KIEL INSTITUTE FOR THE WORLD ECONOMY

KIEL
WORKING PAPER

A Micro-founded Theory of Multilateral Resistance to Migration

No. 2051 September 2016

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Kiel Institute for the World Economy
ISSN 2195–7525

ABSTRACT

A MICRO-FOUNDED THEORY OF MULTILATERAL RESISTANCE TO MIGRATION

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This paper provides a micro-founded theory of multilateral resistance to migration analyzing how financial constraints determine migration trends. We build a RUM model in which we explicitly introduce the budget constraint in the migration decision: individuals cannot afford migrating to a destination for which the migration cost (which depends on the immigration policy of the destination country) is higher than their current income. We find that the migration rate between two countries depends on the characteristics of the origin and destination countries and their relative accessibility, and also on a budget constraint term. This term depends on the attributes of alternative destinations. Thus, the model exhibits multilateral resistance to migration. We perform a numerical analysis based on 23 European countries in 2008 and evidence multilateral resistance to migration induced by the implementation of intra-EU migration restrictions following the 2004 EU enlargement.

Keywords: Migration, Budget constraint, Immigration policy, RUM model, Multilateral resistance to migration
JEL classification: F22, J61, O15, C63

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1 Introduction

In 2004, when 10 new countries[1] joined the European Union (EU), former ("old") member states had the possibility to restrict access to their labor markets to immigrants from these new states, for a maximum period of seven years. Some did restrict entrance, some did not. Old member states took their decisions quite unilaterally, with little coordination with neighboring countries and with migrant sending countries. However, the immigration policy of one country impacts migration flows to that country, but also to other countries. This externality, put forward by Boeri and Brucker (2005) in the case of the 2004 enlargement, is taken into account in the concept of *multilateral resistance to migration*[2].

To the best of our knowledge, only two papers explicitly deal with this concept (Bertoli and Fernández-Huertas Moraga, 2013; Bertoli et al., 2016). They define multilateral resistance to migration as the influence that the attractiveness and the accessibility of alternative destinations exert on the bilateral migration rate between two countries. They demonstrate the presence of multilateral resistance to migration by providing a number of technical improvements to the standard Random Utility Maximization (RUM) model of migration: as summarized by Beine et al. (2015), this literature shows that multilateral resistance to migration may arise in a RUM model either from the assumption made on the distribution of the error term defined in the utility function associated to the migration decision (Bertoli and Fernández-Huertas Moraga, 2013), or from explicitly modeling the sequential nature of migration decisions in the RUM model (Bertoli et al., 2016). Empirically, both papers find that omitting to consider multilateral resistance to migration biases the estimated effects of push and pull factors on bilateral migration flows. However, in this literature, the multilateral resistance term is sort of a black box filled in with unobservable factors. Our paper aims at opening this black box, studying some of the mechanisms lying behind this concept.

To do so, we propose a RUM model in which we explicitly introduce the role of the budget constraint in the migration decision. Several empirical studies show an important discrepancy between migration intentions and migration decisions; and this gap may be partly explained by financial constraints faced by potential migrants. Based on the Gallup World Poll survey 2012, Docquier et al. (2015) estimate about 386.1 millions the number of *potential* migrants in 2010. Yet, only 28.9% of them were actual migrants, the rest were individuals who *desired* migrating but did not. Lacking resources, the poorest individuals are caught in a poverty trap and cannot afford to migrate even if they intend to do so. Relatively richer individuals can afford to migrate to some countries but not necessarily to all destination countries (Hatton and Williamson, 2005).

As standard in the literature, in our model, individuals choose their destination in order to maximize their utility net of bilateral migration costs across all possible destinations, including their home country. However, only individuals who can afford the migration cost to a potential destination are able to migrate

[1] Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia.

[2] The concept of multilateral resistance to migration comes from the concept of multilateral resistance to trade. The latter concept relates to the idea that trade between two countries depends on trade barriers between these countries, but also on trade barriers that each country faces with other trading partners. The concept was first introduced by Anderson and Van Wincoop (2003) who reconcile the gravity equation extensively used in the empirical literature with the theoretical model proposed by Anderson (1979). They show that the theory lying behind the gravity equation requires to consider multilateral resistance in gravity type estimations.

to that country. The sets of potential destinations thus differ across individuals. Bilateral migration costs depend partly on the immigration policies implemented by destination countries. Any decision tightening the immigration policy of one destination country (quota limitations, increased cost of the visa, tighter procedures to access employment, etc.) increases the cost of migrating to that country[3]. Using the standard assumptions of RUM models, we find that the bilateral migration rate between two countries then depends on the attributes of both origin and destination countries, the bilateral migration cost and a budget constraint effect. Interestingly, the latter effect depends on the attributes of alternative destination countries. Thus, when considering individual budget constraints in a standard RUM model, the independence from irrelevant alternatives (IIA) assumption does not hold anymore and multilateral resistance to migration arises.

We then propose a numerical experiment based on 23 European countries in 2008, when some old member states did not implement restrictions anymore, while others were still protecting their labor markets from immigrants coming from new member states. Simulating a liberalization of immigration policies within the EU, we evidence the presence of multilateral resistance to migration induced by intra-EU migration restrictions implemented after the 2004 EU enlargement. This result corroborates the studies of Boeri and Brucker (2005), Baas and Brücker (2012) and Kahanec and Zimmermann (2010).

The contribution of this paper is threefold. First, it contributes to the literature on the role of individual budget constraints on migration decisions. To the best of our knowledge, we propose the first RUM model explicitly taking into account migrants' financial constraints. This leads us to introduce a second source of heterogeneity across individuals with respect to the standard model. Second, similarly to Anderson and Van Wincoop (2003), we reconcile the empirical literature in migration economics that intends to control for multilateral resistance to migration (Beine et al., 2015), with the RUM model that formulates the theoretical foundation of the gravity equation in migration. We propose an explicit source of multilateral resistance to migration, namely the budget constraint. Our results corroborate the studies of Bertoli and Fernández-Huertas Moraga (2013) and Bertoli et al. (2016) showing that multilateral resistance to migration should be taken into account to properly analyze the determinants of migration flows. Third, we propose a new contribution to the literature dealing with migration policy externalities in Europe[4]. Our results call for more dialogue between EU countries implementing unilateral or bilateral migration policies, other European countries, and the rest of the world (including migration source countries).

The rest of the paper is organized as follows. In section 2, we survey the related literature. In section 3, we propose a RUM model of migration in which we introduce a budget constraint. The main results of the comparative static analysis are presented in section 4. In section 5, we present a numerical experiment. Section 6 concludes.

[3] In this paper, we do not look into selective immigration policies. However, by introducing the role of the budget constraint in individual migration choices, we consider that richer individuals have a higher probability to migrate. If the wage distribution in the source country is linked to the skill distribution, then higher-skilled individuals are likely to be richer and thus are more likely to migrate.

[4] See previously cited papers. Giordani and Ruta (2013) provide a theoretical framework to study how immigration policies are strategically decided, when tightening barriers to migration leads to decreasing attractiveness of host countries relatively to others. This spillover effect is also underlined by Sykes (2013) as one of the main obstacles to policy cooperation. Marques (2010) and Sykes (2013) study another form of externality linked to migration policies, namely "migration diversion", when migrants from some origin countries are partly replaced by migrants from other source countries benefiting from a less tightened immigration policy.

2 Related literature

2.1 Migration policies, financial constraints and migration decisions

A number of papers highlight a high discrepancy between migration intentions and migration decisions, due to financial constraints: many people would like to migrate but cannot afford the migration cost. In their extensive study on the determinants of world migration, Hatton and Williamson (2005) have shown that potential migrants may be constrained by their poverty. Similarly, in a theoretical and empirical contribution based on the Gallup World Poll surveys (2005 and 2006), Dustmann and Okatenko (2014) show that when the credit constraint is binding (which is the case in Sub-Saharan Africa and in Asia), the number of migration decisions increase with income; in the opposite case (in Latin America for instance), migration decisions are not much affected by income. Several empirical analysis focusing on different countries confirm the fact that budget constraints are binding for international migration flows from developing countries; it seems to be the case in Bangladesh (Mendola, 2008), Mexico (McKenzie and Rapoport, 2007, 2010; Angelucci, 2015) and El Salvador (Halliday, 2006). In their survey of the empirical studies on the determinants of migration flows, Beine et al. (2015) conclude that credit constraints do hinder migration flows.

Thus, migration decisions are determined not only by the characteristics of origin and destination countries (*e.g.* in terms of wealth differentials) and by the preferences of the individuals, but also by the capacity of the latter to afford migrating. The budget constraint of a potential migrant is determined by his income on the one hand, and by the bilateral migration cost on the other hand. It may be relaxed either when the financing capacity of the individual increases – the individual can get richer, save or borrow money – or when the migration cost decreases – for instance when the destination country loosens its immigration policy[5].

2.2 RUM models of migration and multilateral resistance to migration

Recent contributions make use of the RUM framework to analyze individual migration decisions (Beine et al., 2015). In this framework, which consists in a logit model, an individual selects his destination country in order to maximize his utility net of bilateral migration cost across all potential destinations, including his home country. The number of potential destinations is the same across individuals from the same source country and includes any country open to immigration from that country. The net utility of the individual is made of a deterministic component and an error term. The deterministic component includes variables which are identical across individuals such as the expected wealth or the bilateral migration cost. The error term follows an iid. Extreme Value Type-1 distribution and accounts for unobserved heterogeneity among individuals. The critical part of this assumption is that the unobserved factors are uncorrelated over destinations and have the same variance for all destinations. Once the model solved, the IIA assumption holds: the bilateral migration rate between two countries only depends on the attributes of both origin

[5] More precisely, the cost of migrating from a country k to a destination k' depends on the migration policies implemented by both countries. First, it could be impacted by the unilateral emigration policies implemented by country k. Yet, impediments to emigration have become rather small as most countries now recognize the right to emigrate (Wihtol de Wenden, 2013). Second, the bilateral cost is determined by unilateral immigration policies implemented by country k'. This cost increases with any impediment to immigration. Third, the bilateral cost can be impacted by any bilateral agreement between country k and country k'.

and destination countries, and on the bilateral migration cost, but does not depend on other countries characteristics and policies.

According to Train (2009), models relaxing the IIA assumption allow multilateral resistance to arise. It is the case of generalized extreme value models (GEV) such as nested-logit, mixed-logit and probit models where the error term follows a distribution obtained from a Generalized Extreme Value generating function. Bertoli and Fernández-Huertas Moraga (2013) propose a GEV model and then estimate a nested-logit model using the CCE (common correlated effects) estimator of Pesaran (2006) with high-frequency data on Spanish immigration flows over the 1997-2009 period. They find that neglecting multilateral resistance effects biases downward the estimated effect of GDP at origin and upward the estimated effect of visa policies on migration flows to Spain.

Introducing the sequential nature of migration decisions, Bertoli et al. (2016) also allow multilateral resistance to migration to arise, while keeping the standard assumption on the error term. Estimating a model using the CCE estimator with high-frequency data on migration from the countries of the European Economic Association toward Germany over the 2006-2012 period, they show that the European crisis diverted migration flows away from countries in difficulties toward Germany. They find that variations in the unemployment rate at origin positively influences bilateral migration to Germany, and that this effect is overestimated by standard specifications which do not control for the presence of multilateral resistance to migration.

