

$$R_{ijs} = \frac{n_{iis}}{N_{iis}} \left(1 - k_{ijs} - \frac{v_{ijs}}{y_{is}}\right)^{\rho}. \tag{3.13}$$

The time cost k_{ijs} and residual v_{ijs} are the roots of the following system of two equations of each country pair:

$$\begin{cases} \hat{b}_{ijs} = \hat{B}_{ijs} + \rho \left[ln(\hat{y}_{is}(1 - k_{ijs}) - v_{ijs}) - ln\hat{y}_{is} \right] & (1) \\ \frac{d\hat{R}_{ijs}}{dy_{is}} = \frac{\hat{n}_{iis}}{\hat{N}_{iis}} \rho \left(1 - k_{ijs} - \frac{v_{ijs}}{\hat{y}_{is}}\right)^{\rho-1} \left(\frac{v_{ijs}}{\hat{y}^2_{is}}\right) & (2) \end{cases}$$

The roots of the system are:

$$\begin{cases} \hat{k}_{ijs} = 1 - exp\left(\hat{G}_{ijs}\right) - \frac{\frac{d\hat{R}_{ijs}}{dlny_{is}} \frac{\hat{N}_{iis}}{\hat{n}_{iis}}}{\rho\left(exp\left(\hat{G}_{ijs}\right)\right)^{\rho-1}} \\ \hat{v}_{ijs} = \hat{y}_{is}\left(1 - k_{ijs}\right) - \hat{y}_{is} exp\left(\hat{G}_{ijs}\right) \end{cases}$$

with $\hat{G}_{ijs} = \frac{\hat{b}_{ijs} - \hat{B}_{ijs}}{\rho}$.[17]

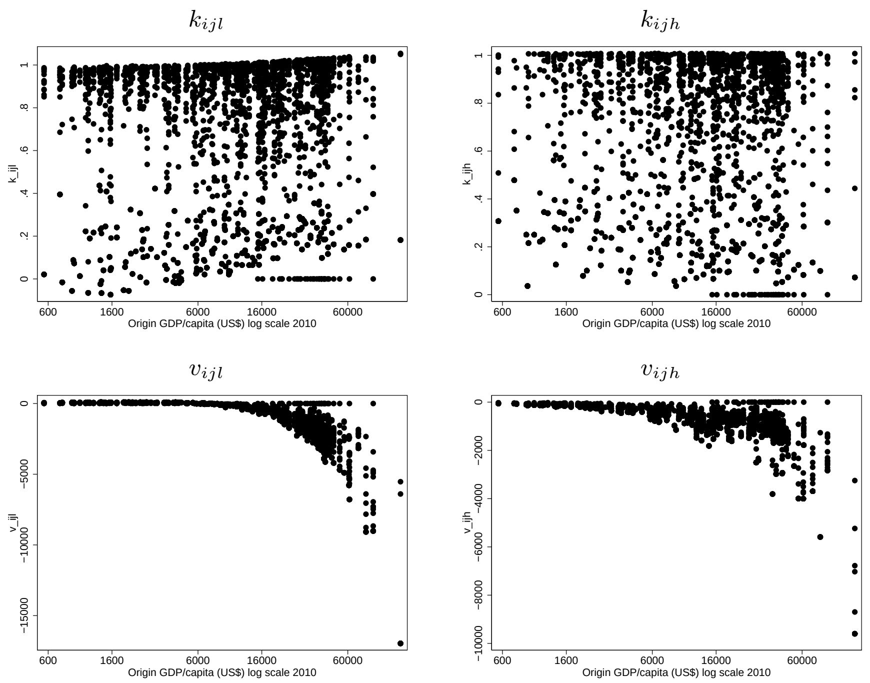
The semi-elasticities of realization rate to income are obtained from Dao et al. (2016). For the highly-skilled $\frac{d\hat{R}_{ijh}}{dlny_{ih}} = -0.0292$ and for the less-educated $\frac{d\hat{R}_{ijl}}{dlny_{il}} = 0.375 - 0.044 lny_{il}$.

The results of the calibration of k_{ijs} and v_{ijs} are shown in Figure 3.2. The majority of values of k_{ijs} lie between 0 and 1. For both skill groups, the mass point of k_{ijs} concentrates on the top right of each graph, meaning that individuals from higher-income groups face larger opportunity costs of realizing migration. For the low skill group, the increasing trend of k_{ijl} is clearly visible. This reflects the opportunity costs of the less educated that increase faster with income than the ones of the college-educated. This allows to obtain after a certain level of income the downward trend of the realization rate of the

[17] It is important to note that the cases where the bilateral number of potential migrant equal to the bilateral number of effective migrants $n_{ijs} = N_{ijs}$ and different from zero, i.e. where success rate is theoretically equal to unity or all who want to migrate can do so, create inconsistency with the setup model. It is because even though $n_{ijs} = N_{ijs}$ bilaterally, the aggregate numbers of actual and potential stayers can be different $n_{iis} \neq N_{iis}$, thus the net utility of realizing migration b_{ijs} $(= ln\,(n_{ijs}/n_{iis}))$ is different from the net utility of aspiring for migration B_{ijs} $(= ln\,(N_{ijs}/N_{iis}))$. This induces that in these cases the migration cost c_{ijs} cannot be null and the realization rate is not equal to unity. As a result, the simulation exercise based on these calibrated results could underestimate the number of future migrants. One solution would be to set $\hat{G}_{ijs}$ to zero in these cases to avoid this theoretical inconsistency. However, this artificially truncates the calibrated k_{ijs} and v_{ijs}. Additionally, a zero cost of migration is hard to be justified in reality. I decide to keep $\hat{G}_{ijs}$ as they are. This concerns many small corridors, namely 53.38% of the low-skill and 68.26% observations of the highly skilled. They however only account for 4.34% and 10.58% of the total effective migrants of the low- and high-skill groups respectively.

less educated. All values of v_{ijs} are negative, representing benefits rather than costs of migration. The less educated obtain a bigger range of v_{ijl}, which means that they receive higher non-monetary benefits to migrate, probably because the network effect facilitating migration is stronger for this skill group. This is in line with common findings in the migration literature (see for example McKenzie and Rapoport, 2010).

Figure 3.2: Calibrated values of k_{ijs} and v_{ijs}



Notes: The figures show the calibrated values of bilateral variables k_{ijs} and v_{ijs} in relation with the log GDP/capita in 2010 of 175 origin countries.

The skill-specific incomes of 2010 and 2020 are calculated using the relationship between GDP per capita y_i, the share of working-age population, the share of each skill groups in the working-age population δ_{is} and the wage premium σ_i. The 2010 and projected 2020 GDP per capita based on purchasing-power-parity (PPP) are collected from the *IMF World Economic Outlook dataset (2016)*.[18] The projected population growth of the two skill groups college-graduates and less educated between 2010 and 2020 are calculated based on the projection of the *Wittgenstein centre database* (Samir et al., 2010). For the baseline analysis, I use the medium scenario of population growth, which can be considered as the most likely with assumptions on medium fertility, mortality and average

[18]The IMF only provides income projection until 2021. Therefore the simulation in this paper only limits to 2020.

path of school expansion.[19] Data on the wage ratio between college-educated and less educated are from Hendricks (2004).

It is important to note that an extension of projection beyond 2020 is possible.[20] However, this task requires additional assumptions on income and population growth prospects. Hanson and McIntosh (2016), for instance, assume the same growth rates of GDP for all countries for the entire period of half a century, which is a very strong hypothesis. The scope of this current paper is rather to propose a migration model and illustratively calibrate it using the most plausible future observations. Moreover, focusing on short horizon allows to mitigate the problem of endogeneity between income and demography.

