Time, Space and Skills in Designing Migration Policy*

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Abstract

The paper proposes a multi-country model of international migration, in which college-educated workers choose their destination country, preferred type of visa, and the optimal duration of stay. Combining these elements into a unified theoretical framework provides a micro-foundation for multilateral resistance to migration. The application of the proposed theory consists in investigating the global demographic implications of decreasing the costs of 6-year visas for the high-skilled professionals in the EU, calibrated as an introduction of H1B visas. This is compared with a policy of reducing income tax for medium-term, college-educated, foreign workers. The two counterfactuals indicate a significant increase in the yearly inflows and total stocks of high-skilled immigrants in the EU. The outcomes of the former policy are driven by a "visa-substitution" effect within the group of current emigrants, while the latter scenario results in increasing the pool of international migrants. Both policies induce a "destination-substitution" effect - losses of skilled migrants by the non-EU states, which is significantly reinforced by the multilateral resistance to migration.

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

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1 Introduction

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

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

The observed discrepancy in migration policies in the EU and other rich destinations is the core motivation for this paper, which identifies the consequences of reducing the gap in selective migration

[1] Recent literature documents that international migration brings a non-trivial impact on the welfare of natives in the sending and the receiving countries (Docquier et al., 2015; Aubry et al., 2013). An important role in this process is played by the selection of migrants regarding their education level (Grogger and Hanson, 2011).

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

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

Along with the quantitative results, this paper contributes to the theoretical literature on modeling international migration. This is the first approach towards enriching a classical discrete choice model (with many sending and receiving countries) in the vein of McFadden (1973), with agents' decisions about the duration of stay, inspired by Djajić (2014a). For a simplified version of this model I provide closed-form solutions for the probabilities of emigration and the distribution of duration of stay. Since the full model becomes relatively complex at some level, I solve it numerically. Furthermore, following Bertoli and Moraga (2013), the proposed theoretical framework gives a micro-foundation for multilateral resistance to migration (MRM), by relaxing the independence of irrelevant alternatives (IIA) axiom (as a consequence of a non-trivial correlation structure between discrete choice options).[3] In this framework, I experiment with alternative visa policies in the EU.[4] I focus on the way the migration policy affects the destination choices of migrants (*geographical dimension*), the duration of stay (*time dimension*), and the selection of migrants with respect to their education levels (*skill dimension*). The theoretical and numerical outcomes show that a simultaneous consideration of these three factors enables to single

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

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

previously overlooked economic effects out. Moreover, neglecting MRM due to disregarding some of those dimensions may bring a significant bias in the quantitative evaluation of counterfactual migration policies.

Considering the numerical outcomes of the simulations, I give evidence that the proposed modifications of the EU's migration policy may have a visible impact on the supply of skilled labor. Implementing an H1B visa in the EU (which can be considered as a substitute for further development of the EBC program) increases the yearly flows of college-educated workers by 3%, and the total stocks 6.1%. This policy improves the relative attractiveness of medium-term visas in Europe, therefore, it induces a "visa-substitution" effect: the current migrants with short-term and long-term visas are now more prone to substitute them for cheaper medium-term visas within the same destination. However, the H1B policy has no impact on the absolute attractiveness of Europe: it leaves the pool of of talents unchanged. Additional flows are procured by a "destination-substitution" effect: some of the current migrants in non-EU countries decide to migrate to the EU. In terms of the tax concession policy, the aggregated flows of high-skilled immigrants in Europe increase by 10.6%, while total stocks change by 5.6%. In this case, the "visa-substitution" effect is quantitatively less important, while the "destination-substitution" effect remains sizable. The main economic force that determines the large change in inflows, is the augmentation of the absolute attractiveness of Europe, which induces a strong "size" effect: an increase in the pool of actual immigrants in the EU.

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

2 Links with existing literature

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

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

The time dimension in people's decisions about international migration has been introduced to theoretical models of migration in the early works by Djajić and Milbourne (1988), Djajić (1989), Galor and Stark (1990), Dustmann (1993), and Borjas and Bratsberg (1996). These papers also treat the choice of the length of the period spent abroad as a solution to the utility maximization problem. A representative person cares about the life-cycle utility which depends on the level of wages or the total stock of financial, or human capital.[5] More recently, Dustmann and Weiss (2007), Adda et al. (2014), and Dustmann

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

and Görlach (2015) mention four mechanisms that bring incentives for deciding to migrate temporarily.[6] Furthermore, Dustmann and Görlach (2015) provide a thorough analysis of hitherto state of literature on temporary migration and construct a theoretical model which incorporates these potential motives for earlier return. Dustmann et al. (2011) proposes a two-skill, two-country model to account for specific selection and return patterns. They conclude that people have more incentives to stay in a country that rewards more their main skill, so that in aggregated terms, temporary migration is a source of "brain circulation".[7] The fact that temporary migrants may bring significant positive spillovers for the sending countries is highlighted, among others, by Dustmann and Görlach (2015). Bijwaard and Wahba (2014) empirically confirm that such a process takes place, and the high-earners are more likely to return home.

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

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

[7]A relatively new strand of literature emphasizes the "brain circulation" process which is a direct consequence of return migration. This approach is a complement rather than a substitute to the well-developed notions of "brain drain" and "brain gain". In the case of "brain drain", emigration necessarily causes impoverishment of the sending countries, because those who decide to leave the country of birth are the well-educated workers (Docquier and Rapoport, 2012). The positive selection of out-migration causes negative economic effects for the sources, since the benefits are transferred to the destinations along with the flow of human capital. An immediate response to this theory is the concept of "brain gain" which stresses the fact that in the poorer countries, rational economic agents would invest in their education in order to increase their chance to emigrate. This process, in the long run, would eventually provide strong positive effect for the developing economies. Finally, considering the fact that not all migrants are permanent, the returnees are expected to bring their human, social and entrepreneurial capital home. This process is broadly referred to as "brain circulation".

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

The relation between temporary flows of people and migration policy is analyzed by Thom (2010). By simulating a two-country model, the author concludes that more restrictions leads to a smaller gross flow of Mexicans to the US. However, the stock of immigrants may rise due to an increase in the average length of stay of those who decide to emigrate. Constant and Zimmermann (2011) point out that people decide to migrate temporarily (and circularly) when the barriers for mobility decline. In a multi-country context, Giordani and Ruta (2013) and De la Croix and Docquier (2012) suggest the possibility of coordination failures in terms of designing international migration policies which lead to a Pareto-dominated outcomes. In conclusion, they express the need for a global coordination in migration policy.[8] Docquier and Machado (2015) impose a global liberalization of migration, and quantify the aggregated flows of high-skilled migrants within a multi-country framework. All of these articles investigate a general decrease in the costs of migration, without explaining which policy instruments are used. Contrary to these studies, this paper considers well defined, easily implementable migration policy reforms, represented by a credible reduction of visa costs, or a realistic tax concession scheme.[9]

3 Decisions about destination and the duration of stay

I start with introducing a general version of the model. The *ex ante* decision (which is made before migrating), is analyzed below. At this stage agents know their individual preferences towards living in

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

[9]In fact some European countries have already introduced a tax reduction scheme for the best candidates. In Italy, Denmark, or Sweden, scientists, researchers, or other experts, who join temporarily local labor markets, may be eligible for a short-term reduction of income taxes. This policy, however, considers only a small fraction of high-skilled immigrants, not every college-graduate is allowed to apply for this program.

different countries $j \in \mathcal{N}$, represented by random components: ε_j, and the expected (or equivalently, anticipated) country-pair-specific cost of migration from i to j: x_{ji}. These variables includes legal (in particular: visa) and psychological, sociological, as well as cultural costs. The *ex post* decision (made after migrating) is subject to additional information. The values of unforeseen costs of living abroad (denoted by ρ_{ji}) are revealed, and force individuals to modify their decisions about the duration of stay. The latter is analyzed in the next subsection.

Consider an economic agent, who currently lives in country i and considers moving to country $j \in \mathcal{N}$.[10] Each individual is economically active for one period which lasts 1 unit of time, equivalent to 50 years.[11] She can choose any of N destinations grouped in the choice set $\mathcal{N}$, including her homeland i. Receiving countries differ in the levels of net wages (denoted by v_j) and in the expected costs of migration, (labeled by $x_{ji}(\bar{d})$), dependent on the authorized maximal duration of stay $\bar{d} \in [0, 1]$.[12] Furthermore, each country $j \in \mathcal{N}$ provides an individual offer of visas for the prospective immigrants. Assume that there are D_j types of permissions of stay in a destination j, and each migrant selects her preferred option $\bar{d} \in \mathcal{D}_j$. Assuming her *ex ante* decision to be binding, an immigrant would spend time $\bar{d}$ abroad and return to her homeland for the remaining part of her life: $1 - \bar{d}$.

People have heterogeneous preferences towards living in each receiving country. Consequently, the utility component related to living in state $j \in \mathcal{N}$ is augmented with an agent-specific random term ε_j, which represents the taste for living in country j.[13] Assume that ε_j is an iid stochastic variable distributed according to the Gumbel's distribution. In this vein, this approach refers to the literature which uses the discrete choice random utility maximization (RUM) model.[14]

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

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

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

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

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

All the above-mentioned values are known to the agent *ex ante*, that is before the actual moving. What is not revealed to the individual, is the unanticipated migration cost, ρ_{ji}, which enters the utility function quadratically. This element represents the unforeseen cultural, social and institutional aspects of living abroad for a migrant from i to j, in contrast with the expected migration cost $x_{ji}(\bar{d})$, known *ex ante*.[15] Having no experience in being a part of a foreign society, an agent predicts that emigration may be either detrimental for his lifetime utility (positive value of ρ_{ji}), or beneficial ($\rho_{ji} < 0$), if the lifestyle in the destination country suits them better. Therefore, she forms an *ex ante* (before emigration) expectation of the value of this parameter. I consider a situation in which ρ_{ji} is distributed according to a probability density function $\bar{\rho}(\cdot)$ defined on $\mathbb{R}$. Since *ex ante* people have neutral expectations about the unforeseen circumstances after migration (all other foreseeable factors are captured by $x_{ji}(\bar{d})$), a necessary requirement is that $\mathbb{E}[\bar{\rho}_{ji}] = 0$. Thus, *ex ante* the expected value of the unforeseen migration cost does not influence the choice of destination and visa type. In this way, ρ_{ji} brings the second source of heterogeneity across agents. In brief, the model considers people having "bad" draws of unexpected migration costs, characterized by $\rho_{ji} > 0$ (where ρ_{ij} is the realization of a random variable $\bar{\rho}_{ij}$, independent of individual preferences towards different destinations, ε_j), and those who assimilate well in the host country, with: $\rho_{ji} < 0$.