Our analysis shows that multilateral resistance to migration can also arise in standard RUM models not taking into account the sequential nature of migration decisions, but considering that individuals are financially constrained in their migration choices. We assume that the individual-specific stochastic term follows an iid. Extreme Value Type-1 distribution. Thus, at the individual level, the model consists in a logit model. Once we aggregate across individuals using an income distribution function, the model does not exhibit the IIA assumption anymore and multilateral resistance to migration arises. Doing so, we add a second source of heterogeneity across individuals (their income levels) with respect to the standard model. We also provide an explicit interpretation of the multilateral resistance term, which relates to a budget constraint effect.

3 A RUM model of migration with budget constraint

In this section, we model the migration decision of an individual i considering P destinations, including his country of current residence, country k. We first present the assumptions of the model, before focusing on the main results.

3.1 Assumptions

To decide whether or not he wants to migrate and where, individual i maximizes his net utility subject to his budget constraint. We will present here the assumptions relating to the utility and to the income of the individual, before introducing some notations allowing us to rank the destination countries according to their respective migration costs. Finally, we introduce the decision tree of an individual facing a migration decision.

The utility function

Following Beine et al. (2015), we assume that individual i takes myopic decisions, deciding whether or not to migrate and where at each period of his life-time. His net utility of migrating from country k to country k' can be written:

$$U_i^{k,k'} = W^{k,k'} - C^{k,k'} + \epsilon_i^{k,k'} \tag{1}$$

where $W^{k,k'}$ represents a deterministic component of the utility in country k' (for instance the expected wealth), $C^{k,k'}$ is the deterministic financial cost of migration from k to k' paid before migrating (with $C^{k,k} = 0$), and $\epsilon_i^{k,k'}$ is an individual-specific stochastic term. The bilateral migration cost between two countries is composed of two parts: a financial cost of migration *per se* (here denoted $C^{k,k'}$) and a psychological cost of being away from home. In the present paper, we consider that the psychological cost differs across individuals; it is then included in the individual-specific stochastic term. Hereafter, for the sake of simplicity, any reference to the *migration cost* refers to the *financial migration cost.*

As standard in the literature, we assume that $\epsilon_i^{k,k'}$ is independent and identically distributed over individuals and destinations, and follows a univariate Extreme Value Type-1 distribution with a scale parameter denoted τ.

The individual gross utility (before subtracting the bilateral migration cost) is given by $V_i^{k,k'} \equiv W^{k,k'} + \epsilon_i^{k,k'}$.

The income distribution

Individuals differ with respect to their preferences, but also with respect to their income. We assume that the income of individual i located in country k, w_i^k, follows a distribution φ^k. The corresponding cumulative distribution function is denoted by Φ^k. Hereafter, for the sake of simplicity, we drop the country superscript in the notation of the distribution and cumulative distribution functions, so that $\varphi^k = \varphi$ and $\mathit{\Phi}^k = \mathit{\Phi}$.

Individuals can only reach affordable destinations. To account for the fact that budget constraints may be binding, we do not introduce any credit market in our model. Doing so, we assume that individuals cannot finance the cost of migrating thanks to a banking system or family solidarity. Individual i can afford to migrate from country k to destination k' if and only if his income is higher than the bilateral migration cost from country k to destination k': $w_i^k \geq C^{k,k'}$.

Thus, the probability that individual i cannot afford the cost to migrate from country k to destination k' is given by $\Pr\left(w_i^k < C^{k,k'}\right) = \Phi\left(C^{k,k'}\right)$. *A contrario*, the probability that he can afford it is given by $\Pr\left(w_i^k \geq C^{k,k'}\right) = 1 - \Phi\left(C^{k,k'}\right)$.

Introducing credit constraints in the model allows us to consider that migration intentions and migration decisions differ (as shown in the literature survey, section 2). It is the case for an individual who would like to migrate to any destination but cannot afford any bilateral migration cost; it is also the case for an individual who cannot reach his utility-maximizing destination because he cannot afford the migration cost and thus migrates to another destination he can afford. To sum up, individual i *decides* to migrate to country k' if and only if he *intends* to go to country k' *and* he can afford the bilateral migration cost.

The ranking of potential destinations

The migration cost being different over destinations, individual i is able to rank the potential destinations (his current country of residence included) from the less to the most costly one. Let $\theta(k, k')$ be the rank of country k' when destinations are ranked in increasing order of migration cost from country k. Then:

$$\forall k, k', k'' \in \{1, \ldots, P\}^3, \ \theta(k, k') < \theta(k, k'') \Longleftrightarrow C^{k,k'} < C^{k,k''}. \tag{2}$$

For every k, $\theta(k, k')$ is a permutation from $\{1, \ldots, P\}$ to $\{1, \ldots, P\}$. Note that, as there is no cost for an individual to stay in his current country of residence $\left(C^{k,k} = 0\right)$, country k is the least costly destination from country k, thus $\theta(k, k) = 1$.

Let $\kappa(k, l)$ be the inverse permutation of $\theta(k, k')$: $\theta(k, k') = l \Longleftrightarrow \kappa(k, l) = k'$. $\kappa(k, l)$ thus denotes the country ranked l by increasing order of migration cost. The fact that $\theta(k, k) = 1$ implies that $\kappa(k, 1) = k$.

The sequence of decisions

There are two ways of presenting the sequence of decisions leading an individual to choose his destination country. Individual i could first identify affordable destinations, and then choose among this set of countries the one maximizing his utility. Although this sequence of decisions is straightforward, such a presentation partly dissimulates the effect of the budget constraint on the migration decision. It does not allow to see whether the chosen destination is the one that maximizes the utility of individual i, or a second order choice.

To better understand the impact of the budget constraint on the migration choice, we can assume that individual i first identifies his favorite destination (his net-utility-maximizing destination). If he can afford that destination, he migrates there; the credit constraint is not binding for him. However, if he cannot afford the migration cost relative to his favorite destination, he will look at his second-best destination, the one maximizing his net utility over the set of destinations excluding his favorite one. Then, he will check whether or not that second-best destination is affordable: if so, he goes there; if not, he goes through the process all over again until he finds the best affordable destination. When the credit constraint is binding, the individual does not migrate to his favorite destination, but to the net-utility-maximizing country chosen among affordable destinations. Figure 1 represents this decision process for individual i.

Taking into account the budget constraint has important consequences. Because individuals can only reach affordable destinations and because they face different budget constraints, they do not have the same set of potential destinations. Simply said, very poor people cannot afford to migrate at all (although migrating to some destinations would probably enhance their net utility), while very rich people can probably afford almost all or all the destinations of the world.

3.2 Main results

Individual i chooses his destination to maximize his utility, subject to his budget constraint. We distinguish here between two cases: in the standard case, the budget constraint is not binding for anyone in country

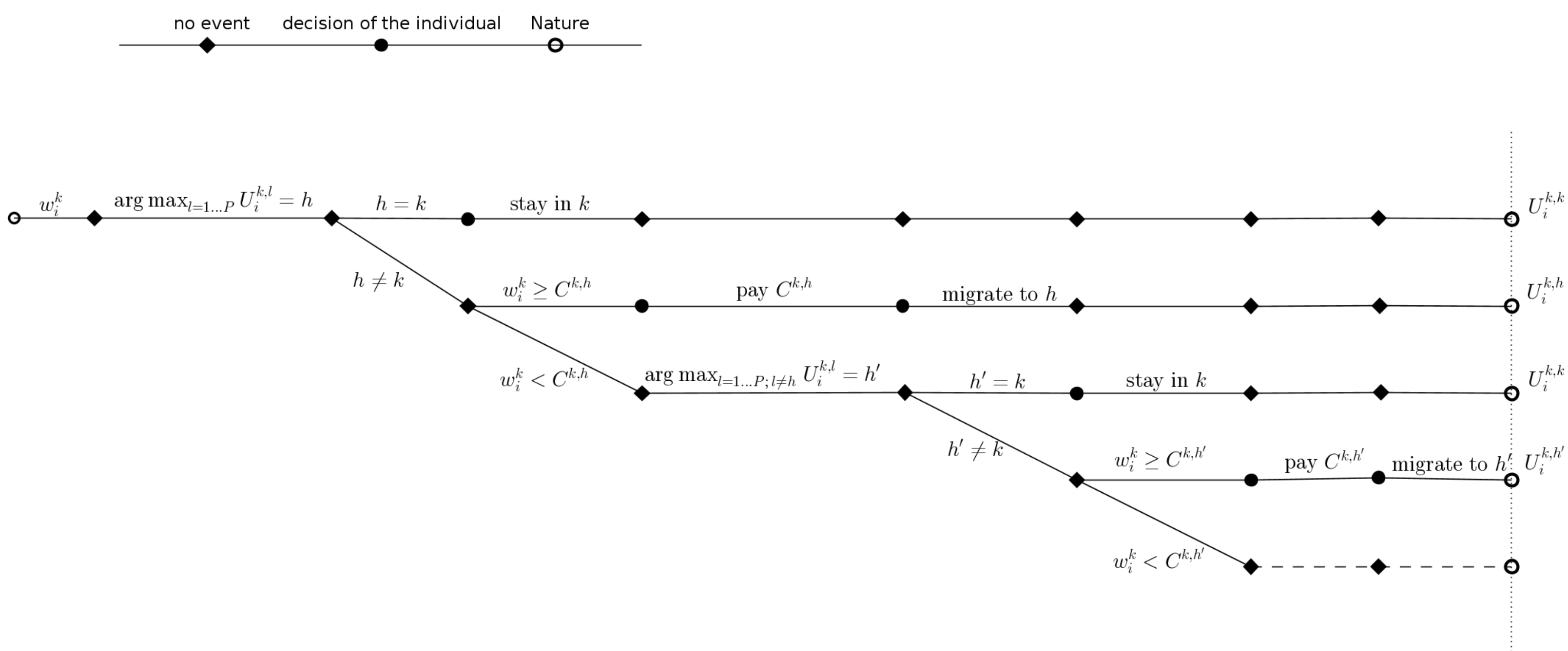

Figure 1: The decision tree of individual i

k; in the general case, it is binding for at least one individual (and more probably for many individuals at different levels).

3.2.1 The standard case: a non-binding budget constraint

Imagine a country k where everybody can afford to migrate to any possible destination. This implies that anybody can travel to the most expensive destination, $\kappa(k, P)$. Thus, incomes in this country are distributed such that: $\forall i,\ w_i^k \geq C^{k,\kappa(k,P)}$; in other words, $\Phi\left(C^{k,k'}\right) = 0\ \forall k' \leq P$. In that case, individuals always migrate to their favorite destination. Thus we fall back on the standard RUM model when we assume a non-binding budget constraint.