Table 3.1 presents the average annual growth in GDP/cap (PPP) between 2010 and 2020, the actual levels of income per worker in 2010 and the new levels of income per worker in 2020, on average and of each skill group. Data are presented for the full sample of 175 countries ranked by the World Bank income classification of 2010, and then for 128 developing countries (defined as upper-middle-income countries and below) by geo-political groups. In 2010, SSA experienced the lowest GDP/cap, followed by South Asia and East Asia and the Pacific. The annual GDP/cap growth rates are forecasted to linearly decrease with development level between 2010 and 2020. On average, high-income countries will exhibit the lowest rate of income growth with the level around +2.66% per year. While low-income countries will experience the highest rate of income growth, which is around +4.33% per year. On average, there will be clearly a trend of convergence in future development. Asian countries show particularly high growth rates. The highest level of growth rate will be reached in the two biggest economies China and India, followed by South Asia. In the developing world, lowest income growth will be found in MENA. Six countries that are Central African Republic, East Timor, Equatorial Guinea, Libya, Venezuela, and Yemen show negative rates of GDP/cap growth due to political economic turmoil. After a decade of growth, SSA will still be the poorest region. While with its highest income growth, China and India will catch up in level with MENA countries and even overpass LAC countries.

[19]The population projection data being used exclude the numbers of migrants predicted by the *Wittgenstein centre database*. They thus represent the estimation of natural population growth.

[20]For example, Hatton and Williamson (2003) offer projection of African emigration until 2025; Hatton and Williamson (2011) predict immigration trends in the US up to 2034; and Hanson and McIntosh (2016) forecast migration to OECD countries until the mid-21st century.

Table 3.1: Average annual GDP growth and skill-specific incomes

	GDP/worker			LS income		HS income	
	%Δ /year	2010	2020	2010	2020	2010	2020
By income groups 2010							
Low-income (n=33)	4.33	1,587	2,547	1,390	2,219	6,186	9,892
Lower-middle-income (n=50)	4.17	5,233	8,088	4,079	6,284	15,635	24,021
Upper-middle-income (n=45)	3.73	14,247	20,550	11,203	16,166	34,039	48,718
High-income (n=47)	2.66	41,220	53,175	34,107	43,930	66,228	84,127
By geo-political groups							
Middle East and North Africa (n=12)	2.38	11,405	13,829	8,714	10,533	29,925	36,592
Sub-Saharan Africa (n=43)	4.00	3,499	5,236	3,004	4,506	12,897	19,298
Eastern Europe and Central Asia (n=20)	4.76	11,494	18,065	9,019	14,036	22,256	35,138
South Asia (n=7)	5.46	5,065	8,818	4,297	7,435	16,242	28,682
East Asia and the Pacific (n=17)	4.35	5,943	9,509	4,489	7,134	17,136	27,392
Latin America and the Caribbean (n=25)	3.50	10,265	14,496	7,925	11,207	25,432	35,641
China (n=1)	8.23	9,157	20,190	8,821	19,450	13,338	29,408
India (n=1)	7.38	4,445	9,060	3,464	7,060	14,143	28,826
Mexico (n=1)	3.19	15,054	20,605	10,001	13,688	45,902	62,828
Turkey (n=1)	4.53	16,193	25,213	13,013	20,262	44,688	69,580
High-income (n=47)	2.66	41,220	53,175	34,107	43,930	66,228	84,127
Average (n=175)	3.68	16,528	22,357	13,468	18,169	32,174	43,850

Notes: The 2010 and project 2020 GDP per capita based on purchasing-power-parity (PPP) are collected from the *IMF World Economic Outlook* dataset of 2016. The skill-specific incomes of 2010 and 2020 are calculated using the relationship between the GDP per capita, the share of working-age population, the share of each skill groups in the working-age population (25+) and the wage premium. The projected populations of college-graduates and less educated of 2010 and 2020 are from the *Wittgenstein centre database*. Data on the wage premium are from Hendricks (2004).

Table 3.2 details the average annual growth of population in working age between 2010 and 2020. On average, the working age population will grow at the rate of +2.12% per annum. The growth rate will be highest in low-income countries (+3.17%) and lowest in high-income countries (+1.15%). The regions that exhibit the highest rates of population growth are SSA (+3.06%), MENA (+2.93%) and South Asia (+2.91%). The high-skill population will grow faster than the lower-skill population, +4.02% against +1.75% on average. This trend in growing educated population will be observed in all income groups across all regions.

The world maps in Figures 3.3a, 3.3b and 3.3c depict the GDP/cap (in PPP), working population and human capital growth rates in the 175 countries in our sample. Fastest income growth will be found in Asia. While MENA and SSA regions will experience very high population growth however lowest income growth. This is a signal of higher emigration *pressure* from these regions in the near future. Additionally, population boom will go hand in hand with human capital growth. This suggests that future migration pattern will become more skill-intensive.

Table 3.2: Average annual growth of native population in working age

	%Δ/year			Total pop. (million)		% of HS	
	Total	LS	HS	2010	2020	2010	2020
By income groups 2010							
Low-income (n=33)	3.17	3.04	5.73	307	414	4.57	5.73
Lower-middle-income (n=50)	2.63	2.38	4.52	1,230	1,553	11.90	13.96
Upper-middle-income (n=45)	1.78	1.38	3.65	1,531	1,775	16.06	19.17
High-income (n=47)	1.15	0.52	2.66	710	760	25.72	29.82
By geo-political groups							
Middle East and North Africa (n=12)	2.93	2.42	5.71	174	230	13.64	17.67
Sub-Saharan Africa (n=43)	3.06	2.94	5.26	303	409	4.69	5.76
Eastern Europe and Central Asia (n=20)	1.11	0.76	2.23	231	244	20.19	22.54
South Asia (n=7)	2.91	2.69	5.68	185	245	7.02	9.00
East Asia and the Pacific (n=17)	2.42	2.13	4.52	330	403	12.65	15.07
Latin America and the Caribbean (n=25)	2.34	1.96	4.22	258	315	15.80	18.78
China (n=1)	1.39	1.06	4.80	858	985	7.56	10.53
India (n=1)	2.25	1.99	4.48	619	773	9.48	11.76
Mexico (n=1)	2.18	1.84	4.20	69	86	13.23	16.08
Turkey (n=1)	1.95	1.69	4.13	42	51	9.86	12.18
High-income (n=47)	1.15	0.52	2.66	710	760	25.72	29.82
Average (n=175)	2.12	1.75	4.02	389	453	15.30	18.01

Notes: The projected populations of college-graduates and less educated aged 25+ of 2010 and 2020 are from the *Wittgenstein centre database.*

3.4 Results

3.4.1 Benchmark results

This sub-section presents the benchmark results of future development on migration for a one-decade period. The results distinguish between potential and actual migrants. Potential migrants are those who will develop a willingness to live permanently in one of the 33 OECD countries, which is not their countries of birth. These potential migrants will attempt to realize their migration project. The volume of potential migrants thus represents the indirect migration *pressure* to OECD countries. While actual migrants in 2020 are those who can fully meet the migration requirement and can realize their migration in the similar socio-political context as in 2010. The volume of actual migrants could be considered as the direct migration *pressure* to OECD countries.

Table 3.3a, 3.3b and 3.3c show the volume of potential and actual emigrants to OECD countries in 2010 and 2020, in total and by skill groups. According to the benchmark simulation, in 2010, there were more than 367 million people expressing a desire to migrate, this number will increase by about +19.12% to reach 437 million in 2020. Of those who would like to migrate, only one fourth to one fifth could actually turn their willingness into reality. In 2020, only 99.6 million among 437 million potential migrants could become actual migrants. This number will increase by +18.69% compared to the volume in 2010. The increase in actual migrants is highly correlated with the rise in potential migrants. The increase of the volumes of high-skill potential and actual migrants will be at higher speed than the ones of the lower-skilled.

The following lines in Table 3.3 present the contribution of each factor in shaping future migration pattern. They correspond to three counterfactual simulations:

- CF 1: only population growth rates vary between 2010 and 2020. The other two factors, income level and skill composition, are kept constant at the levels of 2010.
- CF 2: only skill composition in the population varies between 2010 and 2020. The other two factors, population size and income level, are kept constant at the levels of 2010.
- CF 3: only income varies between 2010 and 2020. The other two factors, population size and skill composition, are kept constant at the levels of 2010.