After entering the labor market in country i, an individual compares the expected, *ex ante*, gains in each country j, represented by a linear, random utility function (considered, among others, by Grogger and Hanson, 2011)[16]:

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

In order to reach their decisions about future location, individuals compare the levels of net wages across all destination $j \in \mathcal{N}$.[17] They also consider their individual tastes towards living in foreign countries and potential costs ascribed to moving (both tangible and non-tangible ones). In details, α is the marginal

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

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

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

utility of income, and v_j is the net wage (gross wage in USD PPP reduced by mandatory income taxes in destination j). $x_{ji}(\bar{d})$ stands for expected, bilateral migration cost of moving from i to j, for a period of length $\bar{d}$, determined by the receiving country visa policy: $\bar{d} \in \mathcal{D}_j$. The legal part of this cost is the main policy instrument of the destination authority targeted at influencing the total flows of high-skilled immigrants. Additionally, as stated before, the utility depends on the individual preferences: ε's, and the expected value of the unforeseen migration cost equal, by assumption, to 0. Finally, the *ex ante* decision boils down to selecting the preferred destination country j^* and the duration of stay $\bar{d}^*$ defined by the visa portfolio $\mathcal{D}_{j^*}$. The agent chooses from $K = \sum_{j=1}^{N} D_j$ options, and takes the optimal *ex ante* decision:

$$(j^*, \bar{d}^*) = \underset{j \in \mathcal{N},\ \bar{d} \in \mathcal{D}_j}{\operatorname{argmax}}\ \mathbb{E}[U_{ji}(\bar{d})]. \tag{2}$$

After reaching a new destination country, agents discover the exact value of the unforeseen migration cost ρ_{ji}. Their *ex ante* measure of utility (1) is therefore modified by considering the actual realization ρ_{ji} of the random variable $\bar{\rho}_{ji}$. Given that the return cost is incorporated in the expected migration cost x_{ji}, the agent has to re-optimize the decision about the length of her stay by defining the time after which she would like to return to her homeland.[18]

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

$$U_{j^*i}(\bar{d}^*, d) = d\left(\alpha\left(v_{j^*} - x_{j^*i}(\bar{d}^*)\right) + \varepsilon_{j^*} - d\rho_{j^*i}/2\right) + (1-d)\left(\alpha v_i + \varepsilon_i\right). \tag{3}$$

Notice that this utility function is defined for a given destination j^* and a given visa type $\bar{d}^*$ determined in the *ex ante* decision problem (2). Eventually, each individual reconsiders her emigration strategy by selecting the optimal duration of migration spell (expressed now by $d \in [0,1]$), through the maximization of her *ex post* (after emigration) utility:

$$d^* = \underset{d \in [0,1]}{\operatorname{argmax}}\, U_{j^*i}(\bar{d}^*, d) \tag{4}$$

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

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

3.1 A model with one, permanent-stay visa

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

$$\begin{aligned} &\exists j \in \mathcal{N} \setminus \{i\}: \quad \alpha (v_j - x_{ji}) + \varepsilon_j > \alpha v_i + \varepsilon_i \quad \Rightarrow \quad \bar{d}^* = 1 \quad \& \quad j^* = j, \\ &\forall j \in \mathcal{N} \setminus \{i\}: \quad \alpha (v_j - x_{ji}) + \varepsilon_j \leq \alpha v_i + \varepsilon_i \quad \Rightarrow \quad \bar{d}^* = 0 \quad \& \quad j^* = i. \end{aligned} \tag{5}$$

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

$$\pi_{ji} = \frac{\exp\left[\alpha \left(v_j - x_{ji}\right)\right]}{\sum_{k=1}^{N} \exp\left[\alpha \left(v_k - x_{ki}\right)\right]}. \tag{6}$$

Notice that the result (6) implies that the ratio of probabilities to emigrate to any two distinct destinations $j, k \in \mathcal{N}$ fulfills the Independence of Irrelevant Alternatives (IIA) axiom:

$$\frac{\pi_{ji}}{\pi_{ki}} = \exp\left[\alpha \left(v_j - x_{ji} - v_k + x_{ki}\right)\right]. \tag{7}$$

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

The second key simplification of the model concerns the distribution of unforeseen costs of living abroad: $\bar{\rho}_{ji}$. Consider the simplest density function that fulfills the demanded requirement (zero expected value): a symmetric two-point distribution. Assume that $\bar{\rho}_{ji}$ can take two possible values: $-\rho_{ji}$ or ρ_{ji}, with equal probabilities. Now, the *ex post* decision reached by a permanent migrant determines the optimal duration of stay. Being granted a visa, a person may stay in the receiving country as long as she wants. By solving the maximization problem (4), one gets:

Proposition 1. *The optimal, ex post duration of migration is given by:*

$$d^* = \begin{cases} \min\left\{\rho_{j^*i}^{-1}\left(V_{j^*i} + \varepsilon_{j^*} - \varepsilon_i\right); 1\right\}, & \text{if} \quad \rho_{j^*i} > 0, \\ 1, \quad \text{if} \quad \rho_{j^*i} < 0, \end{cases} \tag{8}$$

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

Proof. See Appendix A. □

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

$$\Pr\left[d < \delta\right] = \Pr\left[\rho_{ji}^{-1}\left(V_{ji} + \varepsilon_j - \varepsilon_i\right) < \delta\right] = \Pr\left[\rho_{ji}\delta + \varepsilon_i > V_{ji} + \varepsilon_j\right] = \frac{e^{\rho_{ji}\delta}}{e^{\rho_{ji}\delta} + e^{V_{ji}}}. \tag{9}$$

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

Corollary 2. *When* $\rho_{ji} > 0$, *for a given* $\delta \leq 1$, *the probability of staying for a period shorter than* δ *(the CDF of the duration of stay) is:*

$$F(\delta) = \frac{e^{\rho_{ji}\delta}}{e^{\rho_{ji}\delta} + e^{V_{ji}}}. \tag{10}$$

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

$$f(d) = \frac{\rho_{ji} e^{\rho_{ji} d + V_{ji}}}{\left(e^{\rho_{ji} d} + e^{V_{ji}}\right)^2}. \tag{11}$$

Proof. The CDF is derived in equation (9). The PDF is the first derivative of the CDF. □

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

$$\Pr\left[V_{ji} + \varepsilon_j > \varepsilon_i\right] = \frac{e^{V_{ji}}}{1 + e^{V_{ji}}}. \tag{12}$$

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

$$\Pr\left[d < \delta | d > 0\right] = \frac{1 + e^{V_{ji}}}{e^{V_{ji}}} \int_0^{\delta} \frac{\rho_{ji} e^{\rho_{ji} t + V_{ji}}}{\left(e^{\rho_{ji} t} + e^{V_{ji}}\right)^2} dt = \frac{e^{\rho_{ji} \delta} - 1}{e^{\rho_{ji} \delta} + e^{V_{ji}}}. \tag{13}$$

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

Corollary 3. *When* $\rho_{ji} > 0$*, for a given* $\delta \leq 1$*, the probability of staying for a period shorter than* δ *conditional on emigrating (the CDF of the positive duration of stay) is:*

$$F_{d>0}(\delta) = \frac{e^{\rho_{ji} \delta} - 1}{e^{\rho_{ji} \delta} + e^{V_{ji}}}. \tag{14}$$

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

$$f_{d>0}(d) = \frac{\rho_{ji} e^{\rho_{ji} d} (1 + e^{V_{ji}})}{(e^{\rho_{ji} d} + e^{V_{ji}})^2}. \tag{15}$$

Proof. See Appendix A. □

According to equations (14) and (15), a higher unforeseen cost leads to shorter durations of stay (the mass of probability is concentrated on the left hand side, see Figure 1, Panel A for the density function and Panel C for the cumulative distribution). Conversely, if the net value of migration V_{ij} increases, then the length of a period spent abroad increases, which is depicted by a shift of probability density towards the right hand side, see Figure 1, Panel B and D (density and cumulative, respectively).

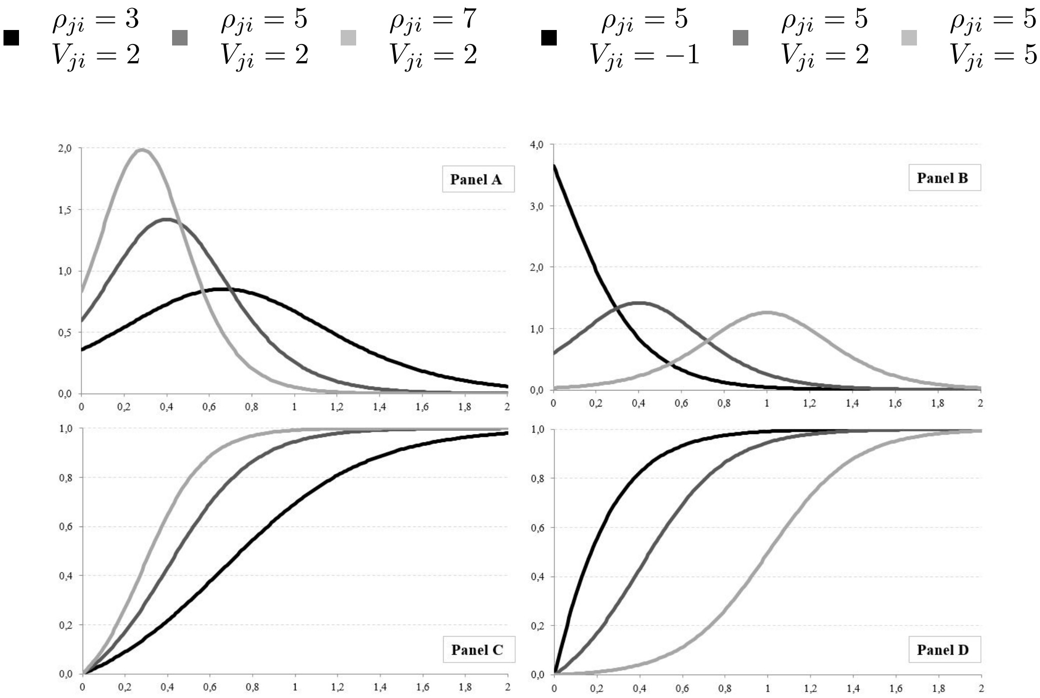

Figure 1: Comparative statics of conditional distributions of durations of stay, with respect to unforeseen migration costs ρ and net value of migration V. Source: own calculations.