Following the results of McFadden (1974, 1984), we find the unconditional probability that an individual relocates from country k to destination k':

$$p^{k,k'} = \Pr\left(U_i^{k,k'} = \max_{l=1\ldots P} U_i^{k,l}\right) = \frac{e^{\left(W^{k,k'} - C^{k,k'}\right)/\tau}}{\sum_{q=1}^{P} e^{\left(W^{k,q} - C^{k,q}\right)/\tau}}. \tag{3}$$

Similarly, the unconditional probability that an individual remains in country k is given by:

$$p^{k,k} = \Pr\left(U_i^{k,k} = \max_{l=1\ldots P} U_i^{k,l}\right) = \frac{e^{W^{k,k}/\tau}}{\sum_{q=1}^{P} e^{\left(W^{k,q} - C^{k,q}\right)/\tau}}. \tag{4}$$

The bilateral migration rate is given by the ratio of these two probabilities:

$$M^{k,k'} = \frac{p^{k,k'}}{p^{k,k}} = \frac{e^{\left(W^{k,k'} - C^{k,k'}\right)/\tau}}{e^{W^{k,k}/\tau}} = \frac{e^{\left(W^{k,k'} - W^{k,k}\right)/\tau}}{e^{C^{k,k'}/\tau}}. \tag{5}$$

As underlined by Beine et al. (2015), this bilateral migration rate depends only on the characteristics of origin and destination countries, and on the bilateral migration cost. This is representative of the IIA property: any change in the *attractiveness* or *accessibility* of other destinations will not affect the bilateral migration rate from country k to country k'. In other words, there is a proportional substitution across alternative destinations.

3.2.2 The general case: a binding budget constraint

We can now study the general case where at least one individual in country k sees his number of potential destinations limited by his budget constraint. Hereafter, we use the subscript BC when the Budget Constraint (BC) is binding.

Intuitively, individuals with an income within the same cost-interval have the same set of affordable destinations, thus the standard RUM model can be applied within each cost-interval. Then, the income distribution in country k must be taken into account to find the unconditional probabilities of migrating to any country. These probabilities and the corresponding migration rates reflect the differences in the set of affordable destinations for different individuals.

Following the results of McFadden (1974, 1984), the unconditional probability that individual i relocates from country k to destination k' when the BC is binding is given by:

$$p_{BC}^{k,k'} = A^{k,k'} e^{\left(W^{k,k'} - C^{k,k'}\right)/\tau} = A^{k,k'} p^{k,k'} \sum_{q=1}^{P} e^{\left(W^{k,q} - C^{k,q}\right)/\tau} \tag{6}$$

with:

$$A^{k,k'} = \sum_{l=\theta(k,k')}^{P} \frac{\Phi\left[C^{k,\kappa(k,l+1)}\right] - \Phi\left[C^{k,\kappa(k,l)}\right]}{\sum_{q=1}^{l} e^{\left[W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right]/\tau}} \tag{7}$$

where we use the convention $C^{k,\kappa(k,P+1)} = +\infty$ so that $\Phi\left[C^{k,\kappa(k,P+1)}\right] = 1$. Note that if the BC is not binding for anyone, then $A^{k,k'} = 1/\sum_{q=1}^{P} e^{\left(W^{k,q} - C^{k,q}\right)/\tau}$ (and $p_{BC}^{k,k'} = p^{k,k'}$).

Similarly, the unconditional probability that individual i stays in country k when the BC is binding is given by:

$$p_{BC}^{k,k} = A^{k,k} e^{W^{k,k}/\tau} \tag{8}$$

with:

$$A^{k,k} = \sum_{l=1}^{P} \frac{\Phi\left[C^{k,\kappa(k,l+1)}\right] - \Phi\left[C^{k,\kappa(k,l)}\right]}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}}. \tag{9}$$

Calculations of these probabilities are presented in appendix A.1.

The bilateral migration rate between country k and country k' when the BC is binding is given by the ratio of these probabilities:

$$M_{BC}^{k,k'} = \frac{p_{BC}^{k,k'}}{p_{BC}^{k,k}} = f^{k,k'} \frac{e^{\left(W^{k,k'} - W^{k,k}\right)/\tau}}{e^{C^{k,k'}/\tau}} = f^{k,k'} M^{k,k'} \tag{10}$$

where:

$$f^{k,k'} = \frac{A^{k,k'}}{A^{k,k}} = \frac{\sum_{l=\theta(k,k')}^{P} \frac{\Phi\left[C^{k,\kappa(k,l+1)}\right] - \Phi\left[C^{k,\kappa(k,l)}\right]}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}}}{\sum_{l=1}^{P} \frac{\Phi\left[C^{k,\kappa(k,l+1)}\right] - \Phi\left[C^{k,\kappa(k,l)}\right]}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}}} < 1 \tag{11}$$

and denotes the *budget constraint effect*.

The bilateral migration rate when the BC is binding is equal to the bilateral migration rate when the BC is not binding (equation 5) multiplied by a term summarizing the budget constraint effect, $f^{k,k'}$. In standard RUM models, the latter term equals unity.

We can illustrate the difference between the two rates with a simple example of a two-country world. Imagine an individual i living in country k and receiving the income w_i^k. He has the choice between staying in country k or migrating to country h. If he stays in country k, he gets utility $U_i^{k,k} = V_i^{k,k}$ (since $C^{k,k} = 0$); if he migrates to country h, he gets the gross utility $V_i^{k,h}$ minus the bilateral migration cost $C^{k,h}$. Assume that: $w_i^k < C^{k,h} < V_i^{k,h} - V_i^{k,k}$. This implies that the individual intends to migrate to country h (since $V_i^{k,k} < V_i^{k,h} - C^{k,h}$) but cannot afford the migration cost (since $w_i^k < C^{k,h}$). Thus, if the BC is not taken into account, this individual will be counted as a migrant in the bilateral migration rate; if the BC is taken into account, he will not.

For two countries k' and k'' such that $C^{k,k'} < C^{k,k''}$, we know that $\theta(k,k') < \theta(k,k'')$. The ratio of migration rates equals:

$$\frac{M_{BC}^{k,k''}}{M_{BC}^{k,k'}} = \frac{f^{k,k''}}{f^{k,k'}} \frac{M^{k,k''}}{M^{k,k'}} = \frac{A^{k,k''}}{A^{k,k'}} \frac{M^{k,k''}}{M^{k,k'}} < \frac{M^{k,k''}}{M^{k,k'}}. \tag{12}$$

Thus, the BC decreases relatively more the attractiveness of the most costly destinations compared to the less costly ones.

In the standard case, the bilateral migration rate does not depend on other destinations' characteristics. However, when the BC is binding, even if we assume that the individual-specific stochastic term ($\epsilon_i^{k,k'}$) follows an iid. Extreme Value Type-1 distribution and that individuals are myopic, the bilateral migration rate depends not only on the attributes of countries k and k', but also on the attributes of alternative destinations and the full set of bilateral migration costs. Multilateral resistance to migration thus arises thanks to the introduction of the individual budget constraint in the modeling of the migration decision.

4 Comparative statics

To analyze how a change in one country's immigration policy can affect flows of migrants to that country but also to other countries, we study the impact of this change on bilateral migration probabilities and rates in the general case. All calculations are presented in appendix A.2.

4.1 Impact of immigration policies on bilateral migration probabilities

The RUM model allows us to determine the unconditional probabilities to migrate from one country to any other. These probabilities depend on the attributes of the origin and destination countries, but also on the attributes of other potential destinations. We can then estimate the consequences of a change in the immigration policy of one country on migration probabilities to that country and to other destinations.

Intuitively, when a country changes its immigration policy toward another country, this will impact *the relative attractiveness* and *the relative accessibility* of all destination countries. The relative attractiveness of one destination depends not only on its characteristics (wealth, amenities...) but also on its immigration policy (thus migration costs). The relative accessibility of one destination from another country depends on the bilateral migration cost between these two countries, on other bilateral migration costs and on the distribution of income in the origin country.

More precisely, when destination k' tightens its immigration policy toward country k, it increases the related bilateral migration cost $C^{k,k'}$. In turn, the probability of migrating to country k' decreases because that destination becomes less attractive, but also because the individual budget constraint becomes more binding (the probability that individuals can afford this migration decreases). From equation (6) we find:

$$\frac{\partial p_{BC}^{k,k'}}{\partial C^{k,k'}} = \left(\frac{\partial A^{k,k'}}{\partial C^{k,k'}} - \frac{1}{\tau} A^{k,k'} \right) e^{\left(W^{k,k'} - C^{k,k'}\right)/\tau} \leq 0. \tag{13}$$

Besides, any increase in the bilateral migration cost between country k and country k' increases the relative attractiveness of any other country k'' $(\neq k')$, but also the relative capacity of individuals to afford migrating to alternative destinations. From equation (6) we find:

$$\forall k'' \neq k', \; \frac{\partial p_{BC}^{k,k''}}{\partial C^{k,k'}} = \frac{\partial A^{k,k''}}{\partial C^{k,k'}} e^{\left(W^{k,k''} - C^{k,k''}\right)/\tau} > 0. \tag{14}$$

In particular, when the cost of migrating increases, staying in country k becomes relatively more attractive and less expensive. Thus, the probability to stay in country k increases when the cost of migrating to any destination increases. From equation (8) we find:

$$\frac{\partial p_{BC}^{k,k}}{\partial C^{k,k'}} = \frac{\partial A^{k,k}}{\partial C^{k,k'}} e^{W^{k,k}/\tau} > 0. \tag{15}$$

The results are qualitatively similar but quantitatively different in a standard RUM model. In that case, a change in the immigration policy of one country toward another impacts bilateral migration probabilities only through a change in the relative attractiveness of destination countries. More specifically, in the standard case, we get:

$$\frac{\partial p^{k,k'}}{\partial C^{k,k'}} = \frac{1}{\tau} p^{k,k'} \left(p^{k,k'} - 1 \right) < 0 \tag{16}$$

$$\forall k'' \neq k', \; \frac{\partial p^{k,k''}}{\partial C^{k,k'}} = \frac{1}{\tau} p^{k,k'} p^{k,k''} > 0 \tag{17}$$

$$\frac{\partial p^{k,k}}{\partial C^{k,k'}} = \frac{1}{\tau} p^{k,k'} p^{k,k} > 0. \tag{18}$$

Let us go back to our previous example of a two-country world where individual i had the choice between staying in country k or migrating to country h. Assume that: $C^{k,h} < w_i^k < V_i^{k,h} - V_i^{k,k}$. Because migrating is the net-utility-maximizing option and because the budget constraint is not binding, individual i intends and decides to migrate to country h.

Assume now that the bilateral migration cost from country k to country h increases because the latter tightens its immigration policy. In that case, there are three possibilities:

- First, if the bilateral migration cost increases such that the previous inequality remains unchanged ($C^{k,h[1]} < w_i^k < V_i^{k,h} - V_i^{k,k}$), then individual i will still migrate from country k to country h. Whether the BC is taken into account or not, individual i's predicted behavior is the same.

- Second, if the bilateral migration cost increases such that $w_i^k < C^{k,h[2]} < V_i^{k,h} - V_i^{k,k}$, then individual i intends to migrate from country k to country h (since $V_i^{k,k} < V_i^{k,h} - C^{k,h[2]}$) but cannot afford this migration (since $w_i^k < C^{k,h[2]}$); thus he will not migrate. In that case, individual i's predicted behavior is not the same whether the BC is taken into account or not.