Table 3.3: Migration flows to OECD countries, in volume (x1000) and percentage change between 2010 and 2020

	Total			Less-educated			College-educated		
	2010	2020	%Δ	2010	2020	%Δ	2010	2020	%Δ
Benchmark									
Potential	367,695	437,986	19.12	274,506	308,384	12.34	93,188	129,602	39.08
Actual	83,973	99,671	18.69	56,836	62,444	9.87	27,137	37,226	37.18
Counterfactual 1									
Potential	367,695	436,792	18.79	274,506	328,624	19.71	93,188	108,169	16.08
Actual	83,973	98,492	17.29	56,836	66,810	17.55	27,137	31,682	16.75
Counterfactual 2									
Potential	367,695	377,474	2.66	274,506	263,583	-3.98	93,188	113,890	22.22
Actual	83,973	87,410	4.09	56,836	54,525	-4.07	27,137	32,885	21.18
Counterfactual 3									
Potential	367,695	359,103	-2.34	274,506	267,949	-2.39	93,188	91,153	-2.18
Actual	83,973	81,294	-3.19	56,836	55,049	-3.14	27,137	26,244	-3.29

Notes: The benchmark scenario considers future development as a continuation of the 2010 situation, incorporating demographic, income and human capital growth between 2010 and 2020. The counterfactual 1 keeps constant the demographic growth. The counterfactual 2 keeps constant the income growth. The counterfactual 3 keeps constant the growth in the share of the college-educated in total population.

The results of the counterfactual simulations show how each factor taken separately can affect migration. Growth in population size predominantly determines the magnitude of future migration. It contributes positively to the surge in potential migration by +18.79% and in actual migration by +17.29%. These numbers are very close to the percentage increases in the benchmark

Figure 3.3: Growth rates of GDP/cap (PPP), total population and high-skill population, 2010-2020

Figure 3.3.a. Growth rates of GDP/cap (PPP), 2010-2020

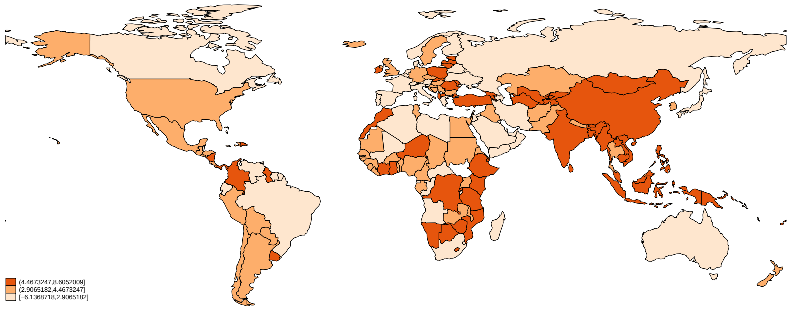


Figure 3.3.b. Growth rates of total population, 2010-2020

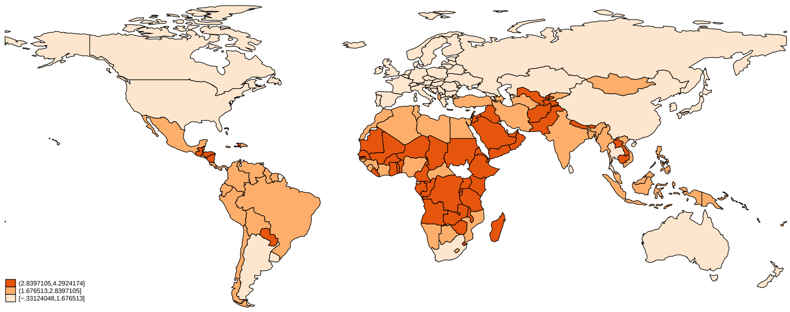
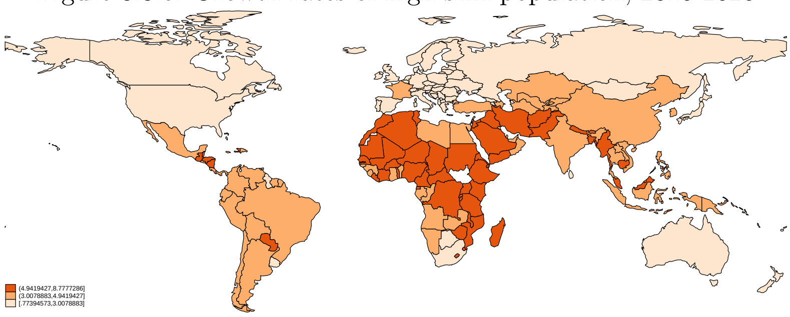


Figure 3.3.c. Growth rates of high-skill population, 2010-2020



scenario when all factors are at play. This proves the essential role of demographic transition in shaping future migration. This finding is in line with Dao et al. (2017) which concludes that the long-run trends of past and future migration are mainly affected by the volume of world population. In the second counterfactual, human capital growth alone helps to explain a relatively smaller portion or migration surge. This counterfactual predicts a decrease in migration of the low-skilled group with a stark increase of the higher-skilled group. Taking both factors of population size and human capital growth together would generate a bigger boost in migration among the college-educated. The third counterfactual reveals the negative impact of income on migration on average across our sample. What may help to explain this pattern is that when income increases incentive to migrate declines and opportunity cost rises. The interplay of these three factors, which this study takes into account, generates the bell-shape relationship between migration and development. Countries that lie along this curve experience different combinations of the three factors and exhibit distinctive levels of migration intensity.

Tables 3.4 and 3.5 report respectively the potential and actual migration volumes from each sending group of countries classified by income and geo-political characteristics as percentages of the total potential and actual migrants in 2010 and 2020. Citizens from upper-middle-income countries constitute the majority in both the potential and actual pools of migrants in this decade. The percentage increases are positive in the low- and lower-middle-income groups. While the higher-income countries exhibit the opposite trend. In the developing world, potential migrants mostly come from SSA (around $13-14\%$ of the total potential migrants) and from the LAC (more than 11% of the total potential migrants) at both the beginning and the end of this decade. Declining shares in the world potential migrant population will be experienced by high-income countries (-2.71 percentage point), Eastern Europe and Central Asia (EECA) (-1.15 percentage point) and China (-0.34 percentage point) due to squeezing wage differential. The biggest increases in proportion in total potential migrants will stem from the Southern border of Europe, i.e. in MENA ($+0.83$ percentage point) and SSA ($+1.60$ percentage point). Considering the actual migration flows, we still observe the highest shares from upper-middle-income countries. In the developing world, the share of Mexico, a single country alone, accounts for about 11% of the total actual migrants in OECD countries. Equivalent shares are contributed by LAC (about $12-13\%$) and EECA (about $10-12\%$). Higher-income countries such as EECA and China will see their shares reduce because of low demographic and high income growth.

Effective migrants originated from Africa constitute a relatively small proportion in total actual migrants (4.82% in 2010 to 6.50% in 2020), in contrast with its important share among potential migrants as shown above. This means that there is a big number of people who would like to migrate out of Africa, but they are still largely constrained by poor financial condition, therefore only a small fraction of them could effectively migrate. However, this small fraction is growing very fast ($+1.68$ percentage point between 2010 and 2020). Compared to the rest of the world, this shows that the future indirect and direct migration *pressure* will be most intensive from SSA. Migration *pressure* from this region will come mostly from the low-skilled group. The second highest speed of increase in emigration will be found in MENA countries, particularly from the high-skilled population. This could be due to the current high unemployment rate among the young and well-educated population of the region.