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

Proposition 4. *The probability of being a temporary migrant is given by:*

$$\Pr\left[d < 1 | d > 0\right] = F_{d>0}(1) = \frac{e^{\rho_{ji}} - 1}{e^{\rho_{ji}} + e^{V_{ji}}}. \tag{16}$$

The probability of being a permanent migrant is given by:

$$\Pr\left[d \geq 1 | d > 0\right] = 1 - F_{d>0}(1) = \frac{1 + e^{V_{ji}}}{e^{\rho_{ji}} + e^{V_{ji}}}. \tag{17}$$

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

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

$$L_j(\tau) = \sum_{i=1}^{N} N_{ji}(\tau). \tag{18}$$

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

$$\tilde{N}_{ji} = \frac{e^{\rho_{ji}} - 1}{e^{\rho_{ji}} + e^{V_{ji}}} \frac{N_{ji}}{2}, \qquad \hat{N}_{ji} = \left(\frac{1 + e^{V_{ji}}}{e^{\rho_{ji}} + e^{V_{ji}}} + 1 \right) \frac{N_{ji}}{2}. \tag{19}$$

The key question from the point of view of the destination country is the actual labor force that is attracted during a period of one generation. One can calculate this number using the density of the average duration of stay of all migrants. Of course, permanent migrants fully contribute to the host country's labor supply, so their weight in the aggregate is 1 (taking the units of the generation period, 50 years). Therefore they provide exactly $\hat{N}_{ji}$ units of labor. More computation is required to determine the labor force of temporary migrants, since everyone stays in the destination country according to her individual optimal decision about d^*. In consequence, a temporary migrant does not participate in the foreign labor market for the whole period, but individually decides about her optimal duration of stay. Knowing the country-pair-specific, conditional distributions of durations of stay (derived in Proposition 4), it suffices to compute the following conditional expectation: $\mathbb{E}_{d>0}[d^*|d^* < 1]$. After summing up temporary and permanent migrants, one arrives at an expression that (multiplied by the total, gross migration flow: N_{ji}) represents the effective labor supply in country j originating from country i during one period of time.

Proposition 5. *The total labor force in country j immigrating from country i (expressed in the number of foreigners available for the period of one generation, 50 years) is equal to:*

$$L_{ji}(V_{ji}, \rho_{ji}) = \frac{N_{ji}}{2}\left(\frac{1+e^{V_{ji}}}{\rho_{ji}e^{V_{ji}}}\ln\left(\frac{1+e^{V_{ji}}}{1+e^{V_{ji}-\rho_{ji}}}\right)+1\right). \tag{20}$$

Proof. See Appendix A. □

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

Corollary 6.

$$\begin{aligned}
\lim_{\rho_{ji}\to 0} L_{ji}(V_{ji}, \rho_{ij}) &= N_{ji}, & \lim_{V_{ji}\to\infty} L_{ji}(V_{ji}, \rho_{ji}) &= N_{ji}, \\
\lim_{\rho_{ji}\to\infty} L_{ji}(V_{ji}, \rho_{ji}) &= N_{ji}/2, & \lim_{V_{ji,t}\to-\infty} L_{ji}(V_{ji}, \rho_{ji}) &= N_{ji}\frac{(1-e^{-\rho_{ji}})}{\rho_{ji}}, \\
\lim_{\rho_{ji}\to 0} L_{ji}(-\infty, \rho_{ji}) &= N_{ji}, & \lim_{\rho_{ji}\to\infty} L_{ji}(-\infty, \rho_{ji}) &= N_{ji}/2.
\end{aligned} \tag{21}$$

Proof. See Appendix A. □

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

4 Multi-destination and multi-visas model

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

4.1 Model with two types of visas

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

$$\begin{aligned}
&\mathbb{E}[U_{ii}] = \alpha v_i + \varepsilon_i, \\
&\mathbb{E}[U_{ji}(\bar{d}^t)] = \bar{d}^t \left(\alpha \left(v_j - x_{ji}(\bar{d}^t)\right) - \bar{d}^t \mathbb{E}[\bar{\rho}_{ji}]/2 + \varepsilon_j\right) + (1 - \bar{d}^t) \left(\alpha v_i + \varepsilon_i\right), \\
&\mathbb{E}[U_{ji}(\bar{d}^p)] = \alpha \left(v_j - x_{ji}(\bar{d}^p)\right) - \mathbb{E}[\bar{\rho}_{ji}]/2 + \varepsilon_j.
\end{aligned} \tag{22}$$

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

Proposition 7. *If all N destination countries offer the same duration of temporary visas (equal to $\bar{d}^t$) and the differences in permanent and temporary migration costs are identical across destinations: $\Delta = x_{ji}(\bar{d}^p) - x_{ji}(\bar{d}^t) = x_{ki}(\bar{d}^p) - x_{ki}(\bar{d}^t)$ for $j \neq k$, $i, j, k \in \{1, ..., N\}$, then the unconditional probabilities of emigrating to a particular country $j \neq i$ are equal to:*

$$
\begin{aligned}
P[\mathbb{E}[U_{ii}] = \max] &= \frac{e^{\alpha v_i}}{\sum_{k=1}^{N} e^{\alpha(v_k - x_{ki}(\bar{d}^t))}}, \\
P[\mathbb{E}[U_{ji}(\bar{d}^t)] = \max] &= \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^t))}}{\sum_{k=1}^{N} e^{\alpha(v_k - x_{ki}(\bar{d}^t))}} - \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^t))}}{\sum_{k \neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))} + e^{\alpha\left(v_i + \frac{\Delta}{1 - \bar{d}^t}\right)}}, \\
P[\mathbb{E}[U_{ji}(\bar{d}^p)] = \max] &= \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^t))}}{\sum_{k \neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))} + e^{\alpha\left(v_i + \frac{\Delta}{1 - \bar{d}^t}\right)}}.
\end{aligned} \tag{23}
$$

Proof. See Appendix A. □

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

Corollary 8. *For any destination $j \neq i$ the ratios of probabilities of emigrating and staying are:*

$$
\begin{aligned}
\frac{P[\mathbb{E}[U_{ji}(\bar{d}^t)] = \max]}{P[\mathbb{E}[U_{ii}] = \max]} &= \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^t))}\left(e^{\frac{\alpha\Delta}{1 - \bar{d}^t}} - 1\right)}{\sum_{k \neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))} + e^{\alpha\left(v_i + \frac{\Delta}{1 - \bar{d}^t}\right)}}, \\
\frac{P[\mathbb{E}[U_{ji}(\bar{d}^p)] = \max]}{P[\mathbb{E}[U_{ii}] = \max]} &= \frac{e^{\alpha(v_j - x_{ji}(\bar{d}^p) - v_i)}\left(\sum_{k \neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))}\right)}{\sum_{k \neq i} e^{\alpha(v_k - x_{ki}(\bar{d}^t))} + e^{\alpha\left(v_i + \frac{\Delta}{1 - \bar{d}^t}\right)}}.
\end{aligned} \tag{24}
$$

Proof. The result is obtained by dividing second and third equations by first equation in (23). □

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

$$cor(\mathbb{E}[U_{ii}], \mathbb{E}[U_{ji}(\bar{d}^t)]) = cor(\varepsilon_i, \bar{d}^t \varepsilon_j + (1-\bar{d}^t)\varepsilon_i) = 1 - \bar{d}^t, \tag{25}$$

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

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

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

and finally:

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

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

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

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

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

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

Proposition 9. *When a host country offers temporary, as well as permanent visas ($\Delta > 0$), then the model exhibits multilateral resistance to migration. The elasticities of choice probabilities with respect to any country-specific characteristic: y_i are:*

$$\begin{aligned} E_j^{\mathbb{P}_{ji}} &\equiv \frac{\partial \mathbb{P}_{ji}}{\partial y_j} \frac{y_j}{\mathbb{P}_{ji}} = \frac{\partial V_{ji}}{\partial y_j} y_j \left(\frac{\pi_{ji}(1-\pi_{ji})}{\pi_{ji} - p_{ji}} - \frac{p_{ji}(1-p_{ji})}{\pi_{ji} - p_{ji}} \right) = \frac{\partial V_j}{\partial y_j} y_j \left(1 - \pi_{ji} - p_{ji}\right), \\ E_j^{\mathbb{P}_{li}} &\equiv \frac{\partial \mathbb{P}_{li}}{\partial y_j} \frac{y_j}{\mathbb{P}_{li}} = -\frac{\partial V_{ji}}{\partial y_j} y_j \left(\frac{\pi_{li}\pi_{ji} - p_{li}p_{ji}}{\pi_{li} - p_{li}} \right). \end{aligned} \tag{26}$$

Proof. See Appendix A. □

In contrast to the classical case with IIA axiom, the cross elasticities are l-specific, so they take different values for all the options $l \in N$.[19] Since one observes an asymmetric change in choice probabilities after an external shock, the IIA property is not maintained.

Let us now move to the *ex post* decisions about the duration of stay. The solution to problem (4) has the following form:

Proposition 10. *The optimal, ex post duration of migration is given by:*

$$d^* = \begin{cases} \min\left\{ \rho_{j^*i}^{-1} \left(V_{j^*i}(\bar{d}) + \varepsilon_{j^*} - \varepsilon_i \right); \bar{d} \right\}, & \text{if} \quad \rho_{i^*} > 0, \\ \bar{d}, \quad \text{if} \quad \rho_{j^*i} < 0, \end{cases} \tag{27}$$

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

Proof. See the proof of Proposition 1. □

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

Finally, one can explicitly represent the distributions of durations of stay (by visa type) in the same way as it was done in a model with one visa type. However, in contrast to what has been concluded before, the overall distribution of duration of stay (concerning the all types of high-skilled immigrants) will now be a combination of two distributions: of the temporary and permanent immigrants. Therefore, this aggregated distribution of duration of stay may not be (and typically is not) unimodal.

