Economic incentives versus institutional frictions: migration dynamics within Europe

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Abstract

The immobility puzzle in European Union takes the form that the observed level of migration within Europe is substantially less than is expected in an union which allows free labor mobility, indicating that there are possibly institutional barriers inhibiting migration. In order to pin down the missing mass of migrants, we propose a theory of cross-region migration in a multi-region setting with heterogeneity in sectoral compositions, productivity and endowments of productive inputs. Migration arises as the result of adjustment process of workers in response to uneven region and sector-specific shocks in factor productivity. When tested on U.S. which we consider to be a benchmark for institutional homogeneity, this model explains substantial part of variability in both the nominal and the relative levels of state-to-state migration. However, for Europe, the model explains the relative flow network well but predicts a higher nominal flow than is seen in the data illustrating the puzzle. Following the hypothesis that heterogeneity across European countries in institutional factors induce a friction on such labor reallocation process driven by economic incentives, we use dyadic regression to analyze the effects of pair-wise institutional distances which broadly captures various types of socio-cultural and political differences between countries, on the missing mass of migrants. Linguistic differences appear to be an important factor explaining the gap.

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And the Lord said, "Indeed the people are one and they all have one language, and this is what they begin to do; now nothing that they propose to do will be withheld from them.
Come, let Us go down and there confuse their language, that they may not understand one anothers speech."
So the Lord scattered them abroad from there over the face of all the earth ...
-Genesis 11:49 (Tower of Babel)

1 Introduction

The question we ask in this paper is how the institutional factors cause an impediment in the process of migration? Across the world, people move from place to place in search for better economic and social lives. In the current age of globalization, rapid improvements in transportation technology along with the removal of legal and political barriers have contributed to the flow of people between countries. However, this process may not work quite smoothly in presence of substantial institutional differences. In the U.S., the average flow of migrants across states was about 2% in the last 20 years[1]. However, in case of Europe this rate is in the order of 1/100-th of the corresponding value for the U.S. even after allowing free labor mobility with the formation of the European union (E.U.) indicating presence of substantial frictions in the process. This phenomenon is referred to in the literature as 'European immobility puzzle' (see for example, Braunerhjelm et al. [2000]). What explains this sizeable missing mass of migrants in case of Europe? As we will show, linguistic differences appear to play a more important role than other types of frictions.

There are multiple reasons why people migrate. It has been argued that the most important motivation arises from purely economic incentives e.g. higher wage or productivity in one country vis-a-vis another (Kennan and Walker [2011], Bertoli et al. [2013]). Institutional factors also play an important role in shaping the decision. For example, Belot and Ederveen [2012] argue that differences in cultures or customs may present an impediment in the process. Thus from a purely economic point of view, the phenomena of migration between countries with similar economic characteristics can be thought of as an adjustment process or a reallocation process of labor resulting from uneven productivity shocks. However, various socio-cultural and political factors can induce frictions on that mechanism reducing the extent of the reallocation. Ultimately, how the actual dynamics shapes up is a complex interplay between such economic and institutional forces.

Understanding the mechanism underlying migration is of great importance as low levels of migration due to institutional rigidities imply less flexible labor market. Such an economy if hit by negative spatial and/or sectoral shocks, will take more time to adjust prolonging the downturn. Batini et al. [2010] for example argues that low inter-state migration was a potential cause of the slow recovery of the U.S. economy after the 2007-08 crisis. What makes it more compelling is that U.S. is usually found to be much more flexible in terms of migration than Europe. Thus a similar downturn would be even more prolonged in Europe with a significantly rigid labor market, a situation which the E.U. largely wanted to avoid

[1] This rate actually shows a secular decline over the same period as in 1990 the rate was about 3% and in 2011, the rate is about 1.5% of the whole population (Kaplan and Schulhofer-Wohl [2013]).

by allowing free movement of labor (Belot and Ederveen [2012]). Therefore a decomposition of the effects of sheer economic forces and institutional factors is key to understanding their relative effects on labor movement across countries.

The case of E.U. vis-a-vis U.S. provides an interesting comparison. These two political unions being 'North' in an economic sense, have far less variation in economic conditions among the constituent states than a 'North-South' relationship like U.S. and India. Thus one might imagine such an union to comprise several regions (states or countries) sharing largely similar economic background (identical labor laws, integrated financial markets etc.), connected to each other by economic linkages though trade and migration. If the constituent regions receive asymmetric productivity shocks, we would expect workers to flow from the low-productivity state to high productivity region in a friction-less world. Thus the process of migration can be observed in two forms; first, there would be people migrating to-and-fro between all pairs of regions which gives us an idea about relative flow of workers between pairs of regions and second, the total mass of migrants i.e. the total mass of workers that were displaced due to the realization of the productivity shocks.

We construct a general model of migration to model the effects of productivity differences on migration. Under suitable calibration, the model is consistent with the U.S. data in terms of the labor network generated as well as the total mass of migrants. Since U.S. is taken to a frictionless case with sufficient institutional homogeneity, a good fit of the model to the U.S. data indicates that the model captures economic incentives arising due to productivity, to a reasonable degree. When calibrated to E.U., the same model captures the relative flow of labor across E.U. well but predicts higher aggregate flow than is seen in data. This gap can be thought of representing missing migrants in the European immobility puzzle, which are explained by an array of various institutional factors, linguistic differences being the the most persistent one across years. Basically, we model migration within U.S. as driven by sheer economic incentives and the same within Europe as driven by economic incentives with negative effects arising from institutional frictions.

In the following, we first present an N-region, two-sector model augmented with sector and region-specific idiosyncratic productivity shocks. The basic productive inputs are capital and labor which we assume to be fixed and movable respectively, in the short-run. Labor being the only movable input, would move in response to uneven productivity shocks across regions according to relative attractiveness based on productivity. Thus from one set of labor allocation, we reach another set such that utilities are equalized across the regions restoring equilibrium. The underlying logic is that migratory responses are ultimately utility enhancing[2] (Ashby [2007]). The analytical structure provided by Caliendo et al. [2014] helps us to explicitly pin down the effects on labor allocation. Assuming homogeneity of labor, we can construct a labor flow network by combining all pairs of regions. Thus when the regions experience series of idiosyncratic productivity shocks, the model generates a labor flow network as an equilibrium outcome. The driving mechanisms behind migration are two-folds. The first one is a pure general equilibrium channel which captures the labor flow

[2]Tiebout [1956] makes an interesting observation that with low rigidities in labor market and no asymmetries in information or externalities induced by government, the consumers would reveal their preference through migration. This idea of 'voting with feet' is found to have significant empirical support Banzhaf and Walsh [2008]. However, in the current paper we do not differentiate between the consumption bundles. Only factor productivity drives migration.

as a result of sectoral reallocation process due to productivity differences across sectors. The second one is the trade channel through which we quantify the inter-country labor flow due to spill-over of productivity shocks due to the trade process. In general, the essential mechanism can be thought of as a planner's problem where the planner treats (perfectly divisible) labor as a movable productive input and allocates it across countries according to productivity shocks realized in different regions.

Broadly, we borrow from the recently blooming literature in international trade theory (in the tradition of the celebrated Eaton and Kortum [2002] model) that combines a rich description of the production processes capturing the propagation of shocks across the network along with adjustable i.e. movable productive inputs. We show that a similarly specified model can serve as a benchmark case for a frictionless world. With repeated shocks (spread calibrated to data) the model generates a *weighted* and *directed* network[3] of labor flow in the steady state that provides a micro-founded theory of multilateral *gravity equation* of migration. However, there are various social-cultural-political-geographical factors working for and against this process which alters the allocation and hence induces a sub-optimal outcome. We augment the labor flow equations derived from the basic model with several types of frictions to analyze their relative deterrence effects. The contiguity of the countries is seen to induce a small increase in labor flow whereas distances in terms of language and culture are seen to deter migration. This finding captures the basic proposition of Belot and Ederveen [2012]. With an enlarged database we also find other institutional factors like financial and legal conditions affect migration.

This paper is related to several streams of literature. On the theoretical dimension, the paper adopts the view that a joint description of the global economy (in the very specific context of current problem i.e. E.U. and U.S.) comprising multiple constituent regions, is important to understand the mechanism underlying migration. The reason being the mass of migrants between two countries is influenced by other countries that are potential donors or receivers of migrants (as documented for example in Bertoli and Moraga [2013]). Thus the most general description of the process would be in terms of a flow network which is both weighted and directed signifying the differential mass of migrants migrating between different pairs of countries as well as capturing the direction of movement. Joint evolution of sectors and propagation of shocks in an interconnected economy and subsequent adjustments has been studied extensively in the recent years (see for example, Acemoglu [2012], Oberfield [2013], Foerster et al. [2011]).