Table 3.4: Share of each origin group in total volume of potential migrants

	Total			Less-educated			College-educated		
	2010	2020	%Δ	2010	2020	%Δ	2010	2020	%Δ
By income groups 2010									
LI (n=33)	10.41	11.57	1.17	12.22	13.90	1.68	5.07	6.05	0.99
LMI (n=50)	26.79	28.54	1.75	27.02	28.74	1.72	26.09	28.06	1.97
UMI (n=45)	34.98	34.77	-0.21	36.14	35.81	-0.34	31.55	32.29	0.74
HI (n=47)	27.83	25.12	-2.71	24.62	21.56	-3.06	37.29	33.60	-3.69
By geo-political groups									
MENA (n=12)	6.31	7.14	0.83	6.63	7.27	0.64	5.37	6.83	1.47
Sub-Saharan Africa (n=43)	13.15	14.75	1.60	15.69	18.05	2.37	5.68	6.89	1.21
EECA (n=20)	8.90	7.75	-1.15	8.62	7.69	-0.93	9.72	7.89	-1.83
SA (n=7)	4.61	4.94	0.33	5.00	5.36	0.36	3.46	3.93	0.47
EAP (n=17)	7.00	7.49	0.49	6.22	6.39	0.17	9.32	10.11	0.78
LAC (n=25)	11.25	11.84	0.59	12.14	12.93	0.79	8.63	9.25	0.62
China (n=1)	7.67	7.33	-0.34	7.28	6.52	-0.76	8.84	9.27	0.43
India (n=1)	6.49	6.68	0.18	5.89	5.89	-0.01	8.26	8.55	0.29
Mexico (n=1)	5.05	5.24	0.19	5.88	6.26	0.38	2.61	2.82	0.20
Turkey (n=1)	1.73	1.72	-0.01	2.04	2.08	0.04	0.82	0.86	0.04
High-income (n=47)	27.83	25.12	-2.71	24.62	21.56	-3.06	37.29	33.60	-3.69

Notes: The potential emigration volumes of 2010 are calculated as the sum of the number of non-migrants expressing a willingness to emigrate to OECD countries (data from *Gallup World Poll* 2007-2010) and actual emigration stock of 2010 (data from *OECD-DIOC*). Henceforth, LI: Low-income, LMI: Lower-middle-income, UMI: Upper-middle-income, HI: High-income, MENA: Middle East and North Africa, SSA: Sub-Saharan Africa, EECA: Eastern Europe and Central Asia, SA: South Asia, EAP: East Asia and the Pacific, LAC: Latin America and the Caribbean.

Table 3.5: Share of each origin group in total volume of actual migrants

	Total			Less-educated			College-educated		
	2010	2020	%Δ	2010	2020	%Δ	2010	2020	%Δ
By income groups 2010									
LI (n=33)	4.26	5.98	1.71	4.10	6.02	1.92	4.61	5.90	1.29
LMI (n=50)	23.63	26.18	2.54	21.27	23.82	2.55	28.57	30.13	1.56
UMI (n=45)	40.95	40.32	-0.63	45.65	45.49	-0.17	31.10	31.66	0.56
HI (n=47)	31.16	27.53	-3.63	28.98	24.67	-4.30	35.72	32.31	-3.41
By geo-political groups									
MENA (n=12)	7.71	8.85	1.14	8.14	8.89	0.75	6.81	8.79	1.98
SSA (n=43)	4.82	6.50	1.68	4.20	6.02	1.81	6.12	7.31	1.19
EECA (n=20)	12.15	10.50	-1.65	12.55	11.19	-1.36	11.30	9.33	-1.97
SA (n=7)	2.66	3.28	0.62	2.35	2.97	0.62	3.31	3.79	0.48
EAP (n=17)	7.45	8.19	0.75	6.33	6.87	0.53	9.78	10.41	0.63
LAC (n=25)	12.58	13.53	0.94	13.59	14.76	1.17	10.48	11.46	0.98
China (n=1)	3.47	3.11	-0.36	2.76	2.08	-0.68	4.96	4.83	-0.14
India (n=1)	3.83	4.26	0.43	2.00	2.27	0.27	7.68	7.61	-0.07
Mexico (n=1)	11.40	11.59	0.20	15.39	16.56	1.17	3.04	3.27	0.23
Turkey (n=1)	2.77	2.66	-0.11	3.71	3.72	0.02	0.80	0.88	0.08
High-income (n=47)	31.16	27.53	-3.63	28.98	24.67	-4.30	35.72	32.31	-3.41

The share of immigrants relative to the number of working-age residents in each OECD country is shown in Table 3.6. On average, immigrants account for 13.48% in 2010 and 14.16% in 2020 in the total residents aged 25+ of the receiving countries - a small increase of 0.68 percentage point after a decade. This trend will be attenuated by the small increase in low-skilled immigrant shares among total working-age residents in the majority of countries, +0.38 percentage point on average. Meanwhile, the share of the highly skilled will increase more significantly by +1.10 percentage point on average. This fact suggests that the future composition of immigrants will become more skill-intensive. This is in line with the worldwide increasing trend of education expansion. The highest shares of immigrants will still be found in Luxembourg (47.07%), Israel (33.14%), Australia (29.13%), Canada, New Zealand and Switzerland (around 25%).

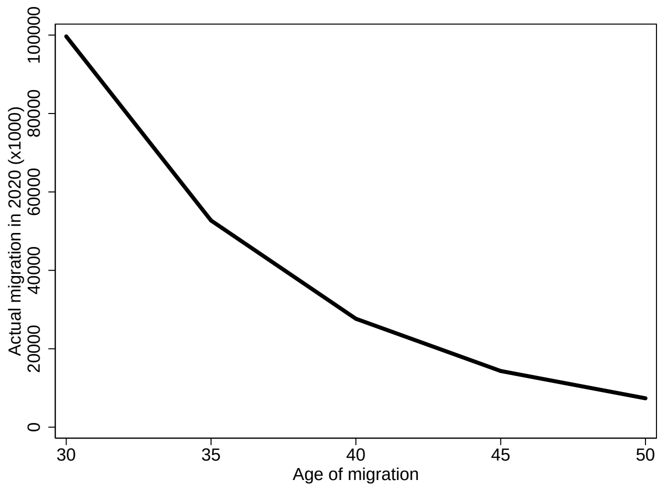
Table 3.6: Immigration rates in OECD countries

	Total			Less-educated			College-educated		
	2010	2020	%Δ	2010	2020	%Δ	2010	2020	%Δ
Australia	29.52	29.13	-0.39	27.39	26.15	-1.24	33.86	33.96	0.11
Austria	13.07	12.74	-0.32	14.37	14.31	-0.06	8.86	8.78	-0.09
Belgium	16.00	17.41	1.40	19.79	22.45	2.66	8.17	9.47	1.30
Canada	24.97	26.60	1.63	25.13	26.17	1.04	24.85	26.89	2.04
Chile	1.53	1.63	0.11	1.09	1.09	-0.01	4.02	4.08	0.06
Czech Republic	7.83	8.01	0.18	7.92	7.93	0.01	7.36	8.35	0.99
Denmark	9.22	10.07	0.85	9.21	9.66	0.44	9.24	11.08	1.84
Estonia	20.05	22.40	2.35	18.67	20.01	1.34	22.63	26.06	3.43
Finland	3.41	3.65	0.25	4.72	4.87	0.14	1.82	2.29	0.47
France	14.21	15.81	1.60	14.29	16.12	1.83	13.95	15.11	1.15
Germany	8.58	8.77	0.19	10.27	10.83	0.56	4.68	4.83	0.15
Greece	12.14	12.66	0.51	12.19	12.97	0.78	11.96	11.70	-0.27
Hungary	4.48	4.96	0.48	3.71	3.91	0.20	9.01	10.29	1.28
Iceland	10.74	11.43	0.69	11.33	11.83	0.49	9.58	10.81	1.23
Ireland	19.24	21.43	2.19	19.85	20.41	0.55	18.41	22.41	4.00
Israel	33.39	34.14	0.76	25.50	25.18	-0.32	49.12	51.49	2.37
Italy	8.26	8.66	0.39	7.99	8.35	0.36	10.35	10.56	0.21
Japan	1.09	1.21	0.11	1.21	1.40	0.19	0.87	0.94	0.07
Luxembourg	46.62	47.07	0.45	46.44	46.06	-0.38	47.16	49.44	2.28
Mexico	0.46	0.43	-0.03	0.33	0.28	-0.05	1.21	1.13	-0.08
Netherlands	11.02	12.34	1.31	10.87	11.75	0.88	11.44	13.66	2.22
New Zealand	25.92	25.28	-0.64	24.06	22.33	-1.73	29.47	30.04	0.57
Norway	12.38	12.86	0.48	11.96	12.17	0.22	13.29	14.01	0.71
Poland	2.00	1.98	-0.01	2.06	2.04	-0.01	1.76	1.79	0.03
Portugal	8.81	10.72	1.91	7.55	9.00	1.45	17.53	19.83	2.30
Slovakia	3.32	3.59	0.26	3.16	3.34	0.18	4.28	4.88	0.60
Slovenia	13.03	13.15	0.12	14.09	14.28	0.19	8.24	8.85	0.61
Spain	12.28	13.24	0.96	11.34	12.16	0.83	16.16	16.57	0.41
Sweden	14.50	15.40	0.90	15.61	16.29	0.67	12.43	14.13	1.69
Switzerland	25.04	25.01	-0.03	21.57	20.57	-1.00	36.30	36.99	0.69
Turkey	1.50	1.33	-0.17	1.33	1.14	-0.20	2.96	2.70	-0.26
United Kingdom	14.28	16.49	2.20	9.77	10.80	1.02	26.79	28.97	2.17
United States	15.94	17.62	1.67	16.65	18.24	1.59	14.69	16.66	1.96
Average	13.48	14.16	0.68	13.07	13.46	0.38	14.92	16.02	1.10