- Third, if the bilateral migration cost increases so much that $w_i^k < V_i^{k,h} - V_i^{k,k} < C^{k,h[3]}$, then individual i does not intend to migrate to country h as migrating is not the net-utility-maximizing option anymore. Whether the BC is taken into account or not, individual i's predicted behavior is the same.

In the last two cases, the question remains as to where this individual would go instead. In our example, he only had the choice between two countries. But if he had had the choice between several countries, instead of staying in country k, he may have decided to go to a third destination h' more attractive than country k ($V_i^{k,h'} - C^{k,h'} > V_i^{k,k}$) and affordable ($C^{k,h'} < w_i^k$), either because country h' becomes more attractive than country h ($V_i^{k,h'} - C^{k,h'} > V_i^{k,h} - C^{k,h}$), or because country h has become too expensive ($V_i^{k,h'} - C^{k,h'} < V_i^{k,h} - C^{k,h}$ and $C^{k,h'} < w_i^k < C^{k,h}$).

To conclude, as long as the bilateral migration cost only slightly increases (case 1), there is no substitution between destinations; individual i still migrates to country h. On the other hand, when the migration cost increases sufficiently (such that $w_i^k < C^{k,h}$, cases 2 and 3), the individual substitutes migration to another country to migration to country h.

4.2 Impact of immigration policies on bilateral migration rates

The RUM model allows us to determine the bilateral migration rate between any country-pair. In the standard case, the bilateral migration rate depends only on the characteristics of origin and destination countries and on their relative accessibility. However, when the BC is binding, the bilateral migration rate also depends on the attractiveness and accessibility of other potential destinations. One question then arises: how does a change in the immigration policy of one potential destination country affect bilateral migration rates to that country and to other destination countries? In other words, what is the importance of *multilateral resistance to migration* in our model?

First, when the bilateral migration cost from country k to country k' increases marginally, then among those who would have migrated from country k to country k' before the increase, some may not intend to migrate anymore to country k', and some may still intend to migrate to country k' but not be able to afford this migration anymore. From equation (10), we get:

$$\frac{\partial M_{BC}^{k,k'}}{\partial C^{k,k'}} = -\frac{1}{\tau} M_{BC}^{k,k'} + \frac{M_{BC}^{k,k'}}{f^{k,k'}} \frac{\partial f^{k,k'}}{\partial C^{k,k'}} \leq 0. \tag{19}$$

The first term relates to the effect of a policy change on the *relative attractiveness*, and the second term represents the effect on the *relative accessibility.*

In the standard case, a change in the immigration policy of country k' only impacts the *relative attractiveness.* From equation (5), we get:

$$\frac{\partial M^{k,k'}}{\partial C^{k,k'}} = -\frac{1}{\tau} M^{k,k'} \leq 0. \tag{20}$$

Intuitively, we expect that $\frac{\partial M_{BC}^{k,k'}}{\partial C^{k,k'}} \leq \frac{\partial M^{k,k'}}{\partial C^{k,k'}}$ (≤ 0). Without considering the budget constraint, a marginal change in the bilateral migration cost from country k to country k' reduces the corresponding bilateral migration rate because destination k' becomes unattractive for some individuals. But when we account for the budget constraint, the bilateral migration rate from country k to country k' should reduce even more because destination k' becomes unattractive for some individuals, and unaccessible for some others (who still consider country k' as their net-utility-maximizing option).

Second, when country k' tightens its immigration policy toward country k, it also affects the bilateral migration rates from country k to any other country. From equation (6), we get:

$$\forall k'' \neq k', \ \frac{\partial M_{BC}^{k,k''}}{\partial C^{k,k'}} = M_{BC}^{k,k''} \left(\frac{1}{A^{k,k''}} \frac{\partial A^{k,k''}}{\partial C^{k,k'}} - \frac{1}{A^{k,k}} \frac{\partial A^{k,k}}{\partial C^{k,k'}} \right). \tag{21}$$

In case the alternative destination k'' is less expensive than destination k' $\left(C^{k,k''} < C^{k,k'}\right)$, we find that:

$$\frac{\partial M_{BC}^{k,k''}}{\partial C^{k,k'}} = M_{BC}^{k,k''} \frac{\partial A^{k,k}}{\partial C^{k,k'}} \left(\frac{1}{A^{k,k''}} - \frac{1}{A^{k,k}} \right) \geq 0. \tag{22}$$

This implies that when country k' tightens its immigration policy toward country k, then among those who would have migrated to k' before the policy change, more decide to migrate instead to country k'' (less expensive than country k') than to stay in country k.

Unfortunately, we are unable to sign the derivative when $C^{k,k'} < C^{k,k''}$. If $\exists\, k''$ s.t. $C^{k,k'} < C^{k,k''}$ and $\frac{\partial M_{BC}^{k,k''}}{\partial C^{k,k'}} > 0$, this would mean that among those who would have migrated to country k' before the policy change, more decide to migrate instead to country k'' than to stay in country k. Conversely, if $\exists\, k''$ s.t. $C^{k,k'} < C^{k,k''}$ and $\frac{\partial M_{BC}^{k,k''}}{\partial C^{k,k'}} < 0$, this would mean that among those who would have migrated to k' before the policy change, more decide to stay in country k than to migrate to country k''.

These comparative statics allow us to put forward the existence of multilateral resistance to migration stemming from the budget constraint. In the standard RUM model, we get $\frac{\partial M^{k,k''}}{\partial C^{k,k'}} = 0 \ \forall k'' \neq k'$. The ratio of migration probabilities remains constant when the immigration policy of destination k' changes, because the two probabilities ($p^{k,k}$ and $p^{k,k''}$) change in the same proportion. The model exhibits the IIA assumption and no multilateral resistance to migration. In the RUM model taking into account the BC, the IIA assumption does not hold anymore: when country k' tightens its immigration policy toward country k, the bilateral migration rate from country k to other countries is impacted.

5 Numerical analysis

To deepen our theoretical analysis, we calibrate the model on the European case in 2008. Doing so, we can compare the explanatory power of the model when the BC is binding and when it is not. We then simulate a liberalization of the German immigration policy toward new EU members and a liberalization of all migration policies within the EU to investigate the presence of multilateral resistance to migration linked to financial constraints.

5.1 The European case

When 10 new European countries joined the EU in 2004, old EU member states had the possibility to restrict access to their labor markets to immigrants coming from the new member states, for a maximum period of seven years. Ireland, Sweden and the United Kingdom did not implement any restriction. Finland, Greece, Italy, Portugal and Spain implemented some restrictions until 2006, Luxembourg and the Netherlands until 2007, France until 2008, Belgium and Denmark until 2009, and Austria and Germany until 2011.

We take advantage of these disparities in immigration policies to develop our numerical analysis. We calibrate the model on 23 European countries (mostly EU members but not only)[6] in 2008. Our calibration sample is made of 394 bilateral migration rates. We approximate the rate from country k to country k' in

[6]The sample includes Austria (AUT), Cyprus (CYP), Czech Republic (CZE), Denmark (DNK), Estonia (EST), Finland (FIN), France (FRA), Germany (DEU), Hungary (HUN), Ireland (IRL), Italy (ITA), Latvia (LVA), Lithuania (LTU), the Netherlands (NLD), Poland (POL), Portugal (PRT), Slovakia (SVK), Slovenia (SVN), Spain (ESP), Sweden (SWE) and the United Kingdom (GBR), currently members of the EU, plus Norway (NOR) and Switzerland (CHE). Concerning old EU member states, no bilateral migration data are available for Belgium and Greece in the UNPD and OECD databases, and we exclude Luxembourg which is an outlier in terms of immigration with respect to its size. Among the new members, data are missing for Malta.

2008 with the ratio of the immigration flow from country k to country k' in 2008 over the population of country k in 2008. Population data come from the World Population Prospects of the UNPD. Migration data come from the International Migration Flows database of the UNPD, except for Ireland and the United Kingdom, for which we use data from the International Migration Database of the OECD. More details on immigration data are given in appendix A.3.

5.2 Model specification

To calibrate the model, we need to formulate some assumptions regarding the utility function of the individual and the income distribution in each country.

The deterministic component of the gross utility

The deterministic component of the gross utility of an individual living in country k and intending to migrate to country k' is akin to the expected wealth in country k' in 2008: $W^{k,k'} = E\left(W_{2008}^{k'}\right) \forall k$. Here, we assume that all individuals, regardless of their residence country, formulate the same expectation regarding the wealth of country k'. This expectation is given by:

$$E\left(W_{2008}^{k'}\right) = \left(1 + r^{k'}\right) W_{2007}^{k'} \tag{23}$$

where $W_{2007}^{k'}$ is the wealth in 2007 in country k' and $r^{k'}$ denotes the wealth growth rate between 2006 and 2007 in country k'. We use the GDP per capita in country k' in 2006 and 2007 from the World Bank.

The deterministic bilateral migration cost

We specify the bilateral migration cost between country k and country k' as follows:

$$C^{k,k'} = \beta_0 + \beta_1 \ln \mathrm{dist}^{k,k'} + \beta_2 \ln \mathrm{lang}^{k,k'} + \beta_3 \ln \mathrm{mig}^{k,k'} + \beta_4 \ln \mathrm{visas}^{k} + \beta_5 \ln \mathrm{lab}^{k,k'} \tag{24}$$

where β_0 is a constant term and β_1, β_2, β_3, β_4 and β_5 are semi-elasticities associated to the explanatory variables. $\mathrm{dist}^{k,k'}$ denotes the distance in kilometers between the most populated cities of countries k and k'. $\mathrm{lang}^{k,k'}$ captures the linguistic distance between countries k and k'. We expect β_1 and β_2 to be positive since the geographic and linguistic distances between two countries should increase the bilateral migration cost. Data come from the CEPII (Mayer and Zignago, 2011; Melitz and Toubal, 2014).

The stock of migrants from country k living in country k' in 1990 is denoted by $\mathrm{mig}^{k,k'}$. Migration networks are known to ease future migration by decreasing the migration costs of would-be migrants, so we expect β_3 to be negative. Data come from the Global Bilateral Migration database of the World Bank.

Unfortunately, no index capturing bilateral migration policies is available at the moment[7]. Therefore, we use the two following indices. The first one, visas^k, denotes the level of visa restrictions implemented against country k in 2007 from all other countries. It increases with the restriction level, so we expect β_4 to be positive. Data come from the Henley & Partners Visa Restrictions Index which ranks countries according to the freedom of travel their citizens enjoy. The second one, $\mathrm{lab}^{k,k'}$, denotes the level of labor market openness

[7]See Gest et al. (2014) for a review of available immigration policy indices.

in country k' in 2007, and measures how easy it is for an immigrant from country k to be employed in country k' (it ranges from 0 to 100). Since it increases with the openness level, we expect β_5 to be negative. Data come from the Migrant Integration Policy Index, which is not bilateral and only relates to country k' (such that $\text{lab}^{k,k'} = \text{lab}^{k'}\ \forall k$ in this database). To capture the level of mobility enjoyed by EU citizens, we set $\text{lab}^{k,k'}$ to its maximum value (100, corresponding to total openness) when country k' does not implement any migration restriction toward country k. This happens either when k and k' are both old EU members, or when k is a new EU member and k' is an old member which does not implement any migration restriction toward k. For now, we leave aside bilateral migration agreements implemented between EU and non-EU countries (Norway and Switzerland).