4.2 A model with three visas

For the purpose of a better representation of visa policies in the analyzed host countries, the last modification of the model considers three types of visas: a short-term one, a medium-term residence permit and a permanent staying permission. This general classification of visas is very close to what is proposed by the main destination countries for immigrants.[20]

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

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

$$
\begin{aligned}
&\mathbb{E}[U_{ii}] = \alpha v_i + \varepsilon_i, \\
&\mathbb{E}[U_{ji}(\bar{d}^{t1})] = \bar{d}^{t1} \left(\alpha \left(v_j - x_{ji}(\bar{d}^{t1})\right) - \bar{d}^{t1}\mathbb{E}[\bar{\rho}_{ji}]/2 + \varepsilon_j\right) + (1 - \bar{d}^{t1}) \left(\alpha v_i + \varepsilon_i\right), \\
&\mathbb{E}[U_{ji}(\bar{d}^{t2})] = \bar{d}^{t2} \left(\alpha \left(v_j - x_{ji}(\bar{d}^{t2})\right) - \bar{d}^{t2}\mathbb{E}[\bar{\rho}_{ji}]/2 + \varepsilon_j\right) + (1 - \bar{d}^{t2}) \left(\alpha v_i + \varepsilon_i\right), \\
&\mathbb{E}[U_{ji}(\bar{d}^{p})] = \alpha \left(v_j - x_{ji}(\bar{d}^{p})\right) - \mathbb{E}[\bar{\rho}_{ji}]/2 + \varepsilon_j.
\end{aligned}
\tag{28}
$$

As before, *ex ante* $\mathbb{E}[\bar{\rho}_{ji}] = 0 \; \forall i, j \in \mathcal{N}$. For this version I restrain from presenting the analytical results

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

due to their complexity and lack of additional insights in comparison to what was presented in the former subsections.

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

5 Numerical solution of the model

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

5.1 Data

The calibration of the model is based on the data for 2013. Each country $j \in \mathcal{N}$ is characterized by a uniform, gross wage for the high-skilled workers. I compute them for 178 countries in the sample, using the data on skill premiums for 52 countries, the shares of tertiary educated for 144 countries from the Barro-Lee database (Barro and Lee, 2013), and several explanatory variables from the WDI by the World Bank.[21] With the estimated parameters, I compute the predicted skill premiums, and, using the data on GDP per capita in PPP, I calculate the wage rates for the whole sample of 178 states. Finally, taking

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

the country-specific data on income taxation (originating from the yearly tax reports by Ernst & Young, KPMG, and Pricewaterhouse Coopers), I compute the net-of-income-tax wages, v_j. For the marginal utility of net income, α, I take the value of 0.05, following Grogger and Hanson (2011). This parameter represent the sensitivity of migration flows to annual wage differences. The full sample of 178 countries is presented in Table E.1, whereas the data on net wages for high-skilled workers are gathered in Table E.2.

Another set of observables concerns the yearly flows of migrants from 178 sources to 35 destinations with a distinction between college-educated workers who come with temporary (short and medium-term) visas and those who obtain permanent residence permits.[22] The gross flows of migrants aggregate individual, discrete-choice decisions about the destination country and the selected visa. Therefore, along with net wages, they determine the visa-specific, expected costs of migration, $x_{ji}(\bar{d})$.

In order to be able to estimate the parameters of the distributions of durations of stay (that is the country-pair-specific, unforeseen migration costs: ρ_{ji}), one needs empirical counterparts of the probabilities of staying, when migrating from any source i to any destination j. To this end, I calculate conditional, and unconditional probabilities of staying for migrants moving from any i to j, which proxies the properties of the distribution of duration of stay. The first strategy considers data on gross flows of immigrants, modified by return migration, taken from DIOC database provided by the OECD. The second computation grounds only on the bilateral gross flows of immigrants, estimated by Abel and Sander (2014). A detailed description of the procedure can be found in Appendix D.

5.2 Calibration algorithm

Considering the complexity of interdependencies between the utilities ascribed to different destinations and durations of stay, I decided to calibrate the model using a Monte Carlo method. One needs to determine the values of country-pair-specific and visa-specific migration costs, labeled by $x_{ji}(\bar{d})$ for all the sources and destinations considered: $j, i \in \{1, ..., N\}$, and three types of visas: $\bar{d} \in \{t_1, t_2, p\}$. Additionally, to be able to define the agents' aggregated behavior in terms of their preferred length of stay, I have to specify the country-pair-specific distribution of duration of stay which is dependent on the value of unforeseen migration cost: ρ_{ji}.

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

The initial step is the calculation of $x_{ji}(\bar{d})$. From the data describing the yearly inflows of immigrants for different visa types, I firstly compute the probabilities of emigration from each source country to any destination. Then, for a given sending country $i \in \{1, ..., N\}$ I separately conduct a Monte Carlo experiment. I draw 250,000 realizations of vectors of random components ε_j from Gumbel distribution, for all the 35 potential hosts j. These 35-dimensional vectors represent 250,000 potential migrants who have random tastes towards each destination. Starting with the initial values for migration costs, I iteratively compute the utilities ascribed to each and every migration option (28), and the simulated probabilities of emigration to any state with a particular visa type. Finally, using a conservative updating rule, I modify the actual values of $x_{ji}(\bar{d})$'s. The algorithm stops when the simulated probabilities of emigration are close to their empirical counterparts (the difference between each pair is less than 10^{-5}). With the values of migration costs in hand, one can predict the flows of migrants (by duration of visa) between any two country pairs. Figure E.1 presents the comparison of the aggregated skill-specific and visa-specific flows for 35 destinations (actual data versus model outcomes). Using the constructed average durations of stay, I compute total stocks of immigrants, as if the yearly flows of migrants were equal to the values from year 2013, over the whole 50-year period.

The second part of the calibration procedure tackles with the unforeseen migration costs. For each source i and each destination j I fit the conditional and unconditional probabilities of staying calculated using the DIOC and Abel and Sander (2014) databases (in fact I consider here only those country pairs, for which I have at least two data points). Initially, I draw 250,000 realizations of the difference between the random components: $\varepsilon_j - \varepsilon_i$ from the logistic distribution. These values represent 250,000 migrants from country i to country j. Then, I define the potential values of ρ_{ji} to be between 0.01 and 20, with step 0.01. For each of these steps, I calculate the simulated distribution of duration of stay of migrants from i to j. After sorting the immigrants with respect to their preferred visa type, I compute their actual durations of stay, after discovering the value of ρ_{ji}. In this way, the simulated distribution of lengths of stays is constructed, and the counterparts of empirical probabilities of staying can be calculated. At the end, the value of $\rho_{ji} \in [0.01; 20]$ which minimizes the Euclidean distance between the simulated and empirical probabilities is chosen as the best estimation. For those country pairs, for which the data on probabilities of stay are not sufficient, I extrapolate the values of ρ_{ji} using the estimations from a cross-section regression with gravity variables, and origin and destination fixed effects (see Table E.5). Figure

E.2 depicts the distributions of estimated values of ρ_{ji}'s for 35 receiving countries. More attractive destinations (i.e. Canada or the US) are generally characterized by lower values of unforeseen migration costs, than the less popular ones (i.e. Bulgaria or Romania).

5.3 Simulation algorithm

Each of the simulations starts with defining a new migration policy (either modifying visa costs, or providing fiscal incentives for immigrants). In the first counterfactual scenario, I assume that in all the EU countries the costs of 6-year visas are reduced to the levels that are observable in the US (where H1B visa is a well-known, well established policy device).[23] In describing this procedure, let me concentrate on a particular destination country - Germany (see Figure 2). The black points represent the average visa costs in the US (considering the 1-year, 6-year and a permanent visa). The light gray points depict the very same values for Germany in the reference scenario. It is clearly visible, that the 6-year visa is relatively cheaper in the US, and relatively more expensive in Germany (which imposes a convex visa cost function for the US, and a concave one for Germany). The goal is to decrease the cost of a 6-year visa in Germany (point X) in a way that imposes the relative cost structure from the US. To achieve this, I reduce this cost (to point Y), such that the ratio of difference in the costs of 6-year and 1-year visas (A^{DEU}) to the difference in the costs of 50-year and 1-year visas (B^{DEU}) is the same as in the US (and equal to A^{USA}/B^{USA}). This procedure is followed for all the other European destinations (computing all the country-pair-specific migration costs separately), and its outcomes are depicted in the Figure 3.

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

With new migration policies in the EU, I run another Monte Carlo simulation to calculate the counterfactual yearly flows of workers. In doing so, I take the modified migration costs and net wages as

[23] Apart from the legal part, the expected migration costs comprise of non-reducible part related to geography, social cohesion of migrants or cultural and social differences. An identification of importance of the main determinant of these elements is proposed in Table E.4. From these estimates, I also compute the legal visa costs for all countries, by investigating the destination-visa specific fixed effects that capture all the formal burdens on immigrants.