Notes: The share of immigrants is equal to the volume of immigrants relative to the total number of residents in each OECD destination country.

The share of youth population, usually considered those between 25-34, is widely shown to significantly affect a country's emigration intensity (Hatton and Williamson, 1998, 2003, 2005, 2011). This fact is captured in this exercise by choosing 30 years old as the age at which migration takes place. Figure 3.4 shows that when migration takes place at older ages, i.e. the weight attached to the first period is higher, the total volume of migration decreases. Additionally, it would be interesting to obtain information of future migration trends broken down by different age groups. However, we only possess one semi-elasticity of realization rate to income for the entire working-age population of each skill group. Therefore, we have no choice but to assume that all age groups have the same propensity to migrate. The fact of using the growth rate of the working-age population does, to some extent, account for the growth of youth population because a higher growth rate of a working-age population also means higher entry rate of the youth cohort to this group of population. Overall, we can only demonstrate in a clear manner the impact of age on migration through the effect of the relative length of the first period in the utility function.

Figure 3.4: Total migration with different ages at which migration takes place



Notes: This graph shows how the total volume of migration varies with different ages at which migration takes place. The values of the relative length of the first period ρ which correspond to the discrete ages of 30, 35, 40, 45, 50 are respectively 0.8, 1.35, 2.15, 3.34, 5.29.

Among the 33 OECD destination countries, immigration mostly concentrates in eight countries including the US, Canada, the UK, France, Australia, Spain, Germany and Italy. These eight countries are the most preferred destination of around 83% of potential migrants worldwide (see Table 3.A1 in the Appendix) and they host around 82% of the total effective migrants in OECD countries (see Table 3.A2 in the Appendix). The US remains by far the most preferred destination and largest receiving country. This country alone hosts close to 40% of the total migrants in the dataset. Tables 3.7, 3.8, 3.9 and 3.10 provide the details of potential and actual migration flows to those 8 biggest destinations.

Table 3.7 depicts the share in 2010 of each sending group in the total immigrant volume in each of the eight major destinations. Mexico tops the list of sending countries to the US, followed by the LAC region. The biggest immigrant communities in France are originated from MENA; in the UK, Canada and Australia from high-income countries; in Germany and Italy from EECA; and in Spain from LAC countries. The proportions of immigrants from SSA in all of the major host countries remain relatively low in 2010.

Table 3.7: Share of each origin group in total volume of immigrants in the top eight destinations in 2010

	US	France	UK	Germany	Spain	Italy	Canada	Australia
MENA	2.72	40.18	4.32	0.09	13.81	12.61	6.35	4.32
SSA	2.59	11.42	15.01	0.00	2.94	5.70	3.83	4.45
EECA	3.61	3.41	4.79	38.29	17.31	35.23	5.43	3.15
SA	1.50	0.88	12.85	0.00	0.73	3.90	5.12	3.47
EAP	10.86	3.78	3.97	0.21	0.74	2.79	11.39	14.44
LAC	20.17	2.83	4.90	0.00	36.67	9.90	9.19	2.04
China	3.86	1.01	2.91	0.53	1.33	3.17	7.96	5.89
India	4.70	0.60	10.20	0.13	0.54	2.03	8.27	5.37
Mexico	28.89	0.13	0.13	0.00	0.83	0.15	1.07	0.06
Turkey	0.30	3.45	1.26	24.18	0.05	0.32	0.37	0.68
High-income	20.81	32.31	39.66	36.58	25.04	24.19	41.02	56.13
Total	100	100	100	100	100	100	100	100

Table 3.8 reports the future actual migration flows between 2010 and 2020 from each geo-political groups as percentage of total actual migration flows to each destination country. Immigrants from SSA will constitute the largest group of newcomers to the UK and Italy. Overall in all receiving countries, the shares of actual migration flows from SSA and MENA will increase substantially compared to other sending regions.

Table 3.8: Share of each origin group in the total flows of actual migrants to the top eight destinations, between 2010 and 2020

	US	France	UK	Germany	Spain	Italy	Canada	Australia
MENA	5.70	58.25	8.24	0.29	26.48	36.08	14.86	11.86
SSA	9.03	29.26	30.24	0.00	12.05	37.06	14.57	13.03
EECA	0.79	-0.66	-0.39	23.61	-4.28	-6.04	1.04	1.07
SA	4.18	1.00	20.28	0.00	2.12	19.55	10.69	10.54
EAP	14.55	6.74	4.84	-0.38	1.28	6.54	18.31	32.43
LAC	24.27	3.71	9.14	0.00	57.56	23.49	13.17	3.90
China	0.82	-1.13	1.83	1.33	0.75	-4.08	4.22	5.18
India	7.16	0.23	11.18	1.63	0.91	3.48	11.52	12.41
Mexico	25.46	-0.04	0.08	0.00	0.92	-0.36	0.29	0.07
Turkey	0.28	1.57	1.36	73.40	0.18	0.28	0.02	0.27
High-income	7.76	1.08	13.20	0.12	2.03	-16.01	11.30	9.25

Table 3.9 displays a remarkable trend that the growth rates of immigration stemming from SSA will be highest compared to the numbers from other sending regions in all major destinations.[21] In other words, SSA, which in 2010 occupied a very small share in the total immigration volume, will send out migrants with the highest speed toward all destinations in the future. This rising trend of effective migration could be explained by the strong willingness to outmigrate from SSA to most of the major destinations as shown in Table 3.10. Table 3.11 reveals that in the top preferred destinations, the growth rates of the potential migration volumes from SSA will be among the most important, along with MENA.

[21]Except Germany whose the data on immigration from many origin countries are missing in OECD-DIOC dataset.