The income distribution at origin

We assume that the income of an individual i living in country k follows a log-normal distribution (Lopez and Serven, 2006) such that:

$$w_i^k \rightsquigarrow \varphi^k = \text{log-}\mathcal{N}\left[\mu^k, \left(\sigma^k\right)^2\right]\ \forall\, i \tag{25}$$

where μ^k and σ^k respectively denote the scale and the shape of the distribution. The mean of the distribution is parametrized using the GDP per capita in country k in 2007. Data come from the World Bank. The standard deviation of the distribution is parametrized using the GINI index of country k in 2007, from the Standardized World Income Inequality Database (Solt, 2016).

5.3 Results

5.3.1 Calibration method and goodness of fit

We calibrate the model using a batch gradient descent for regularized linear regressions. This method allows us to determine the value of the model's parameters ($\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ and τ) that minimize the following objective function:

$$J(\beta) = \frac{1}{2N}\left\{\sum_{n=1}^{N}\left[M_{pred}^{(n)} - M_{cal}^{(n)}\right]^2 + \lambda\sum_{x=1}^{6}\beta_x^2\right\}\ ;\ \beta = \{\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6\}$$

where N denotes the number of observations in the calibration sample, $M_{cal}^{(n)}$ denotes the nth observed bilateral migration rate used to calibrate the model, $M_{pred}^{(n)}$ denotes the corresponding nth predicted bilateral migration rate (obtained either from equation 5 when the CB is not binding, or from equation 10 when it is binding), $\beta_6 = \tau$ for simplification matters, and λ is a positive constant denoting a regularization term.

This objective function is iteratively minimized with the following gradient descent:

```
repeat until convergence{
```

$$\beta_0 := \beta_0 - \tfrac{\alpha}{N}\textstyle\sum_{n=1}^{N}\left[M_{pred}^{(n)} - M_{cal}^{(n)}\right]\frac{\partial M_{pred}^{(n)}}{\partial \beta_0}$$

$$\beta_x := \beta_x\left(1 - \tfrac{\alpha}{N}\lambda\right) - \tfrac{\alpha}{N}\textstyle\sum_{n=1}^{N}\left[M_{pred}^{(n)} - M_{cal}^{(n)}\right]\frac{\partial M_{pred}^{(n)}}{\partial \beta_x}\ ;\forall x = 1;2;3;4;5;6$$

```
}
```

where α is a positive constant denoting a learning rate, and $:=$ means that we *replace* the left-hand term by the right-hand term at each iteration.

Two meta-parameters have to be determined: the regularization term of the objective function (λ) and the learning rate of the gradient descent (α). To do so, we randomly split the calibration sample into two parts. The training-set (80% of the sample, chosen randomly) is used to determine the best combination of learning rate and regularization term. The testing-set (the remaining 20% of the sample) is used to determine the predictive power of the model. Doing so, we can determine the validity of the meta-parameters chosen using a sample of data that has not been used during the training phase.

With the training-set, we implement a grid-search over a number of combinations of the two meta-parameters[8]. For each combination, we implement a 5-fold cross-validation. To realize a cross-validation, we randomly partition the sub-sample into 5 equal-size folds. We repeatedly use 4 of them to minimize the objective function – and the last one to compute a squared-error. Each fold is thus used exactly once to evaluate the model. The final squared-error is computed as the mean of the squared-errors obtained over the 5 folds. At the end of the grid-search, we choose the combination of learning rate and regularization term that gives the best performance *i.e.* the lowest squared-error, here $\alpha = 2.7$ and $\lambda = 2$.

To test the validity of these two meta-parameters, we minimize the objective function using the whole training-set and the learning rate and regularization term that have been determined by grid-search. Then, we use the testing-set to evaluate the model by computing the squared-error.

Table 1 details the performance of the model. Whether the BC is binding or not, the results of the cross-validation indicate that the model is general enough to produce a similar squared-error over the 5 folds. The standard deviation obtained for the general case is slightly lower which indicates a better performance. In both cases, the squared-errors obtained after the cross-validation and the validation phases are close enough. It confirms the accuracy of the meta-parameters chosen and the robustness of the method. In other words, it indicates that the results presented hereafter are not determined by the data chosen to calibrate the model.

	The standard case Non-binding BC				**The general case** Binding BC			
	Cross-validation on 80%			*Validation on 20%*	*Cross-validation on 80%*			*Validation on 20%*
	Obs.	Mean	Std. Dev.		Obs.	Mean	Std. Dev.	
squared-error	5	2.03e-04	6.14e-06	2.41e-04	5	2.03e-04	1.45e-06	2.49e-04

Table 1: Cross-validation and validation results (with $\alpha = 2.7$; $\lambda = 2$)

Finally, we minimize the objective function with the meta-parameters determined above using the full calibration sample. Table 2 shows the parameters obtained; they all have the expected signs. Whether the BC is binding or not, the bilateral migration cost from country k to country k' increases with the geographic and linguistic distances between k and k' (β_1, β_2) and decreases with the past bilateral migration stock (β_3). It is positively determined by migration restrictions implemented toward country k (β_4) and negatively

[8] We follow the online course on Machine Learning proposed by Andrew Ng from Stanford University to determine the values of the grid-search (www.coursera.org/learn/machine-learning) and choose (the following combinations: $\alpha = \{0.3; 0.9; 2.7\}$ and $\lambda = \{0; 1; 2; 3\}$.

determined by the level of labor market openness implemented in country k' (β_5). The scale parameter of the Extreme Value Type-1 distribution (τ) is about 0.23.

	The standard case	**The general case**
	Non-binding BC	Binding BC
β_0	1.670	1.239
β_1	0.059	0.059
β_2	0.051	0.051
β_3	-0.065	-0.065
β_4	0.053	0.053
β_5	-0.064	-0.064
τ	0.232	0.234

Table 2: Model's parameters (with $\alpha = 2.7$; $\lambda = 2$)

5.3.2 Scenario 1: liberalization of the German immigration policy toward new member states

We simulate a complete liberalization of the German immigration policy toward new EU member states in 2007. We focus on Germany as it implemented restrictions toward new member states until 2011.

We present the main results for Germany as a destination country in table 3 for the standard case and in table 4 for the general case. As expected, a relaxation of the German migration policy leads to a decrease in the migration costs from new members toward Germany. The decrease in the bilateral migration cost is such that the rank of Germany (when destinations are ranked in increasing order of migration costs from the source country) decreases for all new members but Czech Republic and Poland. In the standard case, this implies that Germany becomes more attractive for some individuals that did not consider this destination as their favorite one before the policy change. In that case, a relaxation of the German policy toward new EU member states impacts positively, and in the same proportions, migration from these countries toward Germany. However, when the BC is binding, the German policy change not only implies an increase in the attractiveness of that destination, but also that this destination becomes accessible for some individuals who wanted to migrate to Germany but could not afford it before the policy change. In that case, some individuals have changed their choice in the same set of potential destinations, while the set of potential destinations has expanded for some others. Consequently, the migration rates from new EU member states toward Germany increase and these changes are different across source countries.

Similarly, tables 5 and 6 respectively present the main results for Slovakia – one of the new EU member states that suffered from restrictions between 2004 and 2011 – as a source country in the standard and general cases[9]. In both cases, the German policy change results in a decrease in the bilateral migration cost from Slovakia to Germany, leading to an increase in the corresponding bilateral migration rate. In the standard case, bilateral migration rates from Slovakia toward other destinations are not affected: the increase in emigration to Germany affects the other bilateral migration flows in the same proportion; the IIA property holds. However, when the BC is binding, other bilateral migration rates decrease when the attractiveness

[9] Results obtained for Slovakia are similar to those observed for the other new EU member states.

and accessibility of Germany increase (table 6, column d), revealing the presence of multilateral resistance to migration linked to financial constraints. According to our theoretical model, a loosening of the German immigration policy toward new EU member states decreases bilateral migration rates from these countries toward less expensive destinations (equation 22). This result is corroborated by our simulation. Besides, in the simulation, for any destination k'' more expensive than Germany after the policy change, the bilateral migration rate decreases. Thus, we can infer that for any country k in the set of new EU countries such that $C^{k,DEU} < C^{k,k''}$, we have $\frac{\partial M_{BC}^{k,k''}}{\partial C^{k,DEU}} \geq 0$. As expected, when the BC is binding, the IIA property does not hold anymore.

source country k	destination country k'	(a) $\theta_0\left(k,k'\right)$	(b) $\theta_1\left(k,k'\right)$	(c) $\frac{C_1^{k,k'}-C_0^{k,k'}}{C_0^{k,k'}}$	(d) $\frac{M_1^{k,k'}-M_0^{k,k'}}{M_0^{k,k'}}$
DEU	DEU	1	1	0	0
NLD	DEU	2	2	0	0
AUT	DEU	2	2	0	0
POL	**DEU**	**2**	**2**	**<0**	**5.64e-02**
DNK	DEU	4	4	0	0
GBR	DEU	5	5	0	0
ITA	DEU	3	3	0	0
CHE	DEU	3	3	0	0
FRA	DEU	4	4	0	0
IRL	DEU	6	6	0	0
SWE	DEU	9	9	0	0
FIN	DEU	11	11	0	0
CZE	**DEU**	**2**	**2**	**<0**	**5.64e-02**
SVN	**DEU**	**6**	**2**	**<0**	**5.64e-02**
ESP	DEU	5	5	0	0
NOR	DEU	7	7	0	0
PRT	DEU	7	7	0	0
SVK	**DEU**	**4**	**2**	**<0**	**5.64e-02**
HUN	**DEU**	**6**	**2**	**<0**	**5.64e-02**
LTU	**DEU**	**8**	**3**	**<0**	**5.64e-02**
LVA	**DEU**	**10**	**5**	**<0**	**5.64e-02**
EST	**DEU**	**11**	**4**	**<0**	**5.64e-02**
CYP	**DEU**	**11**	**7**	**<0**	**5.64e-02**

Note: Source countries are ranked in increasing order of migration costs toward Germany. For example, Germany is more costly for Czech citizens than for Finish citizens; yet, Germany is the second less expensive destination for Czech citizens while it is the eleventh more expensive destination for Finish citizens. New EU member states are in bold in the table. We use the subscripts 0 and 1 to distinguish the results obtained before and after the policy change. Columns (a) and (b) respectively indicate the rank of Germany for citizens of the source country (when destinations are ranked in increasing order of migration costs) before and after the policy change. Columns (c) and (d) respectively summarize the growth rate in bilateral migration costs and bilateral migration rates induced by the policy liberalization.