In particular, our model depends heavily on the structure laid down by Caliendo et al. [2014] which shows that inter-regional trade propagates the idiosyncratic shocks to the rest of the economy. We borrow this idea of sector and region-specific TFP shocks and argue that the complex structure of regional composition of industries and uneven TFP shocks in these industries lead to migration. We create a network of regional and sectoral linkages which transmits the idiosyncratic shocks throughout the economy. This framework in turn, is based on the international trade literature in the tradition of the Eaton and Kortum [2002] and its subsequent modifications by Alvarez and Lucas [2007]. We analyze the model in the

[3]A network is defined as a collection of edges and nodes. In this case, the countries/states/regions are the nodes and the region-to-region labor flows constitute the edges. Since the mass of labor flowing between different pairs of countries are different, we call the network weighted and since the inflow is not necessarily equal to outflow in terms of labor, we call the network directed.

steady state to pin down the labor flow network. Even though we borrow the methodology of trade theory and we explicitly calibrate the model to match the trade characteristics of the data, for our purpose it only works as a medium of propagation of shocks. More importantly, we recognize the role of various frictions in determining the actual level of migration. Albeit different in scope, Redding et al. [2012] provides a theory of structural change which can be interpreted as two-region migration, based on a similar trade theoretic structure. An expanded framework was used by Redding [2014] to study the welfare gains from trade. As such the present contribution is an attempt to bridge the trade theoretic literature to the labor migration literature (Goston and Nelson [2013]).

There is a huge empirical literature on migration and various factors that magnifies or lessens it. Treyz et al. [1993] was as early attempt that considered a behavioral model of migration and using time-series data showed that migration is affected, among others, by relative employment opportunities, relative wages and industry composition. In our theoretical model, these effects have been explicitly incorporated and we consider a data set richer in scope to pin down more disaggregated effects of various institutional factors. Klein and Ventura [2009] constructs a growth model to study the welfare gains from removing barriers to migration as there exists substantial productivity differences between the countries (see also Klein and Ventura [2007] for the theoretical analysis of the dynamic model). However, they focus on the historical evolution of the migration pattern and study aggregated data whereas we consider a much shorter time-period with disaggregated data. The effects of various types of frictions have been studied in details. For example, Kaplan and Schulhofer-Wohl [2013] studies the reason behind the secular decline in U.S. interstate migration over the last two decades and finds reduced geographic specificity and higher information about the states to be important factors. Even then, U.S. interstate migration is far more prominent than Intra-Europe migration. Empirically, Palmer and Pytlikova [2013] finds lax labor laws to be an attractive factor positively affecting intra-Europe migration whereas Belot and Ederveen [2012] finds cultural differences to present an obstacle in the same context. Finally, Molloy et al. [2011] and Coen-Pirani [2010] provide detailed overviews of the interstate migration in U.S.

2 A model of migration

In this section, our goal is to provide a model to capture annual bilateral migration between different pairs of countries (or states within U.S.). We consider a model with T (finite but potentially large) periods where each year N islands (N countries belonging to the E.U. or N states of U.S.;in general, N regions) experience idiosyncratic shocks exactly T times and the workers can move across the islands depending on the relative intensities of the shocks. In the following, we will refer to both countries and states as 'islands' to avoid confusion, unless explicitly mentioned. Each island is populated by a continuum of homogeneous households. There are tradables and non-tradable final goods produced by firms in each island for the consumption of the households. For fixing the notion, we assume that the manufacturing industry produces the tradables and the service industry produces the non-tradables. Final goods are produced by combining a continuum of intermediate goods which are in turn produced using local labor and a local fixed capital stock. This stock might be interpreted as the structures and land which does not grow over time or at least, grows at a much slower pace than labor movement. The islands trade on intermediate inputs. Final goods are used only for local consumption. The household supplies its labor to both sectors in the home country. Since the islands have their idiosyncratic productivity shocks process and labor is the only mobile factor, sector and island-specific productivity shocks will lead to multi-lateral flow of labor across sectors and islands. This feature is derived from the model proposed by Caliendo et al. [2014]. The flow of workers from one island to another is interpreted as migration.

2.1 Households' problem

In each island a continuum of households constitutes the demand side. They are the sole suppliers of labor which is used in the local production processes. There are two final goods, tradables (M) and non-tradables (S). As has been described above, we lump manufacturing industries to constitutes the tradable sector and the service producing industries to constitute the non-tradable sector. The instantaneous utility function of households in the n-th island at a generic time-point t is defined over consumption of the manufactured goods (C^M) and service (C^S),

$$U_{nt} = (C^M_{nt})^{\alpha}(C^S_{nt})^{(1-\alpha)}, \tag{1}$$

where α is the relative weight attached to manufactured goods. The budget constraint simply states that the total expenditure of the manufactured goods and services has to be less than equal to income. This can be written as

$$P^M_{nt}C^M_{nt} + P^S_{nt}C^S_{nt} \leq I_{nt}, \tag{2}$$

where the term on the right hand side denotes per-capita income which is the sum of rental income earned from fixed capital stock (or structures and land as has been described in Caliendo et al. [2014]) and wage. Lets us denote the interest rate by r, the island-specific fixed capital stock by K, labor by L and wage rate by w. Thus we have the income equation,

$$I_{nt} = r_{nt}\frac{K_{nt}}{L_{nt}} + w_{nt}. \tag{3}$$

The expected lifetime utility of an agent who over time migrates to a sequence of islands $\{n\}_{1,\ldots,T}$, is

$$U^T = \mathbb{E}\left(\sum_{t=1}^{T} U_{nt}\right) \qquad \text{where } U_{nt} \text{ is given by Eqn. 1.} \tag{4}$$

In order to solve the model, we will assume that there is no uncertainty in the economy in the sense that at every period, the agents first see the realized values of the factor productivity and then decide where to move. However, given diminishing productivity of labor, the utility is equalized across all islands to restore equilibrium ensuring an interior solution. This allows us to solve each period separately as there is no dynamic trade-off. Therefore, we will drop the time index in the later calculations with the implicit understanding that the solution holds true for every period. Clearly the consumption choice is given by

$$C^M_{nt} = \alpha\frac{I_{nt}}{P^M_{nt}} \text{ and } C^S_{nt} = (1-\alpha)\frac{I_{nt}}{P^S_{nt}}. \tag{5}$$

By substituting the demand functions in the utility function, we can find out the indirect utility function of households in one island as

$$\begin{aligned} U_{nt} &= (\frac{\alpha}{P^M_{nt}})^{\alpha}(\frac{1-\alpha}{P^S_{nt}})^{1-\alpha} I_{nt}, \\ &= \frac{I_{nt}}{P_{nt}}, \end{aligned} \tag{6}$$

where P_{nt} is the standard ideal price index defined over the prices of sectoral goods as

$$P_{nt} = (\frac{P^M_{nt}}{\alpha})^{\alpha}(\frac{P^S_{nt}}{1-\alpha})^{1-\alpha}. \tag{7}$$

Since the agents are free to move across the islands, in equilibrium we would have utility equalized across the islands and hence,

$$U_{nt} = \bar{U}_t. \tag{8}$$

Note that utility has to be equalized across islands at every point of time, but not necessarily across time. In other words, in general $\bar{U}_t = \bar{U}_{t'}$ for any $t, t' \leq T$. Thus the lifetime utility of an agent is

$$U^T = \sum_{t=1}^{T} \bar{U}_t \tag{9}$$

whatever be the sequence of islands she migrated to in her lifetime.

2.2 Supply side

The final goods (both manufactured goods and the service products) are used for consumption. However, in each sector these goods (M and S) are produced by a bundling technology which uses a continuum of intermediate goods. These intermediates are in turn produced by combining local labor and capital stock. Note that as in Caliendo et al. [2014], we keep the trade channel open as the final goods producing firms can buy intermediate goods from any island. Thus we can identify the source of fluctuation in labor allocation through this channel.