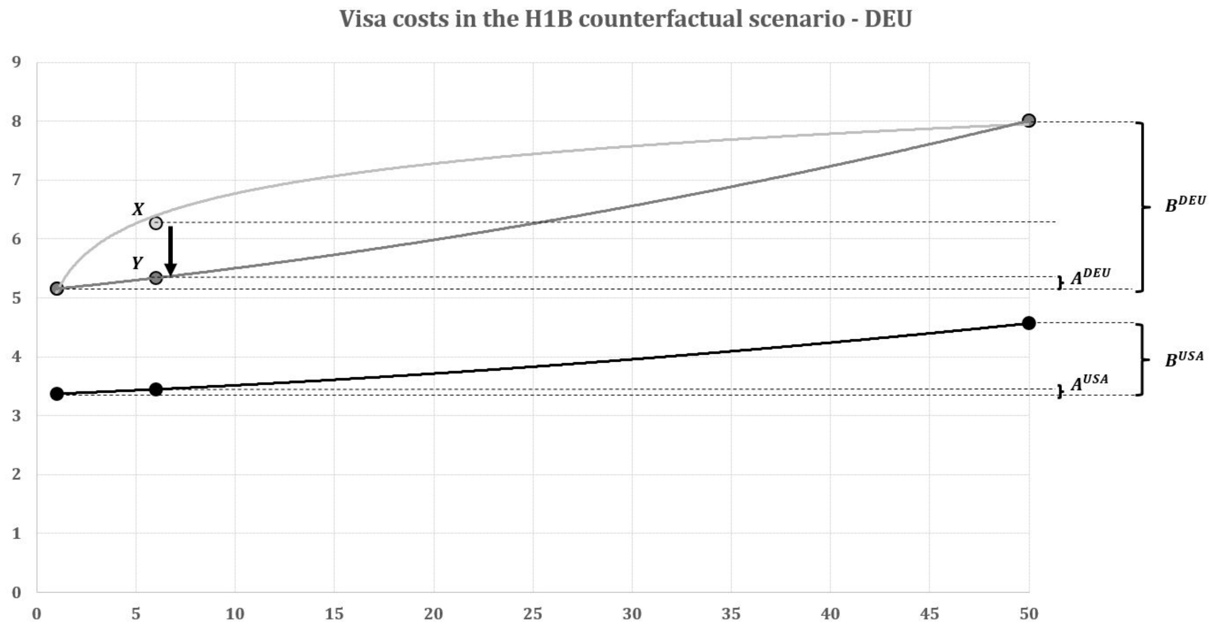

Figure 2: Reduction of visa costs to the H1B level - example of Germany

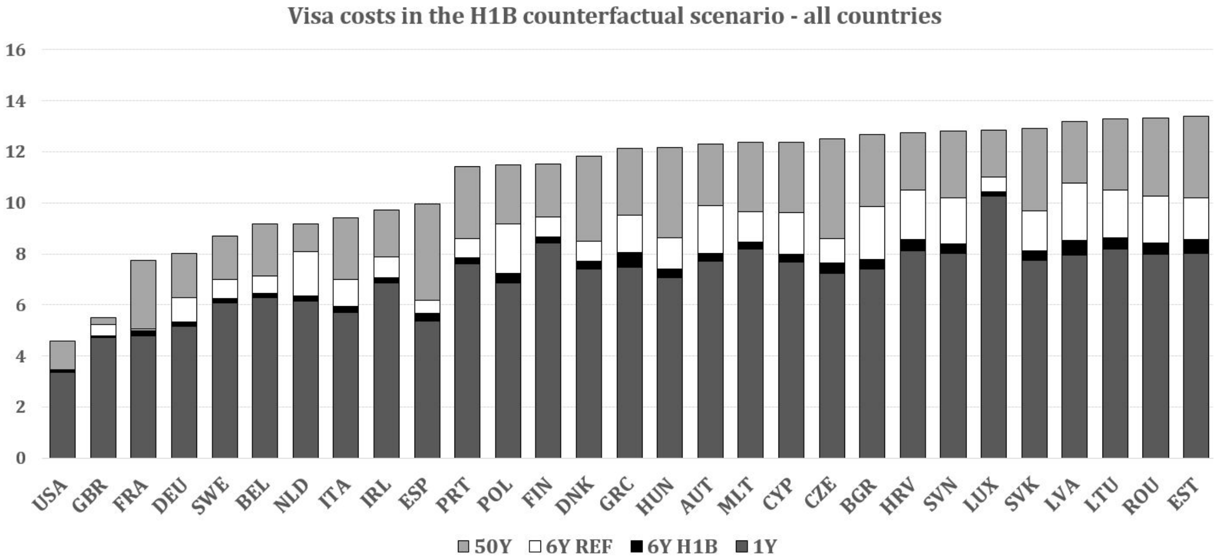

Figure 3: Visa costs in the reference, and in the counterfactual H1B scenarios in Europe

given, for the H1B simulation, and reference migration costs, and counterfactual net wages for the FI simulation. The unforeseen migration costs stay unchanged. For each of 178 sending countries I draw 2,000,000 realizations of the vectors of stochastic preferences towards 35 destinations and compute the optimal migration decisions for these values. This enables to calculate the probabilities of migration, and the actual flows of migrants for each country-pair and visa type.

Another Monte Carlo simulation targets the issue of fitting new duration distributions for each pair of sending and receiving countries. 2,000,000 realizations of the differences of random components $\varepsilon_j - \varepsilon_i$ are drawn, and the optimal durations of stay are determined, according to Proposition 10 in the case of three visas. The only things left to calculate are the average durations of stay, which determine the counterfactual stocks of immigrants.

6 Consequences of alternative migration policies

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

6.1 Introduction of H1B visa in the EU

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

The effects with respect to yearly inflows of immigrants are also heterogeneous across EU-members. The countries which gain the most are: Germany, the UK, the Netherlands and Italy. The only EU-member that loses highly skilled immigrants due to the H1B policy, is France. A possible explanation for this result could be the fact that France is already characterized by low migration costs for the well-educated candidates (which can be observed in Figure 2). Therefore, an H1B policy defined in the proposed counterfactual scenario, brings almost no change to the 6-year visa costs. Since other destinations significantly drop the barriers for medium-term immigrants, France is becoming relatively less attractive, and people substitute this destination for other European countries.

The results gathered in Table E.6 show that the changes in total stocks are not driven mainly by new inflows. The "size" effect of the proposed H1B policy (that is attracting the current non-migrants from all sources) is almost null. Conversely, the impact on aggregate numbers of high-skilled workers is resulting from visa switching of the current immigrants. For the short-term migrants (who have relatively high preferences towards living in the destination countries, but are at the threshold between 1Y and 6Y visa) and some permanent stayers (who have relatively low preferences towards the destination, and are at the threshold between 6Y and 50Y visa), a cheaper 6-year visa is an encouragement to choose a new H1B emigration option. Thus, without a huge number of new entries, some EU members (such as Sweden, Czech Republic, Estonia, or Poland) manage to visibly increase the number of high-skilled workers. To prove this "visa-substitution" property, consider the structures of immigration flows and stocks by visa types (see Figure E.4). In the reference scenario (first row of graphs), short-term immigrants constitute sizable parts of total inflows and stocks. In contrast, after implementing the H1B visa, the European countries experience a significant drop in the share of those migrants in both flows and stocks. For the permanent migrants the directions of the effects are similar, but the magnitudes are smaller.

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

6.2 Implementation of fiscal incentives in the EU

The alternative migration policy proposed in this paper, is a tax concession program for the high-skilled immigrants in the EU. Instead of changing visa costs for the medium-term candidates, I propose an augmentation of their net wage through a decrease in income tax rates by 10 p.p. in all member countries. The detailed results (see columns labeled with FI in Table E.6) for the stocks of high-skilled immigrants are similar to the case of H1B visa. In general, the EU experiences an increase in the total stock of high-skilled workers by 5.6%. Considering the ranking of countries (see Figure E.3b), significant differences relative to the H1B scenario may be observed for France, which is winning, and for Poland, that is losing high-skilled workers when applying the FI. While the former is caused by binding of the FI policy in France (and inefficacy of the H1B), the latter shows that in Poland the main barrier for the prospective high-skilled immigrants is the legal migration costs, not the low level of wages (the same is true in the case of Croatia, Bulgaria, and Latvia). Therefore, the H1B counterfactual is generally more beneficial for the countries with high visa costs (and harmful for the states with already well liberalized visa policy), whereas the contrary may be stated about the FI scenario. However, the majority of EU-members are between the two extremes, and both policies have similar impacts on the number of foreign professionals.

The tax concession brings a substantial increase in yearly flows of new high-skilled immigrants to Europe. The total inflow goes up by 10.6%, without a significantly stronger negative effect for the non-EU destinations. Even though the "destination-substitution" effect is still present, (because the FI improves the relative attractiveness of Europe comparing to other destinations), its magnitude is lower than in the case of H1B visas. The main impact comes from the improvement of EU's absolute attractiveness. This means that higher wages increase the pool of international, high-skilled migrants (a yearly flow of almost 70,000 people), which brings rise to the "size" effect. Simultaneously, the proposed migration policy has a small influence on the structure of inflows and total stocks, relative to the reference scenario (see Figure E.4). This means that the "visa-substitution" effect is far less pronounced then in the case of FI.

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

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

6.3 Accounting for the return premiums

Following the findings by Dustmann et al. (2011) and Dustmann and Görlach (2015), in this section, I propose a modification that includes the skill accumulation process for migrants. Since I do not consider heterogeneity of agents with respect to their skill level, this skill upgrading process is assumed to be reflected in the wages earned by emigrants, who decide to return to their home countries. The gains of returning migrants are assumed to be proportional to the duration of their stay, and the difference in wage levels in the destination and sending countries. The return premium (RP) is set to be equal to 20% of the wage difference (destinations minus source), if a person decides to return just before the end of 50-year migration spell, and proportionally lower, if the duration is lower.[24] Comparing the reference scenarios with and without RP, it can be stated that people tend to stay shorter when accounting for return bonuses (see Figure E.5). This effect confirms the intuition about the utility maximizing agents, who return home faster due to the expected higher wages at home.

[24]This magnitude of return premium is chosen to fit the estimations in the literature, which range from 5 to 34 percent of income in home country. For details see: Barrett et al. (2001); Barrett and Goggin (2010); De Vreyer et al. (2010); Martin and Radu (2012)

The results of H1B and FI counterfactual policies with return premiums are depicted in Table E.7 and in the Figures E.3c, d. Quantitatively, both the flows and stocks of high-skilled migrants are now higher after implementing both migration policies (comparing to a reference state of the world with RP). Therefore the overall effects are reinforced due to the reduced form the skill accumulation. Two economic processes drive these results. Firstly, those who already migrated, reduce their duration of stay, due to a bigger reward to returning. Secondly, people are more prone to emigrate due to a shift in wages, conditional on their return. Since the latter implication dominates, both flows and stocks of migrants are positively affected comparing to the outcomes of both policies without the RP. Qualitatively, the ranking of countries for both H1B and FI counterfactuals is slightly changed. Since the differences in RP are small across European destinations, one observes only minor modifications in the order of states.

6.4 Multilateral resistance to migration

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

The comparison of the aggregated results with and without the MRM is depicted in Figure E.6. The solid bars (left hand side axis) represent changes in the flows of immigrants, while the dashed bars (right hand side axis) give the results for stocks (in both cases the values are differences between model with MRM, and without MRM). The results show that MRM strengthens the positive effects of both migration policies for Europe. Consequently, the lack of MRM would benefit the non-EU countries, through lower losses of high-skilled workers. Indeed, due to correlations between migration options, agents are more responsive to migration shocks, when MRM is allowed. This concerns mainly the current migrants, who can substitute between the destinations more easily. The above mentioned phenomenon gives rise to a stronger "destination-substitution" effect, discussed with the previous results. In contrast, without MRM, all choice options are independent, so that a positive shock in migration policy is followed by a smaller response from the current emigrants, thus the “destination-substitution” effect is partially neutralized. The above exercise gives evidences that it is relevant to consider both geographical and time dimension of agents’ decisions, when conducting multi-country migration policy experiments. Omitting either of two elements (destination or duration choices) dampens the multilateral resistance to migration, and might have substantial consequences for the quantitative evaluation of the simulated policies.

7 Conclusion

This paper introduces a novel approach towards modeling international migration in the context of many source and destination countries, with endogenous choices of the length of stay. I propose a model in which people have heterogeneous tastes for living in different host countries, and may experience unforeseen costs after emigrating. The individual preferences govern the discrete choice of destination and the type of visa to apply for, while the unexpected migration costs determine the continuous decisions about the optimal duration of emigration spell. Since agents compare lifetime benefits from living temporarily or permanently in all the available destinations, the random utility ascribed to each possibility may be correlated with other options. Hence, the choice probabilities are not independent and the decision rule does not fulfill the IIA axiom, which provides a micro-foundation for multilateral resistance to migration.