Table 3: Predicted change in the (im)migration rates toward Germany when the BC is *not* binding (policy change: liberalization of the German migration policy)

source country k	destination country k'	(a) $\theta_0\left(k,k'\right)$	(b) $\theta_1\left(k,k'\right)$	(c) $\frac{C_1^{k,k'}-C_0^{k,k'}}{C_0^{k,k'}}$	(d) $\frac{M_1^{k,k'}-M_0^{k,k'}}{M_0^{k,k'}}$
DEU	DEU	1	1	0	0
NLD	DEU	2	2	0	0
AUT	DEU	2	2	0	0
POL	**DEU**	**2**	**2**	**<0**	**9.83e-02**
DNK	DEU	4	4	0	0
GBR	DEU	5	5	0	0
ITA	DEU	3	3	0	0
CHE	DEU	3	3	0	0
FRA	DEU	4	4	0	0
IRL	DEU	6	6	0	0
SWE	DEU	9	9	0	0
FIN	DEU	11	11	0	0
CZE	**DEU**	**2**	**2**	**<0**	**9.27e-02**
SVN	**DEU**	**6**	**2**	**<0**	**9.02e-02**
ESP	DEU	5	5	0	0
NOR	DEU	7	7	0	0
PRT	DEU	7	7	0	0
SVK	**DEU**	**4**	**2**	**<0**	**9.67e-02**
HUN	**DEU**	**7**	**2**	**<0**	**9.68e-02**
LTU	**DEU**	**8**	**3**	**<0**	**8.98e-02**
LVA	**DEU**	**10**	**5**	**<0**	**8.88e-02**
EST	**DEU**	**11**	**4**	**<0**	**8.80e-02**
CYP	**DEU**	**11**	**7**	**<0**	**8.31e-02**

Note: *Cf.* table 3.

Table 4: Predicted change in the (im)migration rates toward Germany when the BC *is* binding (policy change: liberalization of the German migration policy)

source	destination	(a)	(b)	(c)	(d)
country k	country k'	$\theta_0\left(k,k'\right)$	$\theta_1\left(k,k'\right)$	$\frac{C_1^{k,k'}-C_0^{k,k'}}{C_0^{k,k'}}$	$\frac{M_1^{k,k'}-M_0^{k,k'}}{M_0^{k,k'}}$
SVK	SVK	1	1	0	0
SVK	NLD	2	3	0	0
SVK	SWE	3	4	0	0
SVK	DEU	4	2	< 0	5.64e-02
SVK	GBR	5	5	0	0
SVK	ITA	6	6	0	0
SVK	CZE	7	7	0	0
SVK	AUT	8	8	0	0
SVK	FIN	9	9	0	0
SVK	IRL	10	10	0	0
SVK	DNK	11	11	0	0
SVK	ESP	12	12	0	0
SVK	HUN	13	13	0	0
SVK	CHE	14	14	0	0
SVK	SVN	15	15	0	0
SVK	NOR	16	16	0	0
SVK	PRT	17	17	0	0
SVK	EST	18	18	0	0
SVK	POL	19	19	0	0
SVK	LTU	20	20	0	0
SVK	LVA	21	21	0	0
SVK	FRA	22	22	0	0
SVK	CYP	23	23	0	0

Note: Destination countries are ranked in increasing order of migration costs from Slovakia. We use the subscripts 0 and 1 to distinguish the results obtained before and after the policy change. Columns (a) and (b) respectively indicate the rank of the destination country for Slovak citizens (when destinations are ranked in increasing order of migration costs) before and after the policy change. Columns (c) and (d) respectively summarize the growth rate in bilateral migration costs and bilateral migration rates induced by the policy liberalization.

Table 5: Predicted change in the (e)migration rates from Slovakia when the BC is *not* binding (policy change: liberalization of the German migration policy)

source country k	destination country k'	(a) $\theta_0\left(k,k'\right)$	(b) $\theta_1\left(k,k'\right)$	(c) $\frac{C_1^{k,k'}-C_0^{k,k'}}{C_0^{k,k'}}$	(d) $\frac{M_1^{k,k'}-M_0^{k,k'}}{M_0^{k,k'}}$
SVK	SVK	1	1	0	0
SVK	NLD	2	3	0	-6.78e-04
SVK	SWE	3	4	0	-3.98e-04
SVK	DEU	4	2	< 0	9.67e-02
SVK	GBR	5	5	0	-3.72e-04
SVK	ITA	6	6	0	-3.72e-04
SVK	CZE	7	7	0	-3.71e-04
SVK	AUT	8	8	0	-3.70e-04
SVK	FIN	9	9	0	-3.70e-04
SVK	IRL	10	10	0	-3.69e-04
SVK	DNK	11	11	0	-3.68e-04
SVK	ESP	12	12	0	-3.66e-04
SVK	HUN	13	13	0	-3.66e-04
SVK	CHE	14	14	0	-3.65e-04
SVK	SVN	15	15	0	-3.65e-04
SVK	NOR	16	16	0	-3.65e-04
SVK	PRT	17	17	0	-3.65e-04
SVK	EST	18	18	0	-3.65e-04
SVK	POL	19	19	0	-3.65e-04
SVK	LTU	20	20	0	-3.65e-04
SVK	LVA	21	21	0	-3.65e-04
SVK	FRA	22	22	0	-3.65e-04
SVK	CYP	23	23	0	-3.65e-04

Note: *Cf.* table 5.

Table 6: Predicted change in the (e)migration rates from Slovakia when the BC *is* binding (policy change: liberalization of the German migration policy)

5.3.3 Scenario 2: liberalization of all member states' immigration policy toward new member states

We generalize our experiment assuming a complete liberalization of migration policies within the EU in 2007. We thus consider that Austria, Denmark, France and Germany liberalize their migration policies toward new EU member states. Results in the case of a non-binding BC are in line with those presented herein-above.

Results obtained when the BC is binding are presented in appendix A.4. Looking at the results for Germany as a destination country (table 8), we find that the joint policy change induces an increase in immigration from new EU member states to Germany, as this destination becomes more attractive and more accessible. In addition, we now observe a small decrease in immigration from Austria, Denmark and France. We investigate this effect looking at the results for Slovakia as a *destination* country (table 9). We find that immigration rates from Austria, Denmark, France and Germany increase slightly. These results imply that a liberalization of migration policies within the EU does not only affect migration from EU new member states toward old EU member states, but also migration in the reverse direction. In the present case, some individuals willing to migrate from Austria, Denmark and France to Germany before the policy change decide to migrate to Slovakia or other new EU member states instead. However, migration from new EU member states to Slovakia tends to decrease (while rates toward Germany increase).

5.3.4 Robustness tests

To check the robustness of our results, we perform different tests. First, instead of simulating a complete liberalization of the German immigration policy toward new EU member states in 2007, we simulate a liberalization of migration policies of either Austria, Denmark or France. The results obtained are similar to those obtained for the German case.

Second, we test the validity of our calibration sample. We drop Ireland and the United Kingdom (for which no UNPD data for immigration flows are available) from our calibration sample. Then, we try dropping France, Italy and Portugal for which we only have a limited number of observations available. We also try to account for bilateral migration agreements implemented between EU and non-EU countries, since Norway and Switzerland are part of the Schengen area. Similarly to old EU member states, these two countries could restrict access to their labor markets to immigrants coming from the new EU countries, which Norway did until 2009 and Switzerland until 2011. For each test, the results obtained for both scenarios are similar to those presented herein-above.

Finally, we use a reduced specification of the bilateral migration cost. Until now, when simulating a liberalization of country k's immigration policy toward country k, we assumed that the labor market openness of the country $\left(\text{lab}^{k,k'}\right)$ increases to its maximum value, while the level of visa restrictions implemented against country k $\left(\text{visas}^{k}\right)$ remains unchanged. Yet, any change in $\text{lab}^{k,k'}$ should induce a change in visas^{k}. As we are unable to control for this change when we perform our simulations, we try to omit this variable from the specification of the bilateral migration cost (equation 24). Here again, the results prove to be robust.

6 Conclusion

This paper analyses to what extent financial constraints impact migration decisions. In the first part of the paper, we explicitly introduce the budget constraint in a RUM model of migration. We assume that individuals' financial resources limit their migration choices. Because of this budget constraint, individuals choose their destination country not among all destinations, but only among affordable destinations.

Relaxing the assumption of a non-binding budget constraint implicitly made in the literature, we find that the bilateral migration rate between two countries depends on the attributes of both origin and destination countries, the bilateral migration cost, and on the attributes of alternative destination countries through a budget constraint effect. Therefore our model exhibits multilateral resistance to migration: when a country changes its immigration policy, it impacts not only the migration rate toward that country but also toward other destinations.

To build this model, we made several assumptions. In particular, we assumed that individuals are myopic when taking their migration decisions, and that they cannot borrow to finance their migration. These assumptions are restrictive and could be relaxed in future research, to gain a better insight on the weight of financial constraints on migration decisions. Relaxing these assumptions could also enhance our understanding of the link between migration flows and the development of financial systems in source countries.

In the second part of the paper, we calibrate our model on the European case in 2008, focusing on migration from countries that joined the EU in 2004 toward old EU member states. We evidence the presence of multilateral resistance to migration linked to financial constraints in Europe, by simulating a complete relaxation of the German immigration policy toward new EU member states. In line with our theoretical model, we find that a loosening of the German immigration policy increases the migration rate from new member states toward Germany. We also find that migration rates from new EU member states toward other destination countries decrease.

When we assume that all EU countries liberalize their immigration policies at the same time, we find that even if the attractiveness and accessibility of a destination country do not change (for a source country), migration to that destination may decrease due to a change in the attractiveness and accessibility of other destinations.

These simulations are quite instructive on the link between immigration policies, migration costs and migration rates. However, when the necessary data become available, future research could try instead to empirically estimate the model. More specifically, the analytic expression of the bilateral migration rate when the BC is binding (equation 10) cannot be estimated with a standard econometric approach, the effect of the budget constraint on migration decisions being unobserved. In such a case, one may use the CCE estimator as proposed by Bertoli and Fernández-Huertas Moraga (2013) and Bertoli et al. (2016).

Our results show that the immigration policy implemented by a destination country has consequences on migration rates toward all destination countries. This implies that destination countries, and especially European countries, should cooperate on this issue on a long term basis, and really implement a common European immigration policy. The community could gain to establish both a common internal and external policy for long term migration. Similarly to the common trade policy that allows the free circulation of goods and services within the EU area and sets common tariffs for imports from third countries, the common immigration policy could allow the free movement of European citizens within the EU (policy already implemented) and set the same rules for entrance and long-term stay in any EU member state for citizens of third countries.

Acknowledgments

We are grateful to Hubert Jayet for his constructive remarks. We also thank Frédéric Docquier and Glenn Rayp for their comments. We thank participants at the ETSG conference 2016 (Aalto University & VATT Institute), the 5^{th} conference on "Immigration in OECD countries" (OECD), the 6^{th} International Conference on "Economics of Global Interactions: New Perspectives on Trade, Factor Mobility and Development" (University of Bari), the 2015 AFSE conference (University of Rennes), the International workshop "Economic and social consequences of immigration: A study of some misconceptions about migration" (LEM, University of Lille) and the LEM internal seminar for useful discussions. The usual disclaimer applies.

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A Appendix

A.1 Probability to migrate to country k', conditional on the capacity to afford the migration cost

To find the probability to migrate to country k' conditional on the capacity of the individual to afford his migration, we use the most straightforward reasoning: individual i first identifies affordable destinations and then chooses among this set of countries the one that maximizes his utility.