Table 3.9: Growth rates of actual migration flows to the top eight destinations, between 2010 and 2020

	US	France	UK	Germany	Spain	Italy	Canada	Australia
MENA	49.77	30.03	49.99	14.28	26.21	20.65	48.35	34.13
SSA	82.72	53.09	52.80		56.01	46.98	78.47	36.48
EECA	5.21	-4.01	-2.13	2.83	-3.38	-1.24	3.95	4.21
SA	65.94	23.39	41.37		39.53	36.14	43.14	37.84
EAP	31.78	36.91	31.96	-8.50	23.54	16.89	33.21	27.94
LAC	28.54	27.19	48.91		21.46	17.14	29.56	23.76
China	5.03	-23.20	16.43	11.56	7.67	-9.30	10.94	10.94
India	36.16	7.85	28.75	56.98	23.26	12.35	28.76	28.77
Mexico	20.89	-6.22	16.24		15.07	-17.54	5.65	14.51
Turkey	22.25	9.43	28.35	13.92	48.07	6.22	1.06	4.89
High-income	8.84	0.69	8.72	0.02	1.11	-4.78	5.69	2.05

Table 3.10: Share of each origin group in the total flows of potential migrants to the top eight destinations, between 2010 and 2020

	US	France	UK	Germany	Spain	Italy	Canada	Australia
MENA	5.89	35.85	9.64	16.85	9.55	21.69	15.41	7.40
SSA	24.34	28.57	45.09	14.87	14.71	23.57	16.67	7.49
EECA	0.89	1.09	0.84	13.43	0.46	1.63	0.92	1.48
SA	5.93	1.86	13.45	5.32	0.52	12.63	8.61	8.24
EAP	12.74	3.16	6.65	5.34	0.84	5.77	11.68	21.81
LAC	17.54	8.03	2.80	1.99	58.64	18.22	9.54	3.96
China	5.15	3.45	1.08	1.62	0.11	4.76	8.58	8.68
India	10.64	1.83	8.77	1.48	0.11	2.45	7.57	9.97
Mexico	10.79	3.44	0.80	0.00	5.97	2.79	5.70	0.48
Turkey	0.56	3.01	0.69	17.99	0.02	0.53	1.20	1.38
High-income	5.53	9.71	10.19	21.10	9.07	5.96	14.10	29.11

Table 3.11: Growth rates of potential migration flows to the top eight destinations, between 2010 and 2020

	US	France	UK	Germany	Spain	Italy	Canada	Australia
MENA	41.33	29.87	42.75	34.16	24.81	23.62	43.06	33.76
SSA	32.32	35.22	36.18	27.28	34.81	28.74	35.49	32.28
EECA	5.75	3.07	3.40	3.57	0.89	1.08	4.61	4.65
SA	27.17	28.61	29.53	34.22	46.73	14.37	36.87	29.19
EAP	26.36	22.05	35.16	29.61	30.90	20.68	35.33	30.15
LAC	26.96	26.92	25.81	26.38	22.80	18.66	28.90	24.79
China	10.61	12.12	9.28	12.27	6.82	16.51	17.31	14.22
India	22.60	36.63	22.39	13.32	17.83	28.02	21.71	31.26
Mexico	21.90	33.59	29.98		27.05	23.37	28.26	25.20
Turkey	26.41	17.91	18.50	15.94	31.88	12.33	26.67	17.08
High-income	10.08	6.83	11.19	6.78	5.41	3.22	7.91	7.42

3.4.2 Results from Brexit-Trumpism scenario

This sub-section describes how the world migration would change as a consequence of the surging anti-immigration policies in major receiving countries. It presents a second set of simulations that consist of a complete immigration halt to the US and the UK between 2010 and 2020. This extreme scenario is unrealistic but allows to illustrate in a clear manner how these coercive policies will reallocate migrants across OECD countries and what is the expected utility cost for poorer sending countries.[22]

[22]For simplicity, we assume that there is neither coordination nor interaction between countries, i.e. those policy choices are made independently by each country. While under a

The results of the "Brexit-Trumpism" scenario suggest that as a consequence of the restriction policies in these two major receiving countries, migration in the world would only increase by +7.27% by the end of this decade (Table 3.12), which is much smaller compared to +18.69% in the benchmark scenario. The difference of 10 percentage points correspond to the increase in the volume of potential migrants who will remain home as the consequence of the restrictive policy. As being designed, the actual immigration flows to the US and UK between 2010 and 2020 will be nil or negative[23] shown in Table 3.13. The rest of the migrants who could effectively move will redirect themselves toward other destinations. A comparison between the migration flows of the benchmark scenario and the counterfactual "Brexit-Trumpism" scenario show that immigration will rise in all other destinations after the UK and US close their borders. Overall, the highest increase in immigration will be found in Canada. Migrants from MENA and SSA will migrate more to France and Canada. Immigration flows from LAC will increase in Canada and Spain. More Asian migrants will move to Canada and Australia. Mexico will be the sending country the most affected by this border restriction from the US. The results further reveal that Mexicans will not redirect themselves massively to other destinations, there will only be a small volume of them ending up in Canada.

Figure 3.5 illustrates the effects of this policy on the volume and welfare of migrants in each sending region. Overall, the largest decrease in volume of emigrants will be experienced in Mexico and LAC. While the biggest welfare losses will be suffered by intending migrants from SSA, MENA and South Asia because the utility gains from income differentials between these regions and main richer destinations will become unachievable.[24]

Table 3.12: Volume (in thousand) and percentage changes of migration in Brexit-Trumpism scenario

	Total			Less-educated			College-educated		
Actual volume of migrants	2010	2020	%Δ	2010	2020	%Δ	2010	2020	%Δ
Benchmark scenario	83,973	99,671	18.69	56,836	62,444	9.87	27,137	37,226	37.18
Brexit-Trumpism scenario	83,973	90,079	7.27	56,836	58,029	2.10	27,137	32,050	18.10

cooperative or interactive setting, the direct and spillover effects of those policies could be very different (Facchini and Willmann, 2006).

[23] Because some are already negative in the benchmark scenario.

[24] The percentages of deviation in welfare are calculated based on the deterministic level of utility in Equation 3.3.

Table 3.13: Percentage change in actual immigration flows between 2010 and 2020 in Brexit-Trumpism scenario in comparison to the benchmark scenario, by corridors

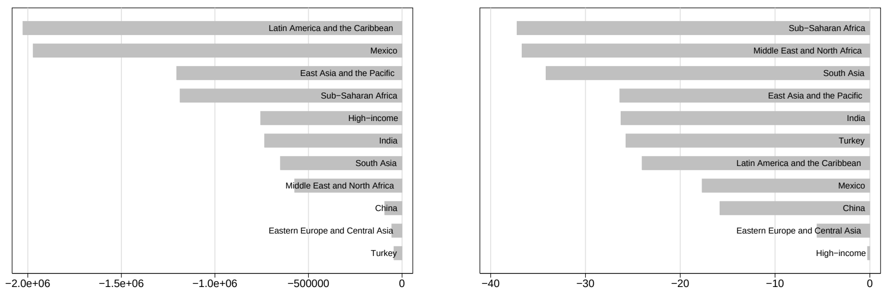
	US	France	UK	Germany	Spain	Italy	Canada	Australia
MENA	-100	1.06	-100	0.28	1.04	1.27	4.13	3.27
	441079	*745619*	*133049*	*714*	*153058*	*98991*	*182740*	*64869*
SSA	-100	1.54	-100		1.61	1.98	5.18	8.63
	698668	*374613*	*488009*	*0*	*69662*	*101688*	*179192*	*71317*
EECA	-100	-2.51	-100	0.59	0.12	-7.32	6.77	3.40
	61478	*-8456*	*-6285*	*57614*	*-24742*	*-16557*	*12773*	*5834*
SA	-100	2.17	-100		1.65	0.91	4.33	3.86
	323308	*12790*	*327233*	*0*	*12279*	*53639*	*131445*	*57692*
EAP	-100	7.00	-100	-0.02	4.66	4.93	6.74	5.48
	1126292	*86224*	*78145*	*-935*	*7387*	*17939*	*225180*	*177415*
LAC	-100	12.24	-100		4.36	4.80	44.37	10.49
	1878841	*47480*	*147553*	*0*	*332728*	*64453*	*161874*	*21325*
China	-100	-0.40	-100	1.72	0.54	0.12	1.66	1.57
	63291	*-14509*	*29477*	*3238*	*4330*	*-11192*	*51842*	*28320*
India	-100	2.33	-100	1.72	0.89	0.83	1.71	2.03
	554531	*2910*	*180502*	*3989*	*5280*	*9548*	*141700*	*67920*
Mexico	-100	-30.98	-100		21.92	-13.22	52.13	22.93
	1970305	*-492*	*1312*	*0*	*5293*	*-978*	*3586*	*375*
Turkey	-100	0.84	-100	0.32	1.28	2.40	38.45	3.84
	21668	*20118*	*21964*	*179151*	*1065*	*755*	*235*	*1470*
High-income	-100	19.66	-100	873.68	17.95	-1.63	18.55	15.62
	600430	*13821*	*212965*	*302*	*11755*	*-43929*	*138998*	*50608*

Notes: The percentage changes are calculated as ((Brexit-Trumpism flow - Benchmark flow)/Benchmark flow) x100. The "Brexit-Trumpism" scenario is a complete border closing in the US and the UK. Small numbers in italic are the volume of actual immigration flows between 2010 and 2020 in the benchmark scenario.