2.2.1 Intermediates

Firms of both sectors $j \in \{M, S\}$ in each island n, produces a continuum of varieties of intermediate goods following an i.i.d. shock process, ξ^j_{nt} and a deterministic productivity level Z^j_{nt}. As in Caliendo et al. [2014], the shock process ξ^j_{nt} follows a Frechet distribution with shape parameter θ^j. The production functions for both sectors ($j \in \{M, S\}$) are defined as

$$q^j_{nt} = \xi^j_{nt} Z^j_{nt} (k^j_{nt})^{\beta} (l^j_{nt})^{1-\beta}, \tag{10}$$

where lowercase letters l and k denote the demand for labor and capital respectively by a representative firm, β being the relative weight assigned to capital. The shock process Z^j_{nt} is assumed to follow a random walk in logarithm that is, we assume that

$$Z^j_{nt}(t+1) = \psi_{it} Z^j_{nt}(t) \quad \text{where } \psi_i \sim \ N(1, \sigma_i) \text{ and } i \in \{M, S\}. \tag{11}$$

The unit cost of production in each sector in island n can be found by minimizing

$$w^j_{nt} l^j_{nt} + r^j_{nt} k^j_{nt}, \tag{12}$$

subject to

$$\xi^j_{nt} Z^j_{nt} (k^j_{nt})^{\beta} (l^j_{nt})^{1-\beta} = 1. \tag{13}$$

Thus we can derive the unit cost as a function of the productivity levels and the input prices-wage and rental rate,

$$c^j_{nt} = \frac{1}{\xi^j_{nt} Z^j_{nt}} [\beta^{-\beta}(1-\beta)^{(1-\beta)}] r^{\beta}_{nt} w^{(1-\beta)}_{nt}. \tag{14}$$

Thus the firms would produce the variety as long as the price more than the unit cost c^j_{nt}. Assuming perfect competition, price is exactly equal to the unit cost. For notational convenience, we lump the terms in the unit cost function and denote them by

$$B = \beta^{-\beta}(1-\beta)^{(1-\beta)} \quad \text{and} \quad \omega^j_{nt} = B r^{\beta}_{nt} w^{(1-\beta)}_{nt}. \tag{15}$$

Let p^j_{nt} denote the equilibrium price of two sectors ($j \in \{M, S\}$) in the n-th island. Thus profit π of a firm producing intermediate goods in the j-th sector is simply given by total revenue minus wage bill and rental payment,

$$\pi^j_{intermediates} = p^j_{nt} q^j_{nt} - w_{nt} l^j_{nt} - r_{nt} k^j_{nt}. \tag{16}$$

Thus at the optimal level the expenditures on labor and capital are (see Eqn. 10)

$$w_{nt} l^j_{nt} = (1-\beta) p^j_{nt} q^j_{nt}, \tag{17}$$

$$r_{nt} k^j_{nt} = \beta p^j_{nt} q^j_{nt}. \tag{18}$$

2.2.2 Final goods

As has been described above, the final goods production in both sectors ($j \in \{M, S\}$) is carried out competitively using a bundling technology,

$$Q^j_{nt} = [\int (\tilde{q}^j_{nt}(\xi^j))^{\gamma^j_{nt}} \phi^j(\xi^j) d\xi^j]^{1/\gamma^j_{nt}}, \tag{19}$$

where the i.i.d. productivity shocks on intermediate goods are distributed as

$$\phi^M(\xi^M) = exp\big(-\sum_{n=1}^{N} (\xi^M_{nt})^{-\theta^M}\big), \tag{20}$$

$$\phi^S(\xi^S) = exp\big(-(\xi^S_{nt})^{-\theta^S}\big), \tag{21}$$

and $\tilde{q}$ is the optimally chosen level of production of the intermediate goods. Since intermediates for manufactured goods are traded, the shocks are jointly distributed whereas for non-tradable service sector, that is not the case. Thus the pattern of trade between the islands is incorporated in the above production functions in terms of intermediates.

Therefore in the n-th island, the profit of the final goods producers in both sectors ($j \in M, S$) are defined as total revenue from selling the final goods minus the cost of procuring and using the intermediates,

$$\pi^j_{n,final} = P^j_{nt}Q^j_{nt} - \int p^j_{nt}(\xi^j)\tilde{q}^j_{nt}(\xi^j)\phi^j_{nt}(\xi^j)d\xi^j, \tag{22}$$

where the final goods production function is given above (Eqn. 19). Clearly the optimal demand for a particular type of intermediate good is given by

$$\tilde{q}^j_{nt} = \big(\frac{p^j_{nt}(\xi^j)}{P^j_{nt}}\big)^{-\frac{1}{1-\gamma^j_{nt}}} Q^j_{nt}, \tag{23}$$

which on substitution in the production function gives us the aggregate price level for the final good as a function of prices of intermediates used in the production process,

$$P^j_{nt} = [\int \big(p^j_{nt}(\xi^j)\big)^{\frac{\gamma^j_{nt}}{\gamma^j_{nt}-1}} \phi^j(\xi^j)d\xi^j]^{\frac{\gamma^j_{nt}-1}{\gamma^j_{nt}}}. \tag{24}$$

Intuitively, this functional form of the aggregate pricing equation reflects the particular bundling technology assumed in Eqn. 19.

2.2.3 Closing the model

Final goods are non-tradable in all sectors. Only the intermediates in the manufacturing sector M are tradables. The cost of transportation from location n to i (in units of good produced in location n) is given as

$$\begin{aligned} \tau^M_{ni} &\geq 1, \\ \tau^S_{ni} &= \infty. \end{aligned} \tag{25}$$

Such a structure imposes a ice-berg cost on transportation. We also assume that the cost is unity for transportation within one island i.e. $\tau^M_{nn} = 1$. Therefore, due to cost minimization the pricing equations for intermediates are given as

$$p^M_{nt} = \min_i \big(\frac{\kappa^M_{in}\omega^M_i}{\xi^M_i Z^M_i}\big). \tag{26}$$

Following Eaton and Kortum [2002], such a specification gives us

$$P^M_{nt} = \Gamma(f^M_{nt})^{\gamma^M_{nt}/(\gamma^M_{nt}-1)}[\sum_{i=1}^{N}[\omega^M_i \kappa^M_{in}]^{-\theta^M}(Z^M_i)^{\theta^M}]^{-1/\theta^M}, \tag{27}$$

where $\Gamma(.)$ denotes a gamma function and $f^M_{nt} = 1 + (\gamma^M_{nt})/(\theta^M(\gamma^M_{nt} - 1))$ where γ^M_{nt} is the measure of substitutability of intermediates in the production function of the final goods (see Eqn. 19). On the other hand, the price index of the non-tradables is given as

$$P^S_{nt} = \Gamma(f^S_{nt})^{\gamma^M_{nt}/(\gamma^M_{nt}-1)}\omega^S_{nt}(Z^S_{nt})^{-1}, \tag{28}$$

where f^S_{nt} is defined analogously in terms of the measure of substitutability (γ^S_{nt}) in the production of the service good. The labor market clearing holds at two levels. Within each island, total labor must be equal to the sum of the sectoral allocation,

$$L^M_{nt} + L^S_{nt} = L_{nt} \quad \forall n \leq N \tag{29}$$

and at the aggregate level, total labor endowment must be equal to the sum of the geographical distribution across islands,

$$\sum_{nt} L_{nt} = 1. \tag{30}$$

Similarly for capital stock, we have regional market clearing

$$K^M_{nt} + K^S_{nt} = K_{nt} \quad \forall n \leq N. \tag{31}$$

Note that since capital is immobile, we do not have market clearing condition for capital at the aggregate level. Solving for labor allocation we get

$$L_{nt} = \frac{[\frac{\omega_{nt}}{P_{nt}\bar{U}}]^{1/\beta} K_{nt}}{\sum_i [\frac{\omega_i}{P_i \bar{U}}]^{1/\beta} K_i}, \tag{32}$$

where ω_{nt} is described in Eqn. 15.

2.2.4 Regional market clearing

Since final goods are only consumed (no investment opportunity), total consumption (C_{nt}) by whole population (L_{nt}) must be equal to production(Q_{nt}) in both sectors $j \in \{M, S\}$,

$$L_{nt} C^j_{nt} = Q^j_{nt}. \tag{33}$$

In terms of expenditure X^j_{nt} on the final goods in sector j in island n, we find

$$X^M_{nt} = \alpha I_{nt} L_{nt} \quad \text{and} \quad X^S_{nt} = (1-\alpha) I_{nt} L_{nt}, \tag{34}$$

where $I_{nt}L_{nt}$ is the total income and α is the weight on manufactured goods in the utility function (see Eqn. 1). The intuition of this result is that due to the Cobb-Dauglas structure of the utility function, the resultant expenditure is linear in aggregate nominal income (follows directly from Eqn. 5).