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

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

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

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Appendix A Proofs of the properties of the model

Proof. (*Proposition 1*) Consider a migrant from country i to country j, characterized by $\rho_{ji} > 0$. Taking the first derivative of equation 3 with respect to duration d:

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

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

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

Proof. (*Corollary 3*) The conditional PDF, defined for $d > 0$ is equivalent to the unconditional PDF divided by the probability that $d > 0$, equation 12:

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

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

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

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

Proof. (*Proposition 5*) The expected, conditional duration of stay (for the temporary migrants characterized by $\rho_{ji} > 0$) is calculated from the definition:

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

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

$$\begin{aligned} L_{ji}(V_{ji}, \rho_{ji}) &= \frac{N_{ji}}{2} \left(\frac{1 + e^{V_{ji}}}{\rho_{ji} e^{V_{ji}}} \ln \frac{1 + e^{V_{ji}}}{1 + e^{V_{ji} - \rho_{ji}}} - \frac{1 + e^{V_{ji}}}{e^{\rho_{ji}} + e^{V_{ji}}} \right) + \frac{N_{ji}}{2} \frac{1 + e^{V_{ji}}}{e^{\rho_{ji}} + e^{V_{ji}}} + \frac{N_{ji}}{2} \\ &= \frac{N_{ji}}{2} \left(\frac{1 + e^{V_{ji}}}{\rho_{ji} e^{V_{ji}}} \ln \left(\frac{1 + e^{V_{ji}}}{1 + e^{V_{ji} - \rho_{ji}}} \right) + 1 \right). \end{aligned} \tag{A.4}$$

□

Proof. (*Corollary 6*) In computing the limits, whenever there appears an undefined symbol (i.e. $0 \cdot \infty$,

$0/0$ or ∞/∞), I write $\doteq$ to inform that the L'Hôpital's rule is used.

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

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

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

□

Proof. (*Proposition 7*) Let us concentrate on calculating the probability of choosing to stay in the homeland, that is: $P[\bar{U}_{ii} = \max]$, where, for simplicity, I take $i = 1$. Therefore, all the source-destination-specific variables are now denoted with a subscript i, instead of $i1$.

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

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

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

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

$$P[\bar{U}_1 = \max] = \frac{e^{\alpha v_1}}{\sum_{k=1}^{N} e^{\alpha(v_k - x_k^t)}} \tag{A.5}$$

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

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

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

$$
\begin{aligned}
&\alpha(v_j - x_j^t - v_i + x_i^t) \geq \alpha \left[d^t(x_i^t - v_i) - (1-d^t)v_1 + v_j - x_j^p\right] - (1-d^t)(\varepsilon_1 - \varepsilon_i) \iff \\
&\alpha \left(v_1 - v_i - \frac{1}{1-d^t} x_j^t + x_i^t + \frac{1}{1-d^t} x_j^p\right) \geq \varepsilon_i - \varepsilon_1.
\end{aligned}
\tag{A.6}
$$

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

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

Therefore, the inequality in A.6 cannot be reversed, provided that the measure of the set of solutions is not zero. Finally, one arrives at the probability equal to:

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

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

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

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

Proof. (*Proposition 9*)

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

□

Appendix B Visas by destination country

The most desired country for immigration, the United States, provides about 90 types of temporary visas, as well as green-cards for permanent immigrants. To apply for a particular type of temporary visa, a potential immigrant has to fulfill specific requirements connected with her education level, purpose of stay, international status (refugees) or affiliation (representatives). Not all the visas allow to work in the US, for example the widely popular B visas are issued only for short business or touristic visits. The potential duration of stay ranges from 1 year (in the case of D - crew visas, H-1A and H-2 - worker visas, P - athletes visas or Q - cultural exchange visas) to indefinite length of stay (as it is for the E - trade business partners visas or NATO - representatives visas). However, the most popular US visas which are issued for working purposes are the medium-term ones. The F-1 student visa allows the beneficiary to take full-time studies and to have a part-time job (or a full-time internship) during the period of stay (which mainly does not exceed 6 years). In 2013 the US issued more than 500,000 such permits. The J-1 "exchange visitor" visa for teachers and scholars, which can be extended up to 7 years, was the second popular type of permission in 2013 with over 310,000 applications. Finally, the H1-B visa program for high-skilled workers is constantly gaining popularity among professionals across all the countries. US companies are allowed to employ foreign highly educated workers for a period of 3 years. In fact, the majority of H1-B workers decides to prolong their stay for another 3 years. In 2014, the total number of accepted new applications was 124,326, whereas 191,531 workers continued their employment.[25] All in all, over 1.2 million immigrants out of 2 million new entrants to the US in 2013 were the medium-term temporary workers.

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

The EU (along with EEA countries) has a less restrictive immigration policy and shows an attitude far less oriented towards high-skilled workers. Any person from a third country may become eligible to enter the Schengen Area for a temporary stay of 3, 6 or 12 months. Then, after the expiration of current permission, one might prolong it for another period. An alternative, temporary migration option, introduced in 2009 by the European Parliament, is the European Blue Card Program. This device is targeted at high-skilled non-EU candidates who wish to work in the EU. The main restriction is connected with the salary of beneficiary, which has to be "at least 1.5 times the average gross annual salary paid in the Member State concerned".[26] The Blue Card program is still at its early stages and is not commonly used by the potential residents (in 2014 the EU granted about 13,000 documents, almost 90% of them concerned Germany). After 5 years of continuous living, working legally and paying taxes a non-EU worker may apply for a long-term immigrant status.[27] Finally, a long-term immigrant may apply for a citizenship after at least 5 years of long-term status.

Appendix C Data sources

For the US, I use the data from the 2013 Report of the Visa Office on the non-immigrant visas. This rich dataset provides the numbers of all visas (by type) issued each year for people originating from every country in the world. Additionally, I gather the data on permanent immigrants (by country of origin and cause of immigration). Both reports are available on the Visa Office web page.[28].

In the case of Australia, I use the data on temporary work visa grants published by the Department of Immigration and Border Protection for years 2012-2013.[29] From this dataset I extract the number of visas issued for the short term business visitors and working holidays (less than 1 year), and temporary

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

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

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

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

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

skilled workers (less than 6 years). Then, using the Australia's Migration Trends 2012-2013 report, I collect the numbers of permanent immigrants to Australia for ten most popular sources and for all the OECD countries.[30] For the rest of countries, which constitute approximately 15% of total inflows, I estimate the shares of sending countries in yearly flows using current stocks of immigrants.

In terms of New Zealand, I take the data on flows of work permits issued by the government in 2012-2013.[31] The applications in the published dataset are divided into 90 categories, each of them characterized by a specific duration of stay (ranging from 1 year to indefinite). Additionally, using the data on flows of new permanent residents (divided into 22 categories), it is possible to define the yearly flows of immigrants to New Zealand.

Concerning Canada, I collect the available data from Facts and Figures 2013: Immigration Overview database, provided by Research and Evaluation Branch, Citizenship and Immigration Canada (CIC).[32] For the temporary immigrants, Canada proposes two types of visas: International Mobility Program work permit, and Temporary Foreign Worker Program work permit. The numbers of new inflows for both categories by citizenship are available for top 50 sending countries. The rest, which constitutes less than 5%, is estimated using the structure of current stocks of immigrants. CIC publishes also the number of new permanent residents for the full set of source countries.

The UK provides a comprehensive dataset with country-specific flows of immigrants considering 24 types of visas. Using the immigration statistics published by Home Office I can compute the number of short and medium-term immigrants coming to the UK in 2013.[33] Finally, using the data on granted permanent settlements and citizenships, I compute the inflow of permanent immigrants.

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

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

Appendix D Computation of probabilities of staying

In the first strategy, I collect the data from Database on Immigrants in OECD Countries (DIOC) created by the OECD.[34] There are three sets of data for three reference years: 2000, 2005 and 2010. For each package, I extract the number of immigrants who arrived to the host country 0-5 years ago, 5-10 years ago, 10-20 years ago and earlier than 20 years ago. The key assumption made in this calibration procedure is about invariability in time of the duration distribution. If one accepts this limitation, it is simple to compute the above mentioned conditional probabilities.

Consider the stock of immigrants from country i to country j, whose actual length of stay in the year 2010 was between 5 and 10 years. This means that all of them must have emigrated between year 2000

[30] The report is available on-line: http://www.immi.gov.au/pub-res/Documents/statistics/migration-trends-2012-13.pdf
[31] See: http://www.immigration.govt.nz/migrant/general/generalinformation/statistics/
[32] The resources are published on: http://www.cic.gc.ca/english/resources/statistics/menu-fact.asp
[33] Available at: https://www.gov.uk/government/collections/migration-statistics#data-tables
[34] Data and metadata are available at: http://www.oecd.org/els/mig/dioc.htm

and 2005, thus they must have been registered in the year 2005 as immigrants from i to j with a duration of less than 5 years. However, in the group 0-5 in year 2005 there are also people who decided to leave the destination country before 2010. These persons are registers in 2005, but they are not registered in 2010. Assuming that the only cause of leaving is returning to the home country (disregarding re-emigration to other countries and deaths), the probability of staying at least 5-10 years, conditional on having stayed at least 0-5 years is equal to the ratio of the stock of immigrants in group 5-10 in 2010 to the stock of immigrants in group 0-5 in 2005.[35] Similarly, I compute the conditional probability of staying 10 years or more conditional on being in a 0-10 years group ten years before. I take the quotient of the stock of immigrants in group 10-20 in year 2010 to the stock of immigrants in group 0-10 in year 2000. The third empirical moment to fit is the probability of staying at least 20 years conditional on staying at least 10 years ten years before. Once again, I take the ratio of the stock of immigrants in group >20 in year 2010, to the stock of immigrants in groups 10-20 and >20 in year 2000.

The main problem with DIOC database is the fact that it is constructed using a random rounding procedure from national censuses, or the Labor Force Survey. As a consequence, the consistency of data from one release to another is not perfect, in a sense that the number of stayers in later groups may be larger than the number of stayers in the earlier groups. This leads to the values of conditional probabilities greater than one. When encountering such problem, I drop these observations. The final number of observations is 3880 values (out of 8316 data points), which gives 46.7% of data coverage.