We defined $\theta(k, k')$ as the rank of country k' when destinations are ranked in increasing order of migration cost from country k, and $\kappa(k, l)$ as the inverse permutation of $\theta(k, k')$: $\theta(k, k') = l \Longleftrightarrow \kappa(k, l) = k'$.

To find the set of affordable destinations, individual i first considers a potential destination country k'. With probability $\Phi\left(C^{k,k'}\right)$, $w_i^k < C^{k,k'}$ and country k' cannot be a destination country. Conversely, with probability $1 - \Phi\left(C^{k,k'}\right)$, k' is an affordable destination. For any $l \geq \theta(k, k')$, we know that $C^{k,k'} \leq C^{k,\kappa(k,l)} \leq C^{k,\kappa(k,l+1)}$. Thus, with probability $\Phi\left[C^{k,\kappa(k,l+1)}\right] - \Phi\left[C^{k,\kappa(k,l)}\right]$, the double inequality $C^{k,\kappa(k,l)} < w_i^k < C^{k,\kappa(k,l+1)}$ holds: country l is affordable but not country $l+1$. Then, the choice set generated by the budget constraint is the set of all the countries ranked from 1 to l (including k'), $\mathcal{A}_{kl} = \{\kappa(k, 1), \ldots, \kappa(k, l)\}$.

Following the results of McFadden (1974, 1984), the probability of individual i to choose country k' is:

$$\Pr\left[U_i^{k,k'} = \max_{q \in \mathcal{A}_{kl}} U_i^{k,q} \mid C^{k,\kappa(k,l)} < w_i^k < C^{k,\kappa(k,l+1)}\right] = \frac{e^{\left(W^{k,k'} - C^{k,k'}\right)/\tau}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}}. \tag{26}$$

Then, summing for every $l \geq \theta(k, k')$, we get the unconditional probability of k' to be a destination country from k:

$$\begin{aligned} p_{BC}^{k,k'} &= \sum_{l=\theta(k,k')}^{P} \Pr\left[C^{k,\kappa(k,l)} < w_i^k < C^{k,\kappa(k,l+1)}\right] \Pr\left[U_i^{kk'} = \max_{q \in A_{kl}} U_i^{kq} \mid C^{k,\kappa(k,l)} < w_i^k < C^{k,\kappa(k,l+1)}\right] \\ &= \sum_{l=\theta(k,k')}^{P} \left\{\Phi\left[C^{k,\kappa(k,l+1)}\right] - \Phi\left[C^{k,\kappa(k,l)}\right]\right\} \frac{e^{\left(W^{k,k'} - C^{k,k'}\right)/\tau}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}} \\ &= A^{k,k'} e^{\left(W^{k,k'} - C^{k,k'}\right)/\tau} \end{aligned} \tag{27}$$

where:

$$A^{k,k'} = \sum_{l=\theta(k,k')}^{P} \frac{\Phi\left[C^{k,\kappa(k,l+1)}\right] - \Phi\left[C^{k,\kappa(k,l)}\right]}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}} \tag{28}$$

using the convention $C^{k,\kappa(k,P+1)} = \infty$ so that $\Phi\left[C^{k,\kappa(k,P+1)}\right] = 1$.

This formula implies that the probability of an individual not to migrate out of country k is:

$$p_{BC}^{k,k} = e^{W^{k,k}/\tau} \sum_{l=1}^{P} \frac{\Phi\left[C^{k,\kappa(k,l+1)}\right] - \Phi\left[C^{k,\kappa(k,l)}\right]}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}} = A^{k,k} e^{W^{k,k}/\tau}. \tag{29}$$

A.2 Comparative statics in the general case

A.2.1 Derivatives of the bilateral probabilities

We know from equation 6 that the probability to migrate from country k toward country k' is:

$$p_{BC}^{k,k'} = A^{k,k'} e^{\left(W^{k,k'} - C^{k,k'}\right)/\tau} \tag{30}$$

where:

$$A^{k,k'} = \sum_{l=\theta(k,k')}^{P} \frac{\Phi\left[C^{k,\kappa(k,l+1)}\right] - \Phi\left[C^{k,\kappa(k,l)}\right]}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}} = \sum_{l=\theta(k,k')}^{P} \Psi^{k,l} \tag{31}$$

with:

$$\Psi^{k,l} = \frac{\Phi\left[C^{k,\kappa(k,l+1)}\right] - \Phi\left[C^{k,\kappa(k,l)}\right]}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}}. \tag{32}$$

First, we calculate the derivative of $A^{k,k'}$ with respect to any cost $C^{k,j}$. Differentiating $\Psi^{k,l}$, we get:

- If $l < \theta(k,j) - 1$, then $\forall q \leq l,\ \kappa(k,q) \neq j$ and:

$$\frac{1}{\Psi^{k,l}} \frac{\partial \Psi^{k,l}}{\partial C^{k,j}} = 0. \tag{33}$$

- If $l = \theta(k,j) - 1$ (or, equivalently, $\kappa(k,l+1) = j$), then:

$$\frac{1}{\Psi^{k,l}} \frac{\partial \Psi^{k,l}}{\partial C^{k,j}} = \frac{1}{\Psi^{k,\theta(k,j)-1}} \frac{\partial \Psi^{k,\theta(k,j)-1}}{\partial C^{k,j}} = \frac{\Phi'\left(C^{k,j}\right)}{\Phi\left(C^{k,j}\right) - \Phi\left\{C^{k,\kappa[k,\theta(k,j)-1]}\right\}}. \tag{34}$$

- If $l = \theta(k,j)$ (or, equivalently, $\kappa(k,l) = j$), then:

$$\frac{1}{\Psi^{k,l}} \frac{\partial \Psi^{k,l}}{\partial C^{k,j}} = \frac{1}{\Psi^{k,\theta(k,j)}} \frac{\partial \Psi^{k,\theta(k,j)}}{\partial C^{k,j}} = \frac{1}{\tau} \frac{e^{\left(W^{k,j} - C^{k,j}\right)/\tau}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}} - \frac{\Phi'\left(C^{k,j}\right)}{\Phi\left\{C^{k,\kappa[k,\theta(k,j)+1]}\right\} - \Phi\left(C^{k,j}\right)}. \tag{35}$$

- If $l > \theta(k,j)$, then $\exists\, q < l\ s.t.\ \kappa(k,q) = j$ and:

$$\frac{1}{\Psi^{k,l}} \frac{\partial \Psi^{k,l}}{\partial C^{k,j}} = \frac{1}{\tau} \frac{e^{\left(W^{k,j} - C^{k,j}\right)/\tau}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}}. \tag{36}$$

Then, since $\frac{\partial A^{k,k'}}{\partial C^{k,j}} = \sum_{l=\theta(k,k')}^{P} \frac{\partial \Psi^{k,l}}{\partial C^{k,j}}$, we get:

- If $j = k'$, then:

$$\frac{\partial A^{k,k'}}{\partial C^{k,k'}} = \frac{1}{\tau} \sum_{l=\theta(k,k')}^{P} \frac{e^{\left(W^{k,k'} - C^{k,k'}\right)/\tau} \Psi^{k,l}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}} - \frac{\Phi'\left(C^{k,k'}\right) \Psi^{k,\theta\left(k,k'\right)}}{\Phi\left\{C^{k,\kappa[k,\theta(k,k')+1]}\right\} - \Phi\left(C^{k,k'}\right)}. \tag{37}$$

- If $\theta(k,j) < \theta(k,k')$, then:

$$\frac{\partial A^{k,k'}}{\partial C^{k,j}} = \frac{1}{\tau} \sum_{l=\theta(k,k')}^{P} \frac{e^{\left(W^{k,j}-C^{k,j}\right)/\tau} \Psi^{k,l}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)}-C^{k,\kappa(k,q)}\right)/\tau}} > 0. \tag{38}$$

- If $\theta(k,j) > \theta(k,k')$, then:

$$\begin{aligned}\frac{\partial A^{k,k'}}{\partial C^{k,j}} =& \frac{\Phi'\left(C^{k,j}\right)\Psi^{k,\theta(k,j)-1}}{\Phi\left(C^{k,j}\right) - \Phi\left\{C^{k,\kappa[k,\theta(k,j)-1]}\right\}} - \frac{\Phi'\left(C^{k,j}\right)\Psi^{k,\theta(k,j)}}{\Phi\left\{C^{k,\kappa[k,\theta(k,j)+1]}\right\} - \Phi\left(C^{k,j}\right)} \\ &+ \frac{1}{\tau} \sum_{l=\theta(k,j)}^{P} \frac{e^{\left(W^{k,j}-C^{k,j}\right)/\tau} \Psi^{k,l}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)}-C^{k,\kappa(k,q)}\right)/\tau}} > 0 \end{aligned} \tag{39}$$

where the positive sign comes from the following equality:

$$\begin{aligned} & \frac{\Phi'\left(C^{k,j}\right)\Psi^{k,\theta(k,j)-1}}{\Phi\left(C^{k,j}\right) - \Phi\left(C^{k,\kappa(k,\theta(k,j)-1)}\right)} - \frac{\Phi'\left(C^{k,j}\right)\Psi^{k,\theta(k,j)}}{\Phi\left\{C^{k,\kappa[k,\theta(k,j)+1]}\right\} - \Phi\left(C^{k,j}\right)} \\ =& \Phi'\left(C^{k,j}\right)\left[\frac{1}{\sum_{l=1}^{\theta(k,j)-1} e^{\left(W^{k,\kappa(k,l)}-C^{k,\kappa(k,l)}\right)/\tau}} - \frac{1}{\sum_{l=1}^{\theta(k,j)} e^{\left(W^{k,\kappa(k,l)}-C^{k,\kappa(k,l)}\right)/\tau}}\right] > 0. \end{aligned} \tag{40}$$

Second, since $p_{BC}^{k,k'} = A^{k,k'} e^{\left(W^{k,k'}-C^{k,k'}\right)/\tau}$, we get:

$$\forall j \neq k' \; \frac{\partial p_{BC}^{k,k'}}{\partial C^{k,j}} = \frac{\partial A^{k,k'}}{\partial C^{k,j}} e^{\left(W^{k,k'}-C^{k,k'}\right)/\tau} > 0 \tag{41}$$

$$\frac{\partial p_{BC}^{k,k'}}{\partial C^{k,k'}} = \left(\frac{\partial A^{k,k'}}{\partial C^{k,k'}} - \frac{1}{\tau} A^{k,k'}\right) e^{\left(W^{k,k'}-C^{k,k'}\right)/\tau} < 0 \tag{42}$$

because:

$$\begin{aligned}\frac{\partial A^{k,k'}}{\partial C^{k,k'}} - \frac{1}{\tau} A^{k,k'} =& -\frac{1}{\tau} \sum_{l=\theta(k,k')}^{P} \left[1 - \frac{e^{\left(W^{k,k'}-C^{k,k'}\right)/\tau}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)}-C^{k,\kappa(k,q)}\right)/\tau}}\right] \Psi^{k,l} \\ & - \frac{\Phi'\left(C^{k,k'}\right)\Psi^{k,\theta\left(k,k'\right)}}{\Phi\left\{C^{k,\kappa[k,\theta(k,k')+1]}\right\} - \Phi\left(C^{k,k'}\right)} < 0. \end{aligned} \tag{43}$$

A.2.2 Derivatives of the bilateral migration rate

The bilateral migration rate between country k and country k' is given by $M_{BC}^{k,k'} = \frac{p_{BC}^{k,k'}}{p_{BC}^{k,k}}$. Thus:

$$\frac{1}{M_{BC}^{k,k'}} \frac{\partial M_{BC}^{k,k'}}{\partial C^{k,j}} = \frac{1}{p_{BC}^{k,k'}} \frac{\partial p_{BC}^{k,k'}}{\partial C^{k,j}} - \frac{1}{p_{BC}^{k,k}} \frac{\partial p_{BC}^{k,k}}{\partial C^{k,j}}. \tag{44}$$

For $j = k'$, we know that $\frac{\partial p_{BC}^{k,k'}}{\partial C^{k,k'}} < 0$ and $\frac{\partial p_{BC}^{k,k}}{\partial C^{k,k'}} > 0$, so that:

$$\frac{1}{M_{BC}^{k,k'}} \frac{\partial M_{BC}^{k,k'}}{\partial C^{k,k'}} = \frac{1}{p_{BC}^{k,k'}} \frac{\partial p_{BC}^{k,k'}}{\partial C^{k,k'}} - \frac{1}{p_{BC}^{k,k}} \frac{\partial p_{BC}^{k,k}}{\partial C^{k,k'}} < 0 \tag{45}$$

and thus $\frac{\partial M_{BC}^{k,k'}}{\partial C^{k,k'}} < 0$. Increasing the migration cost $C^{k,k'}$ decreases the probability to move from country k to country k' and increases the probability to stay in country k, in turn decreasing the migration rate from country k to country k'.