Let us denote the total expenditure on intermediates bought by the n-th island from the i-th island for producing j type final good ($j \in \{M, S\}$) by X^j_{ni}. Similarly, we denote the share of that expenditure in the total revenue in the n-th island by π^j_{ni}. Since the zero-profit condition holds, total cost must exhaust total revenue which in turn implies that the share

$$\pi^M_{ni} = \frac{X^M_{ni}}{X^M_{nt}} = \left(\Gamma (f^M_{nt})^{\gamma/(1-\gamma)} \frac{\tau^M_{ni} \omega^M_i}{P^M_{nt} Z^M_{nt}}\right)^{-\theta^M}. \tag{35}$$

Recall that for the non-tradables the transportation cost is infinite ($\tau^S = \infty$) and hence, For the non-tradables,

$$\pi^S_{nn} = 1, \tag{36}$$

which is almost tautological in the sense that the share of local production is unity in the production of final goods in the non-tradables sector.

Let us introduce a hat notation here which simplifies the exposition of considerably. Define

$$\hat{x} = \frac{x_{new}}{x_{old}}, \tag{37}$$

which says that the ratio of the new and the old values of any variable x, is denoted by $\hat{x}$. This trick is useful because as Caliendo et al. [2014] shows that the whole model can be solved in ratios of the old and the new values of all variables rather than actually deriving the old and the new values separately.

2.3 Equilibrium

Now we can define a competitive equilibrium. First, we define it for a static model which is equivalent to assuming the time horizon $T = 1$. Given labor endowments $\{L_{nt}\}$ (we normalize it so that $L = 1$) and the capital endowment $\{K_{nt}\}_{nt}$, a competitive equilibrium is an utility level $\bar{U}$, factor prices $\{r_{nt}, w_{nt}\}_{nt}$, labor allocation $\{L_{nt}\}_{nt}$, final goods expenditure $\{X^M_{nt}, X^S_{nt}\}_{nt}$, consumption vector $\{c^M_{nt}, c^S_{nt}\}_{nt}$, prices of final goods $\{P^M_{nt}, P^S_{nt}\}_{nt}$ and pairwise regional intermediate expenditure share in every sector $\{\pi^M_{nt}, \pi^S_{nt}\}_{nt}$ such that all markets clear in all islands $n \in N$.

In the dynamic case with $T \geq 1$, we claim that under the equilibrium configuration, the above defined static equilibrium would hold for each and every time period $t \leq T$. To see why that is true, we can use backward induction. There are two crucial assumptions in the whole model that delivers this result. One, there is no cost involved in migration and two, the workers decide to move after they see the realized shocks. Now consider the penultimate period $T-1$. When the productivity shocks occur in the period T, depending on the relative intensities of the shocks the workers would migrate. Thus from the perspective of period $T-1$, there is no state dependence of the decision that will be made in period T. In other words, it does not matter which island the worker belongs to to make a decision about period T. Therefore from the perspective of period $T-2$, the island where a particular worker is does not matter for the decision that will be made on period $T-1$. Extending the same argument, we see that right from period 1 the sequence of islands that a worker travels, does not matter. Utilities are always equalized across islands in every period.

This is very helpful in solving the model as we can essentially solve for the labor allocation in each period separately after realization of the productivity shocks specific to the island and the sectors. Another implicit assumption plays an important role here. Note that we did not define capital ownership explicitly. The underlying idea is that the government is the owner of all capital stock within each island. The firms rent capital from the government who in turn distributes the proceeds to the workers. Thus even if we do have repeated migration within these T periods i.e. the same worker can come back to one particular island over and over again depending on productivity shocks, we have no problem allowing that since the workers are not capital owners. In reality, we do see a large amount of repeat migration which might relate to the issue of capital holding. For example, Thom [2014] documents a large amount of repeat migration among workers.

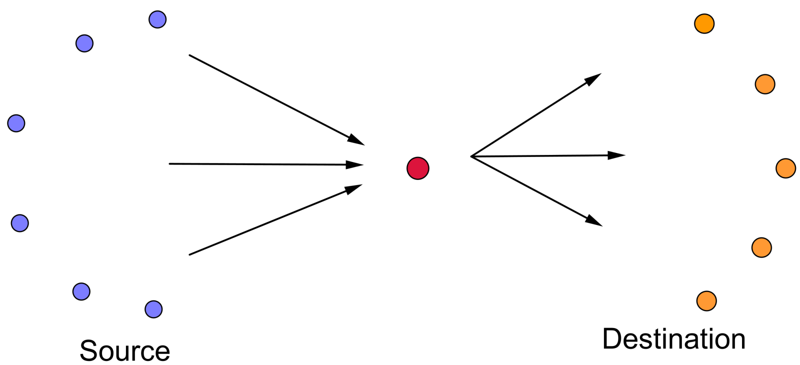


Figure 1: An illustration of flow of workers after realization of productivity shocks. Some islands are donors (blue) and others are receivers (yellow). Workers from the islands receiving comparatively worse productivty draws form a pool of migrants (red) and then they go to the islands receiving better draws.

2.4 The effects of shocks

The above system of equations can be solved at every time point t after realization of the sequence of sector and island specific shocks $\hat{Z}^j_{nt}$. Given a set of parameters $\{\theta^j, \alpha, \beta\}^N_{n,j=\{S,M\}}$ and data for $\{I_{nt}, L_{nt}, \pi^j_{ni}, \hat{Z}^j_{nt}\}^{N,N}_{n,i,j=\{S,M\}}$ the system yields solution for $\{\hat{w}_{nt}, \hat{L}_{nt}, \hat{X}^j_{nt}, \hat{P}^j_{nt}, X'^j_{nt}, \pi'^j_{ni}\}^{N,N}_{n,i,j=\{M,S\}}$ with the hat notation denoting the ratio of the new value of a variable to that of the old value. From these we can find out the changes in real prices and output along with utility $\{\hat{r}_{nt}, \hat{\pi}^j_{nn}, \hat{I}^j_{nt}, \hat{\hat{U}}\}^N_{n,j=\{M,S\}}$.

2.5 The network of migration

Given the labor dynamics across countries, we are in a position to construct the labor mobility network. Note that due to any TFP shock, all of the countries will face a fluctuation in the efficient level of employment. Some countries will lose workers whereas others will gain.

Since workers are assumed to be homogeneous both in terms of consumption pattern and labor supply, they would show no particular preference for any country under the no-friction regime that is when there is no friction opposing labor mobility. Recall that for the n-th country, the total change is $\hat{L}_{nt}$. Therefore, total change for the n-th country is $(\hat{L}_{nt} - 1)L_{nt}$. Thus one can write the labor flow from the j-th country to the i-th country at time t as

$$F^t_{ji} = \left(\frac{(\hat{L}_{jt} - 1)L_{jt}}{\sum_{n \in \mathcal{N}^{out}} (\hat{L}_{nt} - 1)L_{nt}} \right) (\hat{L}_{it} - 1)L_{it}, \tag{38}$$

where $\mathcal{N}^{out}$ is the set of countries from which labor migrates to other countries and $j \in \mathcal{N}^{out}$. The above flow equation uses the fact that the labor is homogenous in that the inflow from a country j to country i will be proportional to the contribution of country j relative to the total mass of displaced workers. Note that one could alternatively write it as

$$F_{ji}^{t} = -\left(\frac{(\hat{L}_{it}-1)L_{it}}{\sum_{n\in\mathcal{N}^{in}}(\hat{L}_{nt}-1)L_{nt}}\right)(\hat{L}_{jt}-1)L_{jt}, \tag{39}$$

where $\mathcal{N}^{in}$ is the set of countries to which labor migrates from other countries. Evidently in absence of links to the rest of the world,

$$\sum_{i\in\mathcal{N}^{in}}(\hat{L}_{it}-1)L_{it} = -\sum_{j\in\mathcal{N}^{out}}(\hat{L}_{jt}-1)L_{jt}, \tag{40}$$

that is total inflow must be equal to total outflow.

With a single realization of a set of shocks across the sectors and the islands, there will be donors and receivers of migrants. Those island that experienced relatively better shocks will be ranked higher in relative attractiveness. Thus workers will migrate to the receivers. Therefore, at every point of time such a set of shocks would generate a directed and weighted network of migrants. But this network would be unidirectional in the sense that labor flow is always one-way between any pair. However, with repeated shocks in the steady state, an island that was a net donor in one period, may turn out to be a net receiver the next period. Thus in general over sufficient number of time points (with large enough T), we will generate bilateral flow for each and every possible pairs of islands. Evidently the net flow (inflow-outflow) would be much smaller than the gross flow (inflow+outflow). This is another characteristic of model that matches the data well, for example in case of U.S. the gross flow is about 10 times larger than the net flow as has been documented in Kaplan and Schulhofer-Wohl [2013].