Considering the above mentioned problems, and the fact that there are many missing observations, I decided to increase the set of observables with the values of unconditional probabilities: the shares of stayers in groups 0-5, 5-10 and 10-20 in year 2010 to the total flows of immigrants who came in years 2005-2010, 2000-2010 and 1990-2000 respectively. The latter, country-pair-specific data for the whole 196×196 country matrix are provided by Abel and Sander (2014). They estimate the gross flows of immigrants in 5-year intervals using the data on stocks of migrants, population of countries and births and deaths statistics.[36] Apart from controlling for values greater than one, one also has to notice that the unconditional probability of being in group 0-5 (that is the unconditional probability of staying at least the average number of years in group 0-5) is greater than the respective value for 5-10 years, which, in turn, exceeds the value for 10-20. The share of acceptable data equals 54.8%. All in all, for each of 2,772 country pairs I obtain one to six data points which characterize the distributions of duration of stay.

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

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

Appendix E Additional figures and tables

Table E.1: Sample and country codes

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

Source: ISO.

Table E.2: Net wages and fiscal burden for college-graduates

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

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

Table E.3: Yearly inflows and total stocks of high-skilled immigrants (by visa type)

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

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

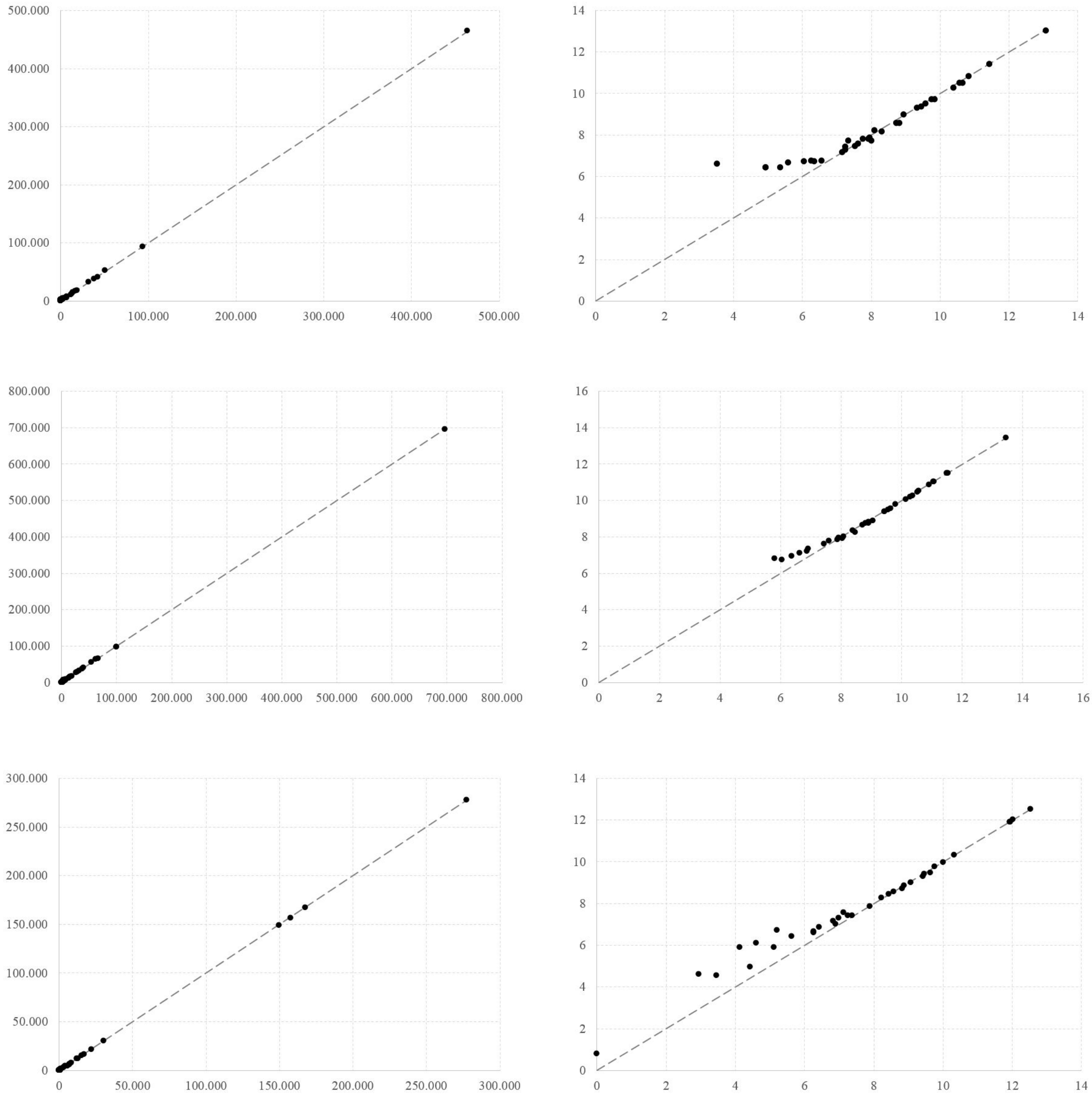

Figure E.1: Data (X axis) versus model outcomes (Y axis) for the yearly flows of short-term (first row), medium-term (second row), long-term (third row) high-skilled immigrants in 35 destination countries. First (second) column represents the values in number of people (in logs of the number of people).

Source: own calculations.

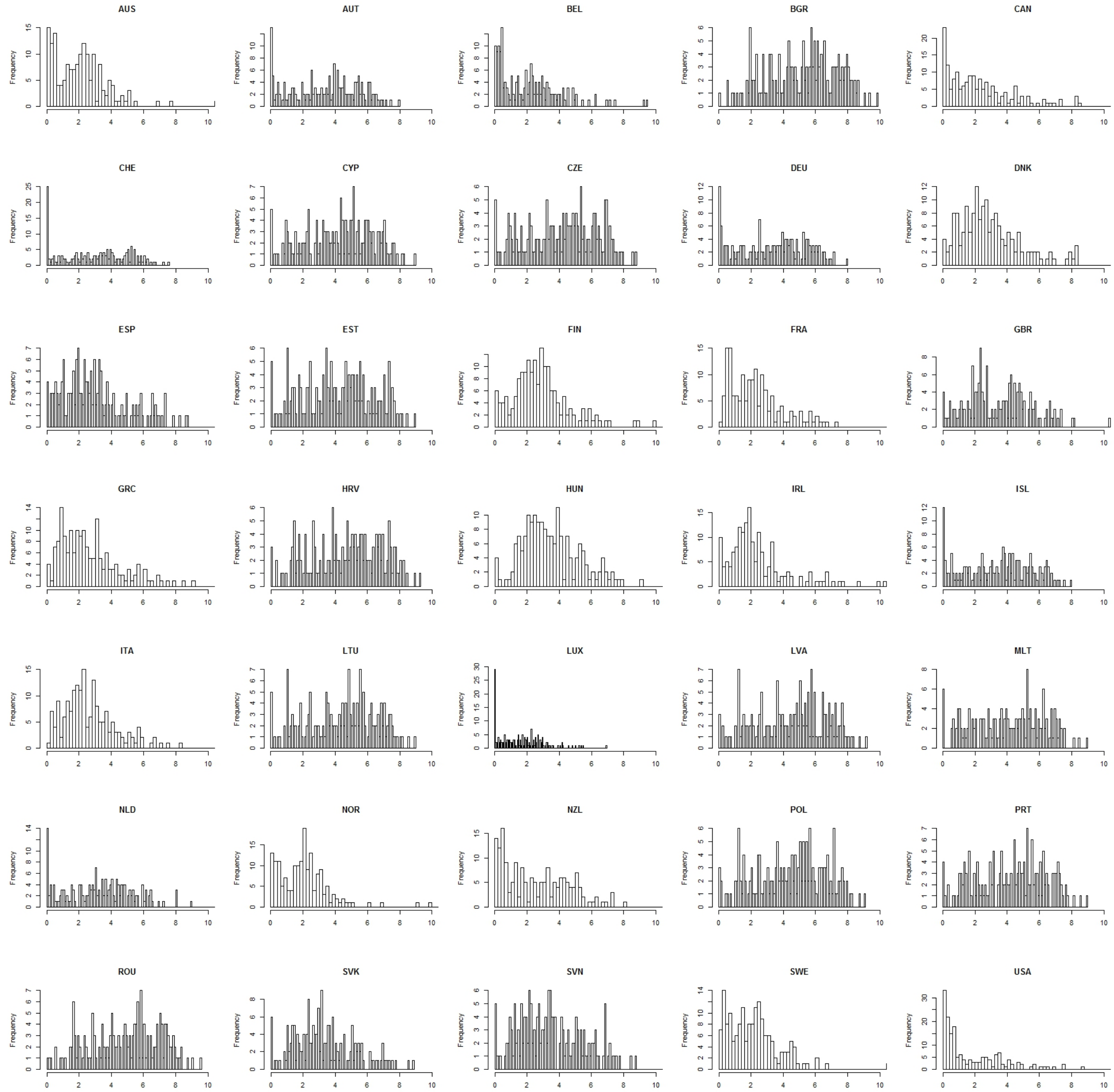

Figure E.2: Histograms of the computed values of unforeseen costs of living abroad, ρ_{ij}. Each figure presents the empirical distribution of the parameters for a particular destination country, and all 177 sending states.

Source: own calculations.