For $j \neq k'$, knowing that $p_{BC}^{k,k'} = A^{k,k'} e^{\left(W^{k,k'} - C^{k,k'}\right)/\tau}$, we get:

$$\frac{1}{M_{BC}^{k,k'}} \frac{\partial M_{BC}^{k,k'}}{\partial C^{k,j}} = \frac{1}{A^{k,k'}} \frac{\partial A^{k,k'}}{\partial C^{k,j}} - \frac{1}{A^{k,k}} \frac{\partial A^{k,k}}{\partial C^{k,j}}. \tag{46}$$

- If $\theta(k,j) > \theta(k,k')$, which means that $C^{k,j} > C^{k,k'}$, then from equation (39) we get:

$$\frac{\partial A^{k,k}}{\partial C^{k,j}} = \frac{\partial A^{k,k'}}{\partial C^{k,j}} > 0 \tag{47}$$

so that:

$$\frac{1}{M_{BC}^{k,k'}} \frac{\partial M_{BC}^{k,k'}}{\partial C^{k,j}} = \left(\frac{1}{A^{k,k'}} - \frac{1}{A^{k,k}} \right) \frac{\partial A^{k,k}}{\partial C^{k,j}} > 0 \tag{48}$$

because:

$$0 < A^{k,k'} = \sum_{l=\theta(k,k')}^{P} \Psi^{k,l} < \sum_{l=1}^{P} \Psi^{k,l} = A^{k,k}. \tag{49}$$

- If $\theta(k,j) < \theta(k,k')$, which means that $C^{k,j} < C^{k,k'}$, then from equations (38) and (39), we get:

$$\begin{aligned}
\frac{1}{M_{BC}^{k,k'}} \frac{\partial M_{BC}^{k,k'}}{\partial C^{k,j}} =& \frac{1}{A^{k,k'}} \frac{1}{\tau} \sum_{l=\theta(k,k')}^{P} \frac{e^{\left(W^{k,j} - C^{k,j}\right)/\tau} \Psi^{k,l}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}} - \frac{1}{A^{kk}} \frac{1}{\tau} \sum_{l=\theta(k,j)}^{P} \frac{e^{\left(W^{k,,j} - C^{k,j}\right)/\tau} \Psi^{k,l}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}} \\
& - \frac{1}{A^{k,k}} \left(\frac{\Phi'\left(C^{k,j}\right) \Psi^{k,\theta(k,j)-1}}{\Phi\left(C^{k,j}\right) - \Phi\left\{C^{k,\kappa[k,\theta(k,j)-1]}\right\}} - \frac{\Phi'\left(C^{k,j}\right) \Psi^{k,\theta(k,j)}}{\Phi\left\{C^{k,\kappa[k,\theta(k,j)+1]}\right\} - \Phi\left(C^{k,j}\right)} \right) \\
=& \frac{1}{\tau} \left(\frac{1}{A^{k,k'}} - \frac{1}{A^{k,k}} \right) \sum_{l=\theta(k,k')}^{P} \frac{e^{\left(W^{k,j} - C^{k,j}\right)/\tau} \Psi^{k,l}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}} \\
& - \frac{1}{\tau} \frac{1}{A^{k,k}} \sum_{l=\theta(k,j)}^{\theta\left(k,k'\right)-1} \frac{e^{\left(W^{k,j} - C^{k,j}\right)/\tau} \Psi^{k,l}}{\sum_{q=1}^{l} e^{\left(W^{k,\kappa(k,q)} - C^{k,\kappa(k,q)}\right)/\tau}} \\
& - \frac{1}{A^{kk}} \left(\frac{\Phi'\left(C^{k,j}\right) \Psi^{k,\theta(k,j)-1}}{\Phi\left(C^{k,j}\right) - \Phi\left\{C^{k,\kappa[k,\theta(k,j)-1]}\right\}} - \frac{\Phi'\left(C^{k,j}\right) \Psi^{k,\theta(k,j)}}{\Phi\left\{C^{k,\kappa[k,\theta(k,j)+1]}\right\} - \Phi\left(C^{k,j}\right)} \right)
\end{aligned} \tag{50}$$

which is uncertain in sign, as the first term is positive while the second and third terms are both negative.

A.3 Immigration flow data

Reporting country	Data source	Residency criterion	Available origin countries	Note
Austria	UNPD	more than 3 months	Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland	*
Cyprus	UNPD	more than 1 year	Austria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland	
Czech Republic	UNPD	permanent	Austria, Cyprus, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland	
Denmark	UNPD	more than 6 months	Austria, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland	*
Estonia	UNPD	more than 1 year	Austria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland	
Finland	UNPD	more than 1 year	Austria, Cyprus, Czech Republic, Denmark, Estonia, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland	*
France	UNPD	more than 1 year	Switzerland	
Germany	UNPD	no minimum duration	Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland	
Hungary	UNPD	more than 3 months	Austria, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland	
Ireland	OECD	no minimum duration	the United Kingdom	
Italy	UNPD	more than 1 year	France, Germany, Poland, Switzerland	
Latvia	UNPD	more than 1 year	Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland	

Lithuania	UNPD	more than 6 months	Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland	
The Netherlands	UNPD	other criterion	Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland	
Norway	UNPD	more than 6 months	Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland	*
Poland	UNPD	permanent	Austria, Czech Republic, Estonia, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Slovakia, Spain, Sweden, Switzerland	*
Portugal	UNPD	permanent	France, Germany, Spain	
Slovakia	UNPD	permanent	Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland	
Slovenia	UNPD	more than 1 year	Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland	
Spain	UNPD	no minimum duration	Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Sweden, Switzerland	
Sweden	UNPD	more than 1 year	Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Switzerland	*
Switzerland	UNPD	more than 1 year	Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden	*
The United Kingdom	OECD	more than 1 year	Germany, Italy, Poland	

Note: (*) In the UNPD database, a zero indicates that the value is zero, not available or not applicable. Therefore, we replace zeros by missing values.

Table 7: Immigration flows of foreign citizens by reporting country in 2008

A.4 Scenario 2: simulation results

source country k	destination country k'	(a) $\theta_0\left(k,k'\right)$	(b) $\theta_1\left(k,k'\right)$	(c) $\frac{C_1^{k,k'}-C_0^{k,k'}}{C_0^{k,k'}}$	(d) $\frac{M_1^{k,k'}-M_0^{k,k'}}{M_0^{k,k'}}$
DEU	DEU	1	1	0	0
NLD	DEU	2	2	0	0
AUT	DEU	2	2	0	-4.22e-04
POL	**DEU**	**2**	**2**	**<0**	**9.11e-02**
DNK	DEU	4	4	0	-3.22e-04
GBR	DEU	5	5	0	0
ITA	DEU	3	3	0	0
CHE	DEU	3	3	0	0
FRA	DEU	4	4	0	-9.86e-04
IRL	DEU	6	6	0	0
SWE	DEU	9	9	0	0
FIN	DEU	11	11	0	0
CZE	**DEU**	**2**	**2**	**<0**	**8.89e-02**
SVN	**DEU**	**6**	**3**	**<0**	**8.77e-02**
ESP	DEU	5	5	0	0
NOR	DEU	7	7	0	0
PRT	DEU	7	7	0	0
SVK	**DEU**	**4**	**3**	**<0**	**9.18e-02**
HUN	**DEU**	**7**	**3**	**<0**	**9.11e-02**
LTU	**DEU**	**8**	**4**	**<0**	**8.48e-02**
LVA	**DEU**	**10**	**6**	**<0**	**8.42e-02**
EST	**DEU**	**11**	**5**	**<0**	**8.43e-02**
CYP	**DEU**	**11**	**9**	**<0**	**8.15e-02**

Note: *Cf.* table 3.

Table 8: Predicted change in the (im)migration rates toward Germany when the BC *is* binding (policy change: liberalization of all EU member states migration policy)

source country k	destination country k'	(a) $\theta_0\left(k,k'\right)$	(b) $\theta_1\left(k,k'\right)$	(c) $\frac{C_1^{k,k'}-C_0^{k,k'}}{C_0^{k,k'}}$	(d) $\frac{M_1^{k,k'}-M_0^{k,k'}}{M_0^{k,k'}}$
SVK	**SVK**	**1**	**1**	**0**	**0**
NLD	SVK	11	11	0	0
SWE	SVK	16	16	0	0
ITA	SVK	7	7	0	0
GBR	SVK	14	14	0	0
FIN	SVK	15	15	0	0
IRL	SVK	16	16	0	0
ESP	SVK	13	13	0	0
PRT	SVK	13	13	0	0
AUT	SVK	19	6	< 0	2,45e-01
DEU	SVK	21	11	< 0	2,50e-01
DNK	SVK	22	15	< 0	2,40e-01
CZE	**SVK**	**18**	**19**	**0**	**-1,93e-03**
CHE	SVK	20	20	0	0
HUN	**SVK**	**18**	**19**	**0**	**-3,13e-03**
SVN	**SVK**	**20**	**20**	**0**	**-1,28e-03**
POL	**SVK**	**22**	**22**	**0**	**-4,04e-03**
NOR	SVK	22	22	0	0
FRA	SVK	21	15	< 0	2,57e-01
LTU	**SVK**	**21**	**22**	**0**	**-2,90e-03**
LVA	**SVK**	**21**	**22**	**0**	**-2,84e-03**
EST	**SVK**	**21**	**22**	**0**	**-2,30e-03**
CYP	**SVK**	**23**	**23**	**0**	**-9,51e-04**

Note: *Cf.* table 3.

Table 9: Predicted change in the (im)migration rates toward Slovakia when the BC *is* binding (policy change: liberalization of all EU member states migration policy)