3 Results

We calibrate the parameters (see table 1 for the numerical values) of the theoretical model for two sets of data. The first one is for 15 of the countries in the European Union and Norway. The second one is for the states of U.S. In both cases, as mentioned earlier we will not be seeing any 'South' to 'North' kind of migration. The islands in both the cases have inherent homogeneity in terms of economic factors like standard of living. However, institutional frictions should be much clearer in the E.U. countries. In the following, we discuss the 2 data sets (U.S. and European countries) briefly and then compare the results from the theoretical model with the real data. The shape parameters (of the shock distribution z) θ describe competitiveness in production process. Its value is taken to be the average value of θ computed in Eaton and Kortum [2002] which shows that it varies over a long range from 3.60 to 12.86. We have rounded the average value to the nearest digit to keep it simple. For the same value describing the service sector, we chose a smaller value for it to indicate a higher range of heterogeneity in the service sector. However, it does not really matter because in the current formulation, service goods are not traded. Another important point is that while generating the shocks to the productivity Z (Eqn. 11), we divided each shock by the length of the time horizon T to keep the system in the steady state. Thus, for any $i-$th sector

$$\psi_{it} = \frac{\tilde{\psi}_{it}}{T} \quad \text{where } \tilde{\psi}_{it} \sim N(1, \tilde{\sigma}_i), \tag{41}$$

so that

$$\sum_{t}^{T} \psi_{it} = \sum_{t}^{T} \frac{\tilde{\psi}_{it}}{T} \to 1 \quad \text{for } T \to \infty \tag{42}$$

and

$$\sigma = \frac{\tilde{\sigma}_i}{T}. \tag{43}$$

Table 1 presents the calibrated values of the parameters. The values which we take to be common across regions and time, are given at the begining. For others, we mention where it is from as well as the sectors and years.

Table 1: Calibrated parameter values

Description	parameter	value
Service goods' share in cost	1-α	0.6
Capital's share in cost	β	0.3
Length of simulation	T	200
# simulations averaged	-	O(10)
Dispersion of shocks (intermediates): Manf.	θ_m	8
Dispersion of shocks (intermediates): Serv.	θ_s	2
Std. dev. of aggregate shocks (U.S., 2007): Manf.	σ_M	0.038
Std. dev. of aggregate shocks (U.S., 2007): Serv.	σ_S	0.005
Std. dev. of aggregate shocks (E.U., 2000): Manf.	σ_M	0.027
Std. dev. of aggregate shocks (E.U., 2001): Manf.	σ_M	0.023
Std. dev. of aggregate shocks (E.U., 2002): Manf.	σ_M	0.028
Std. dev. of aggregate shocks (E.U., 2003): Manf.	σ_M	0.034
Std. dev. of aggregate shocks (E.U., 2004): Manf.	σ_M	0.028
Std. dev. of aggregate shocks (E.U., 2005): Manf.	σ_M	0.067
Std. dev. of aggregate shocks (E.U., 2006): Manf.	σ_M	0.042
Std. dev. of aggregate shocks (E.U., 2007): Manf.	σ_M	0.105
Std. dev. of aggregate shocks (E.U., 2000): Serv.	σ_S	0.014
Std. dev. of aggregate shocks (E.U., 2001): Serv.	σ_S	0.019
Std. dev. of aggregate shocks (E.U., 2002): Serv.	σ_S	0.010
Std. dev. of aggregate shocks (E.U., 2003): Serv.	σ_S	0.011
Std. dev. of aggregate shocks (E.U., 2004): Serv.	σ_S	0.009
Std. dev. of aggregate shocks (E.U., 2005): Serv.	σ_S	0.020
Std. dev. of aggregate shocks (E.U., 2006): Serv.	σ_S	0.014
Std. dev. of aggregate shocks (E.U., 2007): Serv.	σ_S	0.024

3.1 The migration network for USA

To check robustness of the mechanism and to test the model on a frictionless benchmark case, we calibrate the model on USA data. We plug in data of population, per capita GDP, bilateral trade and TFP distribution for 51 states in the model to generate a migration network. The American Community Survey (ACS) provides data of interstate migration for 2007. Data for other years are not available. To simulate productivity shocks-driven bilateral migration from the theoretical model, we use a block recursive algorithm (see App. 6.2 and 6.3). We use the parameter values described in 1, and provide the population data for the countries (L_i; we normalize it so that $\sum_i L_i = 1$), the per-capita GDP and the bilateral trade relationship between countries (π_m and π_s) as inputs of the model (see App. 6.2 and 6.3).

We compare the theoretical results (referred to henceforth as TFP driven migration) with the actual data of migration. In order to compare meaningfully, we consider the dyads for which actual migration data is available (both m_{ij} and m_{ji}) and sum up ($m_{ij} + m_{ji}$) to get the gross flow of migration and regress this on its theoretical counterpart, the TFP driven migration (theoretical $m_{ij}+m_{ji}$). Table 2 shows the results of regressing actual data (at level values - nominal and normalized - relative) on theoretical model results. For that purpose, we construct the dependent variable as

$$y_k = \frac{m_{ij}^{data} + m_{ji}^{data}}{\sum_{nt} L_{nt}^{data}}. \tag{44}$$

We normalize the migration flow by the total population so that we can talk about total flow of migration in percentage terms. Similarly, we construct the explanatory variable as

$$x_k = \frac{m_{ij}^{model} + m_{ji}^{model}}{\sum_{nt} L_{nt}^{model}}. \tag{45}$$

Note that we already normalized the labor allocation in the model so that the denominator is 1. In the regression we control for contiguity which is a dummy variable showing whether two countries in a dyad shares a border or not. Thus the specification is

$$y_k = \alpha_0 + \alpha_1 x_k + \alpha_2 D_{cont.} + \epsilon_k \tag{46}$$

where $D_{cont.}$ is a dummy for contiguity and ϵ_k is an $i.i.d.$ error term. A good fit of the model would imply $\hat{\alpha_0} = 0$ and $\alpha_1 = 1$.

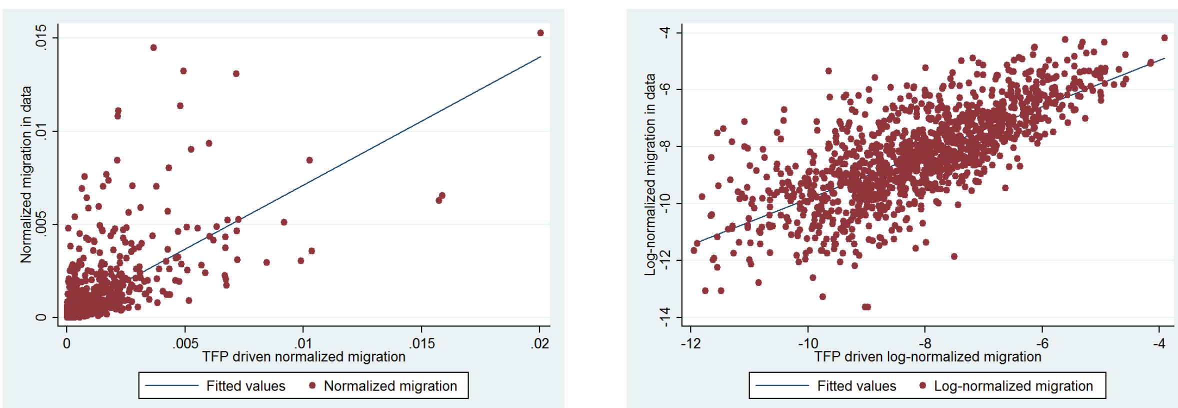
At the nominal level the table shows that TFP changes can explain most of the migration seen in real data. These regressions are on dyads and do not consider the direction of flow of migration. The interesting result is that the predicted total mass of migrants match pretty well with the data. Calibrating the model we see that the total flow should be around 2%. From previously mentioned ACS data (table 9) we do get the overall migration to be around 2%. Thus the orders of the nminal flows as is seen in the data and derived from the model, are perfectly comparable.

Given that we are considering multiple islands as possible destinations of migrants at every point in time, we also characterize the relative flows of migrants across pairs. For example, assume that there are three islands A, B and C. We also want to make a comparison between the flow from A to B and back, and from B to C and back. For relative strength of edges between pairs of islands, we divide the relevant variables on both sides of the regression by the sum of the all values of weights that is the new dependent variable is $\tilde{y}_k = y_k / \sum_k y_k$ and the explanatory variable is $\tilde{x}_k = x_k / \sum_k x_k$. The control variable remains as is. The result is presented in table 2.