Table E.4: Decomposition of the expected migration costs, x

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

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

Table E.5: Extrapolation of unexpected migration costs, ρ

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

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

Table E.6: The results of H1B and FI simulations as deviations from the reference

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

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

Table E.7: The results of H1B and FI simulations as deviations from the reference, with return premiums

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

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

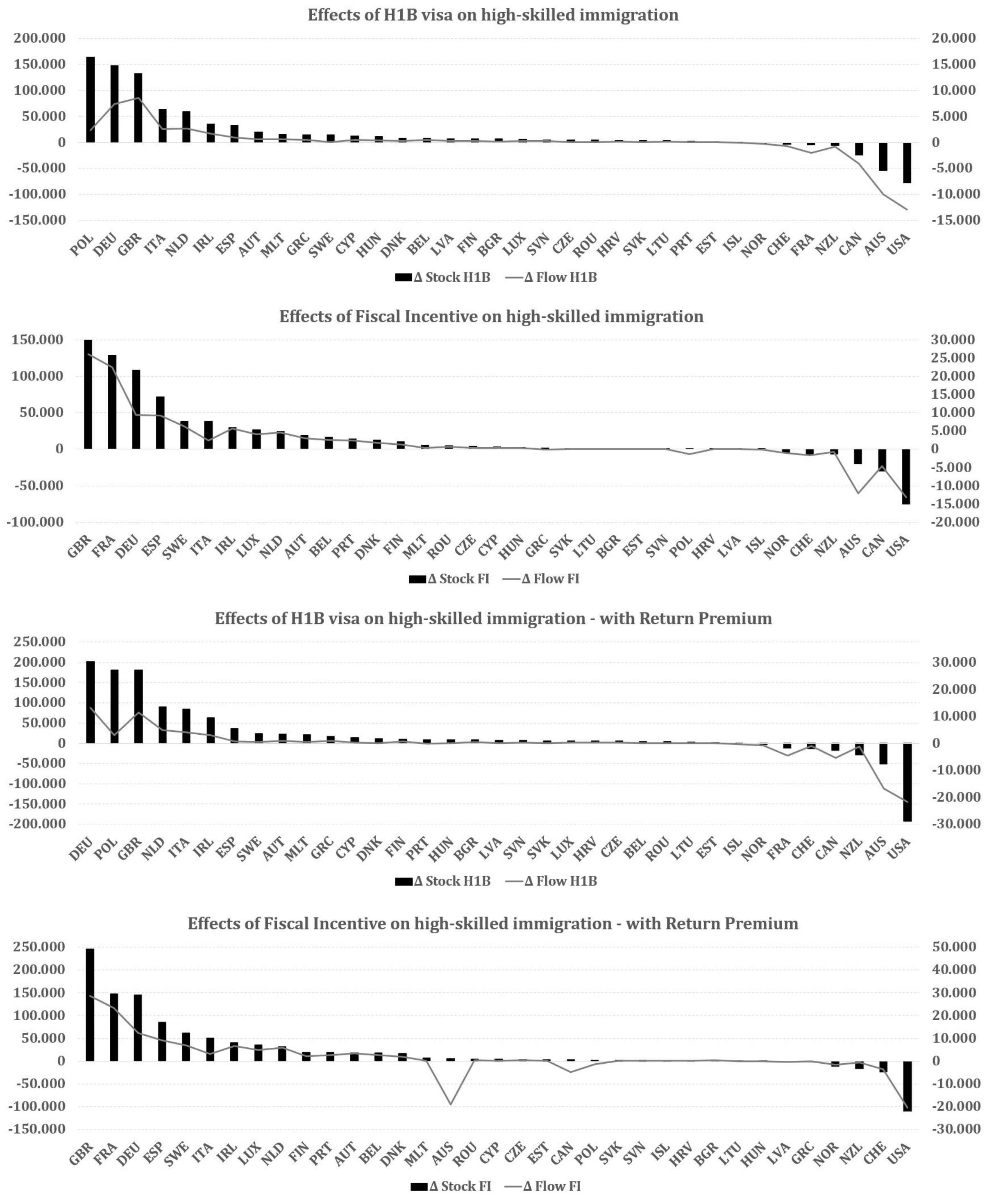

Figure E.3: The results of simulations

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

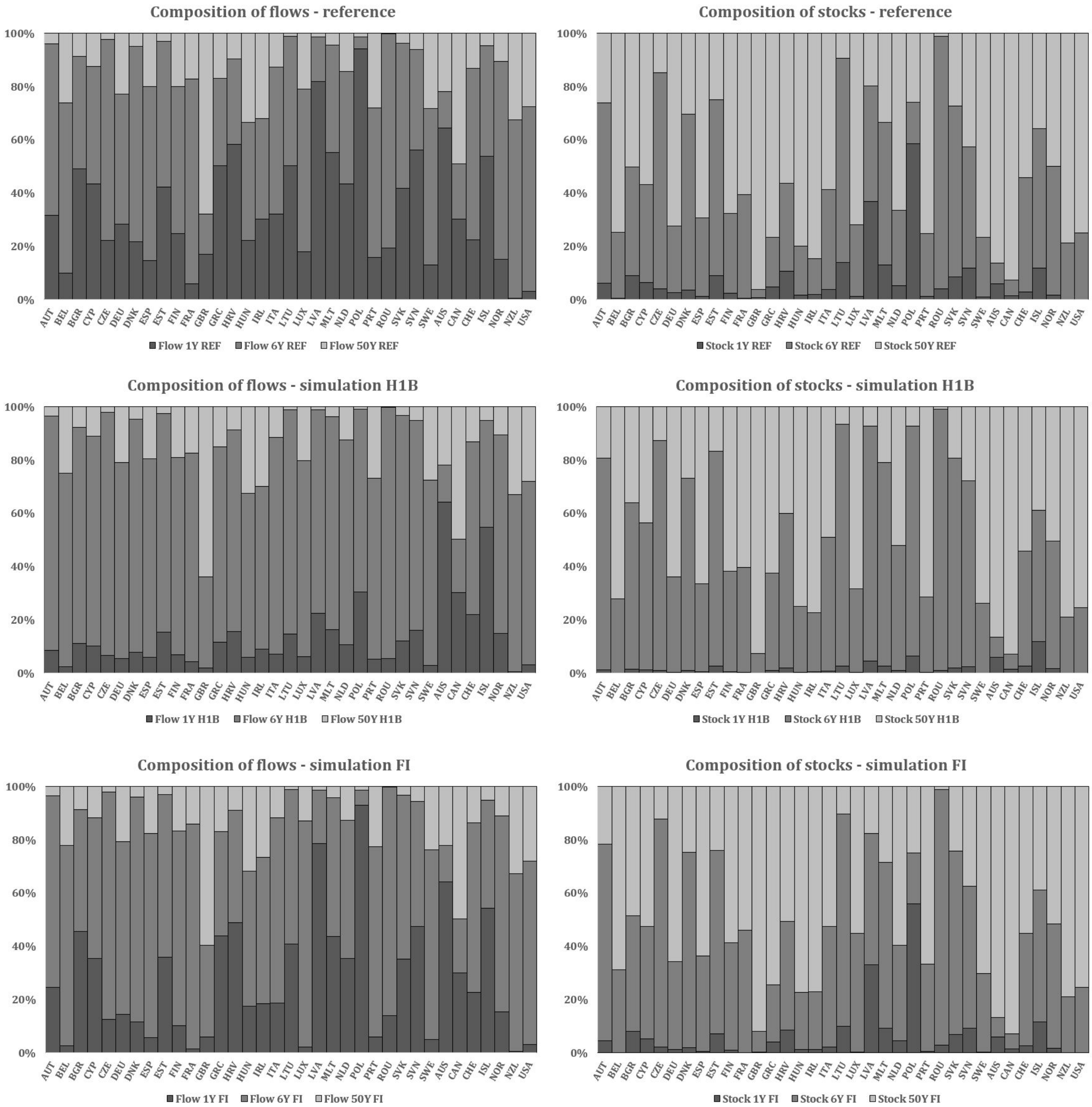

Figure E.4: Composition of migrants flows and stocks

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

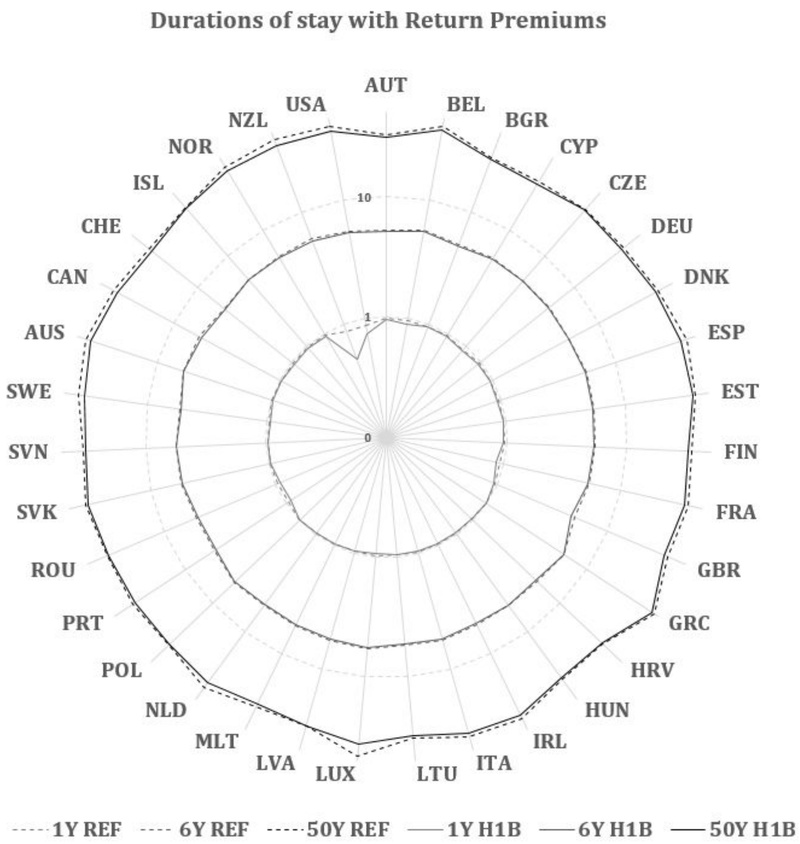

Figure E.5: The effects on average durations of stay after including return premiums

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

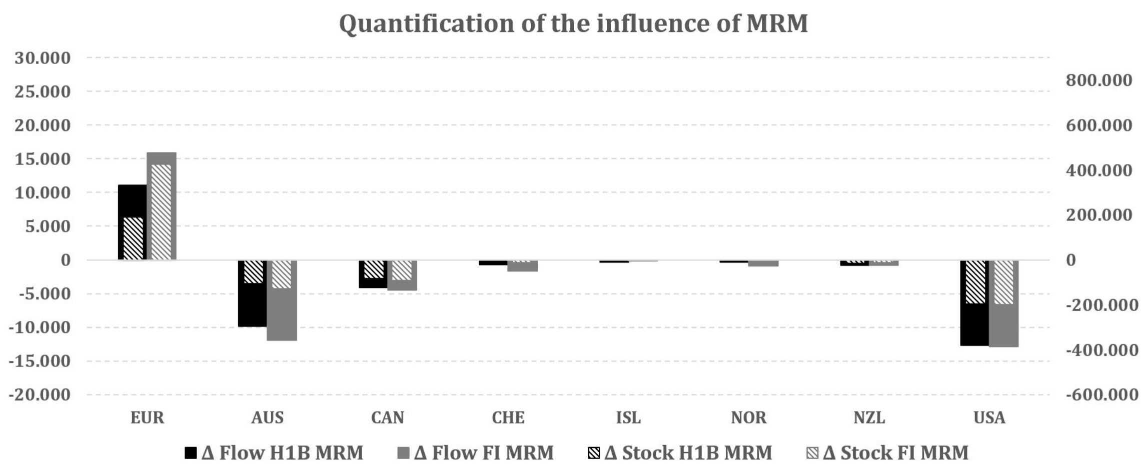

Figure E.6: The effects of multilateral resistance to migration

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