Figure 3.5: The effects of the Brexit-Trumpism scenario on the volume and welfare of migrants by sending regions

3.5.a. Decrease in volume of out-migration flows

3.5.b. Percentage decrease in utility



Notes: The decreases in volume of out-migration flows and in utility are calculated from the comparison between the Brexit-Trumpism scenario and the benchmark scenario. LAC: Latin America and the Caribbean, EAP: East Asia and the Pacific, SSA: Sub-Saharan Africa, HIC: High-income countries, MENA: Middle East and North Africa.

3.4.3 The effectiveness of developmental policies

The benchmark results indicate that there will be a rising migration intensity from Africa and MENA to OECD countries over the coming decades. This seems to feed the current EU's concern about how to limit migration. The New Migration Partnership framework is the response to this concern. In this framework, the EU is collaborating with several countries in MENA and SSA to address the root causes of irregular migration by increasing investment in these regions. The objective of the policy is in line with other well-known international cooperation programs that target the problem of rising migration *pressure*. For example the Maquiladora program which established a manufacturing zone along the US-Mexican border with the objective of fostering employment and increasing Mexican wages. This would ultimately contribute to limiting illegal migration from Mexico. To assess the effectiveness of a measure that intends to limit migration, this analysis determines the development levels that poorer sending countries should experience in order to reduce their migration *pressure* on richer destinations. To do so, a counterfactual is designed keeping the stocks of immigrants from MENA and SSA countries in eight major receiving OECD countries constant between 2010 and 2020. The corresponding expected wages[25] are then computed by minimizing each of the following equations, in which b_{ijs}^{CF} is the counterfactual level of the log ratio of bilateral migrants over total stayers and y_{is}^{CF} the expected wage to keep migrant stock constant.

$$\begin{cases} b_{ijl}^{CF} - lny_{jl} + ln(1 + d_{ijl}^{*}) + \alpha lny_{jl} = \rho ln((1 - k_{ijl})y_{il}^{CF} - v_{ijl}) - (1 + \rho)\, lny_{il}^{CF} + \alpha lny_{il}^{CF} \\ b_{ijh}^{CF} - lny_{jh} + ln(1 + d_{ijh}^{*}) + \alpha lny_{jl} = \rho ln((1 - k_{ijh})y_{ih}^{CF} - v_{ijh}) - (1 + \rho)\, lny_{ih}^{CF} + \alpha lny_{il}^{CF} \end{cases}$$

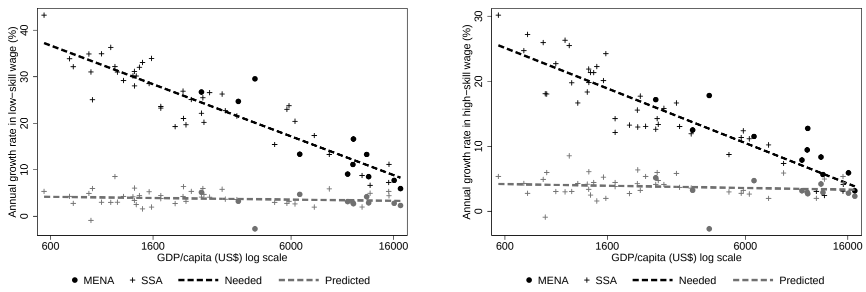
Figures 3.6 summarizes the results of the average yearly growth rates in GDP per capita of 12 MENA and 41 SSA countries which would keep the volumes of low and high skill emigrants constant as in 2010. The results clearly show that the projected annual GDP/cap growth rate between 2010 and 2020, which we will most likely observe, are not enough to keep migration constant. For the migration *pressure* to the OECD countries to be stable or even reduced, the GDP/cap annual growth rates are expected to be twice or three times larger on average in relatively well-off sending countries. Most of these countries are located in MENA region such as Algeria, Egypt, Lebanon, Tunisia; and in the upper-middle-income group of Africa like Botswana, Mauritius and South Africa. For the poorer countries, the growth rates are expected to be of double-digits. Some are just unimaginably high. It is because these countries are at the very beginning of the left wing of the bell-shaped migration curve, their emigration will only intensify with development in the foreseeable future. These countries can only reach the other end of the emigration curve in the very long term. According to the result of this simulation, the corresponding amount of development aid to keep migration in 2020 as constant as in 2010 is enormous,

[25] Only the levels of wages that are higher than the ones we observed today are presented. There is another solution from my algorithm is to reduce the wages, i.e. to tax potential migrants making them even poorer and not to be able to migrate.

it is equivalent to more than 20% of the OECD's total GDP in 2010.

Figure 3.6: Counterfactual average annual wage growth rates between 2010 and 2020 to keep emigration constant at the 2010 levels

3.6.a. Less educated 3.6.b. College-educated



Notes: The figures compare the observed average annual growth rates of skill-specific wages between 2010 and 2020 and the needed average levels to keep emigration from MENA and SSA constant at the level of 2010.

The answer of this study is in line with previous existing research that directly test the impact of development policies on migration. Many studies have failed to justify the negative relationship between risings in income and out-flow migration. This is the case of NAFTA which is proven to increase Mexican migration to the US (Martin, 1993); of a rural development policy that further encourages migration to cities in Burkina Faso (Beauchemin and Schoumaker, 2005), and of the Official Development Assistance (ODA) that has positive significant effect on migration outflows in SSA (Belloc, 2015). Similarly, Berthélemy et al. (2009) show that aid stimulates out-migration by 24% in countries with income per capita lower than US $7,300 (PPP 2000 prices). Or to a lesser extent, the conditional cash transfers of Mexico's primary poverty-reduction program reduce rural out-migration to the U.S. but not domestic migration (Stecklov et al., 2005).

3.5 Conclusion

This paper provides projection of future migration under different scenarios. It incorporates three factors of development that affect migration: the demographic transition, income change and human capital accumulation. The combinations of these three factors give rise to different patterns of migration. To study the impact of income on migration, this paper proposes a microfounded behavioral model of migration, in which migration decision and realization are the two building elements. The model is conceptually based on the empirical facts found in Dao et al. (2016) on the determinants of the migration hump. Decision to migrate is governed by wage differential between origin and destination, as well as that within the society of origin country. Migration realization depends on the willingness to migrate, financial capacity and migration cost. The latter is modeled to vary with income to explicitly reflect the opportunity cost of migrating. The model is calibrated using data on real and potential bilateral migration stocks, GDP, average income, skill composition and wage premium. Once being properly calibrated, it is then used to predict future migration flows from 175 countries to 33 OECD destinations between 2010 and 2020. This is done using projections on future GDP/cap and demographic growth.

The results of the benchmark simulation exercise suggest that after a decade of development, immigration volume to OECD countries will rise by +18.69%, which is equivalent to +1.7% per year. Because of this short period of time, we will still observe big migration volumes from Mexico and LAC into the US. However, their speeds of change are becoming smaller. Even though the current migration volumes from SSA and MENA are small, they will increase very rapidly in the future. Due to the high burden of financial constraint, the direct migration *pressure* from SSA will be however limited compared to the indirect *pressure*. Overall future migration will shift toward being more skill-intensive. The contribution of demographic growth to migration intensity is shown to be sizeable.