Table 2: Regression results with robust errors for US

	TFP driven migration	Contiguity	Intercept	R^2
Nominal	0.82695***	0.00006***	0.00000	0.6305
	(0.06435)	(0.00001)	(0.00000)	
Relative	0.68521***	0.00243***	0.00004	0.6305
	(0.05332)	(0.00023)	(0.00003)	

Note: *p<.1, **p<.05, ***p<0.01. $N = 1275$



(a) Relative - normalized values

(b) Log relative - log of normalized values

Figure 2: Scatter plots showing the normalized interstate migration data on the simulation results for US year 2007, in level and in log.

Fig. 2 plots the normalized actual interstate migration on the normalized values of migration predicted. This provides a visual to judge the fit of the model to data. In the right panel we take natural log - showing a very clear clustering around the fitted line. Evidently, the bulk of the labor flow is captured by the theoretical model which emphasizes the productivity-driven migration in line of Klein and Ventura [2009] and Kennan and Walker [2011]. That is, in case of U.S. which was taken as the closest approximation to a frictionless place (in terms of social and political dimensions), is actually described well by a model emphasizing only economic incentives behind migration.

3.2 The migration network of Europe

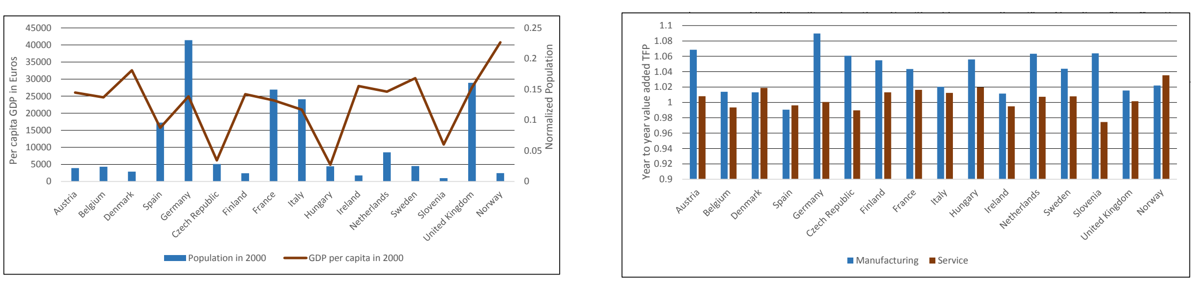
We look into migration data from 2000 to 2007 for 16 countries (see App. 6.1 for details on sources of data) which gives us the full 16×16 migration matrix depicting the bilateral flow.

Our objective is to build the complete matrix from the theoretical model and compare each element with the data. However, there is incompleteness in the available data showing the bilateral flow of labor as a few countries do not report the migration statistics at all, some countries stop reporting after a period of time and some start only after a time point. So we extract the maximum amount of data available and compare it with the results that the theoretical model provides. Table 3 provides a summary of the data available.

Table 3: Descriptive summary for bilateral migration within Europe (16 countries)

Year	Obesrvations	Mean	Std.Dev	Min	Max
2000	66	5056.924	8813.484	0	45439
2001	66	5231.076	9290.369	0	43375.5
2002	66	5377.379	9570.473	2	41312
2003	66	5203.114	9455.308	6	49670
2004	66	5608.924	10292.27	3	59337
2005	66	5830.758	10729.29	7	57652
2006	69	5239.217	10345.33	8	56612
2007	66	4307.53	7815.329	16	34417

Fig. 3 provides snapshot of the data for a single year (2000) for the European countries. The left panel shows variations in per capita output and population and the right panel shows the dispersion in sectoral shocks.



(a) GDP per capita and normalized population

(b) TFP distribution

Figure 3: Data description for E.U. countries for the year 2000

From the model we get that due to TFP differences net migration in the 16 countries should be around 1.5%. In the next table we regress the dyad specific bilateral migrations from actual data on the TFP driven migration results (from theoretical model). Table 4 contains results of regressing data on model-predicted migration. In tables 5 and 7 we present the panel results for the 16 countries over 2000-2007.

Table 4: Regression results with robust errors for E.U. - Nominal

	TFP driven migration (Rob Std Err)	Contiguity (Rob Std Err)	Intercept (Rob Std Err)	R^2
2000	0.05836***	0.00001***	0.00000	0.7808
	(0.00781)	(0.00001)	(0.00000)	
2001	0.05870***	0.00002**	0.00000	0.7700
	(0.00683)	(0.00001)	(0.00000)	
2002	0.06118***	0.00001***	0.00000	0.7794
	(0.00613)	(0.00000)	(0.00000)	
2003	0.05456***	0.00001**	0.00000	0.6468
	(0.00980)	(0.00001)	(0.00000)	
2004	0.05709***	0.00001**	0.00000	0.5938
	(0.01216)	(0.00001)	(0.00000)	
2005	0.06132***	0.00001**	0.00000	0.6788
	(0.00921)	(0.00001)	(0.00000)	
2006	0.06376***	0.00001**	0.00000	0.6927
	(0.01324)	(0.00001)	(0.00000)	
2007	0.06030***	0.00001**	0.00000	0.7450
	(0.00512)	(0.00001)	(0.00000)	

Note: *p<.1, **p<.05, ***p<0.01. $N = 68$

Table 5: Panel regression result for E.U. - Nominal

Variable	**Coefficient** (Rob Std Err)
TFP driven migration	0.061***
	(0.010)
Intercept	0.000
	(0.000)
N	528
R^2 overall	0.6629
$\chi^2_{(2)}$	34.82

We find from table 4 that though the coefficient of TFP driven migration is much lower than 1 which should have been the case if the model match the data perfectly, but it is significant and in each year the model has sufficiently high R^2. This is an interesting finding as it basically suggests that the total mass of migrants predicted by the model is much higher than what is seen in the data. Table 5 presents a panel estimate of the same. The estimated coefficients indicate similar conclusion.

Table 6: Regression results with robust errors for E.U. - Relative

	TFP driven migration (Rob Std Err)	Contiguity (Rob Std Err)	Intercept (Rob Std Err)	R^2
2000	0.84328***	0.01700***	-0.00046	0.7808
	(0.11289)	(0.00612)	(0.00116)	
2001	0.83180***	0.01779**	-0.00042	0.7700
	(0.09676)	(0.00675)	(0.00105)	
2002	0.85237***	0.01418***	-0.00013	0.7794
	(0.08539)	(0.00522)	(0.00100)	
2003	0.79403***	0.01494**	0.00063	0.6468
	(0.14261)	(0.00591)	(0.00113)	
2004	0.77543***	0.01344**	0.00116	0.5938
	(0.16522)	(0.00600)	(0.00120)	
2005	0.81675***	0.01351**	0.00052	0.6788
	(0.12271)	(0.00606)	(0.00101)	
2006	0.75724***	0.01441**	0.00122	0.6927
	(0.15722)	(0.00702)	(0.00127)	
2007	0.71356***	0.01980**	0.00104	0.7450
	(0.06064)	(0.00894)	(0.00122)	

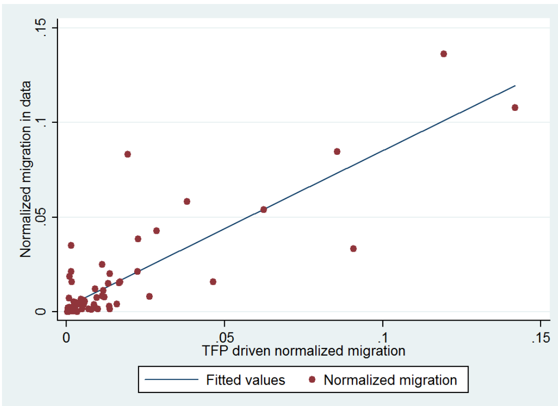
Note: *p<.1, **p<.05, ***p<0.01. $N = 68$

Table 7: Panel regression result for E.U. - Relative

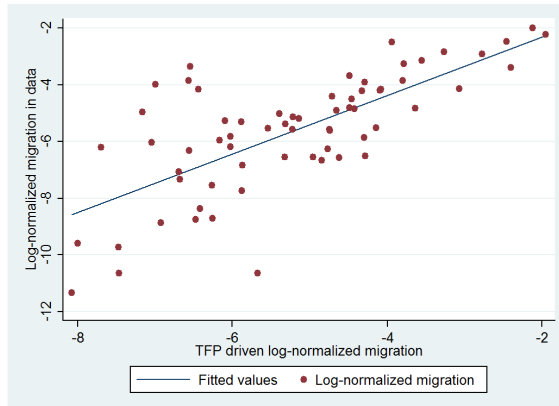
Variable	**Coefficient** (Rob Std Err)
TFP driven migration	0.650***
	(0.097)
Intercept	0.005***
	(0.002)
N	528
R^2 overall	0.6611
$\chi^2_{(2)}$	44.746

Next, we regress the relative weights of edges of the data on model. The results are presented in table 6. Clearly, after normalization the estimated coefficient increases to about

0.8 which is much closer to 1. Note that $\tilde{y}$, $\tilde{x} \in [0, 1]$ making them comparable in order. So in relative sense the theoretical model does quite well in explaining the migration in Europe. However, the it does not match the total migration; in fact predicts a much higher value. Table 7 presents a panel estimate on the relative flows.