A counterfactual scenario of a complete immigration ban to the UK and US is analyzed. It suggests that as a consequence of such circumstance, the world migration will be more than halved, Mexican migrants will be most affected and migration flows will increase in other main destinations, especially in Canada.

Any development policy would encounter difficulty in reducing migration *pressure* from SSA and MENA in the short and medium term, as suggested by the last sets of simulation in this paper. It would take very long time for SSA to reach a level of development that would reduce its emigration intensity.

This paper does not aim to provide the most comprehensive method to project migration, nonetheless it contributes to enhance the methodologies used in the existing literature.

3.6 Appendix

A. The impacts of income changes on migration aspirations

Proposition 1 details the responses of migration aspirations to changes in skilled average incomes at origin and destination.

Proposition 1

1. If average incomes per worker in origin and destination countries grow at the same pace, aspirations for migration of both skill groups remain unchanged.
2. If α - the parameter of feeling attached to relative position - is lower than 1, aspirations for migration of both skill groups increase with average incomes per worker in destination, and decrease with that in origin countries. And vice versa if α is larger than 1.
3. If α is lower than 1, a faster increase in income per worker at destination relative to that at origin country boosts migration willingness. On the contrary, a slower increase in income per worker at destination relative to that at origin country reduces migration willingness. And vice versa if α is larger than 1.

Proof.

1. We denote y_i the average income per worker in country i. The skill-specific incomes are computed as $y_{il} = y_i/(\delta_{ih}\sigma_i + \delta_{il})$ and $y_{ih} = \sigma_i y_i/(\delta_{ih}\sigma_i + \delta_{il})$ where σ_i is the skill premium. Therefore, an increase in y_i will change proportionally y_{ih} and y_{il}, keeping the level of skill premium σ_i intact.
   The two subfunctions in the Equation 3.9 of B_{ijs} are homogenous of degree zero $ln(ay_{js}/ay_{is}) = ln(y_{js}/y_{is})\ \forall a \in \mathbb{R}$, i.e. they are unaffected by a similar increase in incomes at origin and destination.
2. The expected average net utility gain when less-educated individuals want to migrate writes: $B_{ijl} = (1-\alpha)\left[lny_{jl} - lny_{il}\right] - ln\left(1 + d_{ijs}\right)$. The partial derivatives $\frac{\partial B_{ijl}}{\partial y_{jl}} > 0$ and $\frac{\partial B_{ijl}}{\partial y_{il}} < 0$ if $\alpha < 1$. We obtain opposite results if $\alpha > 1$.
   The expected average net utility gain when college-educated individuals want to migrate writes: $B_{ijh} = \left[lny_{jh} - lny_{ih}\right] - \alpha\left[lny_{jl} - lny_{il}\right] - ln\left(1 + d_{ijs}\right)$. With $y_{jl} = \frac{y_{jh}}{\sigma_j}$ and $y_{il} = \frac{y_{ih}}{\sigma_i}$, $\frac{\partial B_{ijh}}{\partial y_{jh}} > 0$ and $\frac{\partial B_{ijh}}{\partial y_{ih}} < 0$ if $\alpha < 1$. We obtain opposite results if $\alpha > 1$.
3. We denote $a_i,\ a_j \in \mathbb{R}$ the percentage changes in income per worker in origin i and destination j respectively. The new expected net utility gain when aspiring to migrate after changes in incomes in the two countries is $B'_{ijs} = (1-\alpha)\left(lna_j - lna_i\right) + B_{ijs}$. When $\alpha < 1$, $B'_{ijs} > B_{ijs}$ if $a_j > a_i$, $B'_{ijs} < B_{ijs}$ if $a_j < a_i$. And vice versa if $\alpha > 1$.

∎

B. The impacts of income changes on migration realization

Proposition 2 details the effects of development on migration, through migration aspirations and realizations, under the interplay between incentive and financial constraints.

Proposition 2

1. If aspirations for migration decrease, i.e. the total derivative $dB_{ijs} < 0$ with $dB_{ijs} = \frac{\partial B_{ijs}}{\partial y_{is}} dy_{is} + \frac{\partial B_{ijs}}{\partial y_{js}} dy_{js}$,

    (a) and if the migration gap increases due to increasing opportunity cost $\frac{dg_{ijs}}{dy_{is}} > 0$ (case where $v_{ijs} < 0$), migration realization decreases.

    (b) and if the migration gap decreases due to higher financial capacity to afford migration $\frac{dg_{ijs}}{dy_{is}} < 0$ (case where $v_{ijs} > 0$), then

    i. migration realization decreases if the effect of decreasing migration aspirations dominates the effect of higher financial capacity $|dB_{ijs}| > \left|\frac{dg_{ijs}}{dy_{is}}\right|$.

    ii. migration realization increases if the the effect of higher financial capacity to afford migration dominates the effect of decreasing migration aspirations $\left|\frac{dg_{ijs}}{dy_{is}}\right| > |dB_{ijs}|$.

2. If aspirations for migration increase, i.e. $dB_{ijs} > 0$,

    (a) and if the migration gap decreases due to higher financial capacity to afford migration $\frac{dg_{ijs}}{dy_{is}} < 0$ ()case where $v_{ijs} > 0$), migration realization increases.

    (b) and if the migration gap increases due to increasing opportunity cost $\frac{dg_{ijs}}{dy_{is}} > 0$ (case where $v_{ijs} < 0$), then

    i. migration realization decreases if the effect of increasing opportunity cost dominates the effect of increasing migration aspirations $\left|\frac{dg_{ijs}}{dy_{is}}\right| > |dB_{ijs}|$.

    ii. migration realization increases if the effect of increasing migration aspirations dominates the effect of increasing opportunity cost $|dB_{ijs}| > \left|\frac{dg_{ijs}}{dy_{is}}\right|$.

C. Top eight destinations of migration

Table 3.A1: Potential Immigration to OECD countries 2010-2020: Top eight destinations

Rank 2010	Destination	Geo.-pol. group	2010 Total pot. migrants (x1000)	2010 % of All pot. migrants in data	2010 % Cum.	2020 Total pot. migrants (x1000)	2020 % of All pot. migrants in data	2020 % Cum.
1	United States	United States	128529	34.96	34.96	157597	35.98	35.98
2	Canada	CANZ	39379	10.71	45.67	47588	10.87	46.85
3	United Kingdom	EU15	29465	8.01	53.68	36917	8.43	55.28
4	France	EU15	25527	6.94	60.62	30737	7.02	62.29
5	Australia	CANZ	23323	6.34	66.96	26709	6.1	68.39
6	Spain	EU15	21678	5.9	72.86	25380	5.79	74.19
7	Germany	EU15	20420	5.55	78.41	22526	5.14	79.33
8	Italy	EU15	16099	4.38	82.79	18172	4.15	83.48

Notes: The potential immigration stocks of 2010 are from *OECD-DIOC* and the *Gallup World Poll*.

Table 3.A2: Actual Immigration to OECD countries 2010-2020: Top eight receiving countries

Rank 2010	Destination	Geo.-pol. group	2010 Total migrants (x1000)	2010 % of All migrants in data	2010 % Cum.	2020 Total migrants (x1000)	2020 % of All migrants in data	2020 % Cum.
1	United States	United States	32643	38.87	38.87	40382	40.52	40.52
2	France	EU15	6180	7.36	46.23	7460	7.48	48
3	United Kingdom	EU15	6157	7.33	53.56	7771	7.8	55.8
4	Canada	CANZ	5955	7.09	60.66	7184	7.21	63.01
5	Germany	EU15	5323	6.34	66.99	5567	5.59	68.59
6	Australia	CANZ	4396	5.24	72.23	4944	4.96	73.55
7	Spain	EU15	4229	5.04	77.27	4807	4.82	78.37
8	Italy	EU15	3801	4.53	81.79	4075	4.09	82.46

Notes: The actual immigration stocks of 2010 are from *OECD-DIOC*.

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