(a) Relative - normalized values



(b) Log relative - log of normalized values

Figure 4: Scatter plots showing the normalized actual dyad migration data on TFP simulated results for the European countries for year 2000.

In the left panel of Fig. 4, we plot the normalized bilateral migration data on the y-axis and the predicted values of the same on the x- axis. In the right panel we take the natural log of both variables to reduce the effects of the outliers. Each point on the scatter plot denotes the real data and the prediction for a dyad.

3.3 Working of the model: multilateral gravity equations

From the tables presented above, the model explains about 63% of the fluctuations in edge weight of the migration network in case of U.S. (see table 2)) controlling for contiguity. Similarly, in case of Europe the model explains about 70% on an average (see table 6). In both cases the coefficient assigned to the TFP-driven migration is sufficiently high (about 0.8 on an average). The reason the model fits well with the data is that it effectively creates a network that describes a multilateral gravity equation between all pairs of islands. The basic descriptive equation of gross flow of labor between any dyad i.e. any pair ($\{i, j\}$) of islands is

$$\mathbb{F}_{i,j} = C_{i,j} \left(\frac{L_i.L_j}{d_{i,j}^{\eta}} \right), \tag{47}$$

where the $\mathbb{F}_{i,j}$ is the weight of the edge of the network between the $i-$th and the $j-$th island (representing trade flow or migration) and C is a constant. The equation shows that the labor flow is proportional to the product of the two islands' population and inversely proportional to some power of the distance ($d_{i,j}^{\eta}$) between these two islands. Usually, η is found to be very close to 1. The emergence of such a pattern have been subject to a huge number of empirical studies in the trade theoretic literature. Chaney [2014]) in particular gives a framework to understand why η is close to one. In the present context, we do not attempt to embed distance in the model. Therefore, in all empirical analysis we have controlled for it by using contiguity data. For the same reason, a reduced form description of our model is

$$\mathbb{F}_{i,j} = C_{i,j}(L_i.L_j). \tag{48}$$

Fig. 5 describes the relationship generated by the model, between weights of the dyads in terms of labor flow and products of populations of the corresponding countries. Evidently it has a good fit with the idea of multilateral gravity approach except that there is no counterpart of distance in our model (following Eqn. 48). It should be mentioned that the distance proxy (contiguity) has no or little explanatory power by itself (see tables 15 and 16).

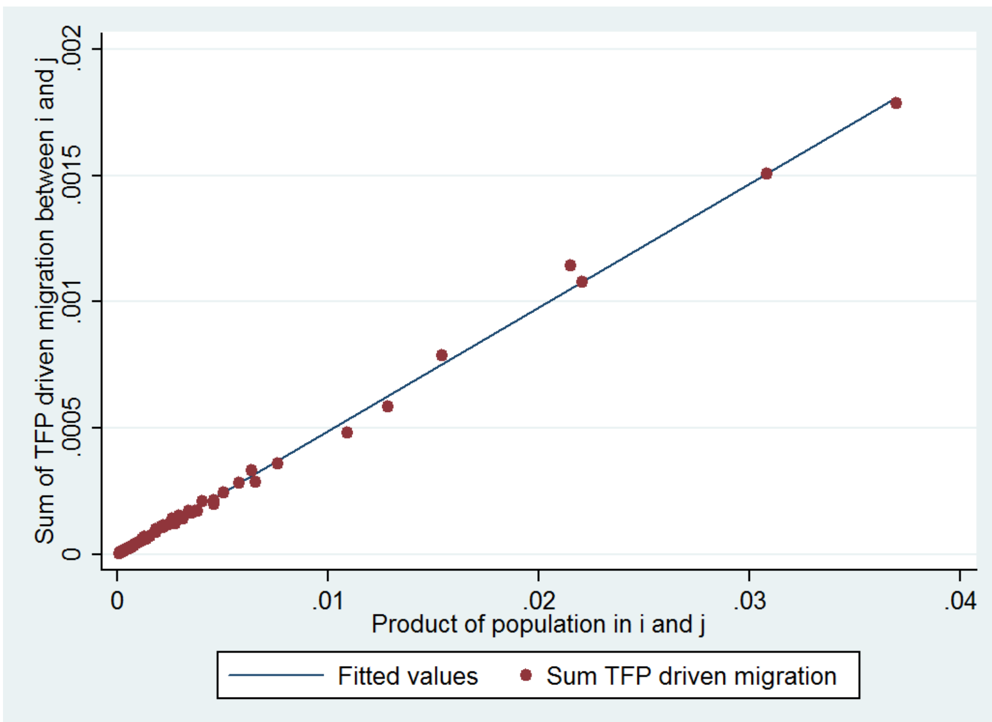


Figure 5: The model captures the multilateral gravity relation between donor and receiver countries. We have plotted the weight of dyads $(m_{ij} + m_{ji})$ as a function of the product of populations $(L_i.L_j)$ for all dyads $i, j \in N$

Since in case of European union the distances between the countries do not have particularly large variations, the weights of the dyads capturing the migration flow depend almost linearly on the product of population. This is precisely what our model generates in terms of labor flow. Thus the relationship can be further simplified to

$$\mathbb{F}_{i,j} = C(L_i.L_j). \tag{49}$$

Thus the model captures the broad description of the migration network at the macro level as well as country-pair specific level. An interesting feature of the model is that $C_{i,j} = C$ as is shown in Fig. 5. This constant parameter C embodies the structure of the economy in the sense that it captures the structural parameters of the global economy (in our case, the E.U. or the U.S.) including the preferences, production technology and the trade patterns. When we make any changes in such structural parameters, that will be reflected in the magnitude of that constant and will have corresponding effects on the level of migration.

4 European immobility puzzle

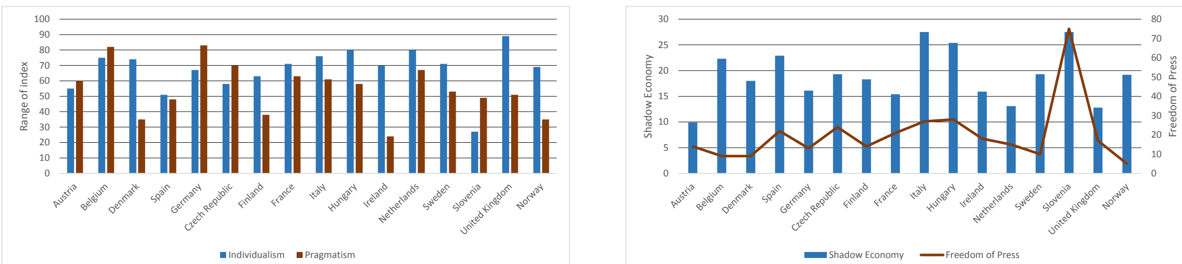
One of the basic principles behind the formation of the European union was to ensure freedom of movement of productive inputs. In particular, it was supposed to reduce the barriers in the labor flow making the market more flexible. Multilateral gravity equation helps us to pin down the relative strengths of the edges of the migration network. However, as is clear from the above results, the model shows that under reasonable parameterization the predicted mass of migrants are in the order of 100 times more than what is seen in Europe for the period we considered (2000-07). This refers to the puzzle that even after the legal and political barriers have been systematically removed thus potentially reducing economic frictions on the labor allocation process, people did not respond immediately to the existing incentives. This problem has attracted attentions both from theoretical and policy-making point of view. In particular, Belot and Ederveen [2012] ascribes this role to the negative effects of cultural differences indicating that such distances can induce an extremely low migratory response if properly addressed. In this paper, we complement this analysis using many other types of frictions ranging from social to political along with the obvious factor, linguistic differences. Generally, in this section we look into a list of fine-grained measures of institutional differences between the 16 European countries and argue that these substitute some of the TFP driven migration instead of complementing and thus, provide "frictions" opposing the incentives.

4.1 Distances in institution and culture

We look at a broad list of variables which could ideally be considered as frictions. We start with historical links between countries. We used the CEPII data to determine colonial links between countries or whether the two countries in the dyad were the same country historically.

One of the hypothesis could be that language barrier is one of the reasons which stops people from migrating easily. To control for this we looked into several language indices. From the CEPII, bilateral data on whether two countries speak same official language, native language, language proximity index and common language index was obtained. In table 8, LangIndex is the common language index. This index gives an approximate distance between two countries due to language. If the index is higher that means the two countries have less language barriers. We also looked into Ethnologue language statistics - country specific data on total number of languages used as first language, immigrant languages in the country and probability that two people selected at random will have different mother tongues (Greenberg's diversity index).

Differences in culture could be another barrier to migration - to control for this we use the Hofstede's cultural indices. This is a rich set of index encompassing cultural aspects such as individualism versus collectivism in the economy, uncertainty avoidance, power distance (strength of social hierarchy), masculinity-femininity (task orientation versus person-orientation), long-term orientation and indulgence versus self-restraint (see App. 6.7). In Table 8 'Indiv' refers to Individualism and 'Pragm' refers to Pragmatism and they are two of the Hofstede cultural index. These indices are country specific. For dyad level regression we considered the numerical differences between these indices for the two countries as a proxy of their 'distance' in the corresponding category. So a higher value in distance for 'individualism' between a pair of countries would mean that one country in the pair believes in individualistic society as a way of life and the other country believes in a relatively less individualistic society which is another way of saying that the country believes in a more collective/family-oriented way of life.



(a) Hofstede index: individualism & pragmatism (b) Shadow economy and freedom of press in 2001

Figure 6: Cultural and institutional indices for European countries

Next we considered several stability indices broadly related to the polity. All data were collected from various reports compiled and made publicly available by World Bank. We looked into government stability, democracy index, ethnic tensions, religious conflicts, military in politics and external conflicts to understand the political stability in the economy. For each of these risk rating available on country level we considered the 'distance' between the ratings between two countries for dyad regressions. For socio-economic stability we looked into corruption index, freedom of press, socio-economic conditions and voice and accountability. Distance between financial stability indices like financial risk, investment profile and existence of shadow economy are also included as controls. Distance in shadow economy index would mean in the dyad one of the countries has a huge underground economy and the other one does not. We also looked into some of the Europe specific dummies - such as using E.U. or not and entry into European union. In the next section we look into the regression results on all the mentioned distance variables.

A general rule we followed is that since many of these frictional variables are extremely correlated especially so when they belong to the same family. We use stepwise regression methodology to pin down the predictors. Most of the considered 'friction' variables under an umbrella term broadly defining similar characteristics, are correlated. For example, table 10 shows the correlation matrix a number of variables that belong to a broad class of political stability indicators. Given this level of correlation in the data, we do not consider all variables simultaneously as that will not increase the predictive power. The point is that many of the frictional variables that turns out to be important in explaining the puzzle, are not unique.

They often have some other measures, almost similarly defined and hence very correlated, that can be almost equally effective in explaining the same phenomena.

4.2 Explaining the missing flow: effects of institutional factors

For the 16 countries in Europe (see App. 6.1 for data description) we computed all the institutional distance measures. As a response variable we consider the ratio of actual bilateral migration data to TFP driven migration. We regress this on the various institutional measures. The results are tabulated in table 8. The reason we took the ratio of the data to the model (y_k/x_k as defined in Eqn. 44 and 45 resp.) as the variable to be explained is that this way we get rid of the gravity-effects which is driven solely by economic causes. Thus the left over variations would be driven by other non-economic factors. Two methodological points are to be noted. One, some variation in the data could be due to misreporting which we cannot rectify and two, we are considering the model to capture the economic incentives completely and in the gravity equation set up, the proportionality term captures all institutional effects, magnifying or lessening the flow. Consider any pair of islands $\{i, j\}$ and call it dyad k. Given this notation, we see that $y_k = C_{ij}^{data}.L_i.L_j/d_{ij}^{\eta}$ and $x_k = C_{ij}^{model}.L_i.L_j/d_{ij}^{\eta}$ and from Fig. 5, we see that $C_{i,j}^{model}$ is roughly a constant, independent of the specific dyad considered (i.e. $C_{i,j}^{model} = C^{model}$). Hence, we have

$$\frac{y_k}{x_k} = \left(\frac{C_{ij}^{data}}{C}\right) d_{ij} \tag{50}$$

as η is usually found to be very close to one in the gravity equations (Chaney [2014]). Thus after taking ratios, the gravity terms wash out and we get the pair-specific constants capturing the socio-economic and political distances. The idea is that a low value of the variable (y_k/x_k) indicates that less migration occurred between a pair of countries consisting the dyad k in reality than in the model. Therefore, a negative value of the coefficient of a suitably defined distance metric would indicate presence of a friction. Alternatively, in presence of similarities in any dimension for example, linguistic, we would expect a higher flow.

Therefore, following the notation in Eqn. 44 and 45, the regression specification is

$$\frac{y_k}{x_k} = \delta_0 + \delta V_k + \delta_1 D_{cont} + \epsilon'_k \tag{51}$$

where V_k is a vector of distances measured for multiple socio-political and economic attributes, D_{cont} is a dummy for contiguity and ϵ' is an error term. Table 8 shows the regression results for the European country dyads. For each year, from 2000 to 2007, we regress ratio of actual bilateral migration data to TFP driven migration on Euro currency dummy and distance between -language index, Hofstede index of individualism (vs. collectivism) and pragmatism, financial risk index and shadow economy, controlling for contiguity. We also tested for a bunch of other variables including various social and political factors which did not turn out to be significant.

Table 8: Regression results with robust errors for E.U. - frictions

	Contiguity	LangIndex	Indivi	Pragm	E.U.ro	ShadowEco	Intercept	R^2
2000	0.23*	0.43**	-0.12***	-0.11**	-0.06	-0.01**	0.72***	0.4901
	(0.13)	(0.19)	(0.04)	(0.05)	(0.05)	(0.01)	(0.25)	
2001	0.26*	0.44**	-0.13***	-0.12**	-0.06	-0.01**	0.77***	0.4923
	(0.14)	(0.19)	(0.05)	(0.06)	(0.05)	(0.01)	(0.26)	
2002	0.21	0.45**	-0.13***	-0.12**	-0.07	-0.01**	0.78***	0.4798
	(0.13)	(0.20)	(0.05)	(0.06)	(0.05)	(0.01)	(0.27)	
2003	0.21	0.46**	-0.13***	-0.12**	-0.07	-0.02**	0.78***	0.4765
	(0.13)	(0.20)	(0.05)	(0.05)	(0.06)	(0.01)	(0.26)	
2004	0.18	0.49**	-0.13**	-0.13**	-0.07	-0.01*	0.78***	0.4599
	(0.13)	(0.20)	(0.05)	(0.06)	(0.05)	(0.01)	(0.29)	
2005	0.18	0.44**	-0.11**	-0.10**	-0.06	-0.01*	0.66***	0.4522
	(0.12)	(0.18)	(0.04)	(0.05)	(0.05)	(0.01)	(0.23)	
2006	0.18	0.53**	-0.08**	-0.09*	-0.09	-0.01*	0.57**	0.3977
	(0.13)	(0.23)	(0.04)	(0.05)	(0.06)	(0.01)	(0.22)	
2007	0.15	0.59**	-0.09**	-0.10*	-0.15**	-0.02**	0.67***	0.4431
	(0.13)	(0.23)	(0.04)	(0.05)	(0.07)	(0.01)	(0.23)	

Note: *p<.1, **p<.05, ***p<0.01. $N = 68$

The signs of the coefficients have meaningful interpretation - for example having similar language helps in migration (positive signs of the LangIndex) and different cultures act as an impediment to migration (negative signs for distance between cultural index). This exercise shows that there are factors which encourage or discourage migration, over and above mere economic incentives. We have done robustness checks in App. 6.5 in terms of partial regressions. The partial residual plot for language is also shown. All results agree with the prior interpretation.

5 Summary and conclusion

We have presented a model of migration based on a richly specified structure originally developed in the trade theoretic literature following the Eaton-Kortum model (Eaton and Kortum [2002]). We employ a technique originally developed by Caliendo et al. [2014] to pin down the migratory responses in a static multi-region, multi-sector economy. Essentially, we treated the model as representing a general equilibrium set-up. In steady state, the economy is subjected to consecutive shocks under realistic parameterization and from that we generate an *directed* and *weighted* network of migration. We calibrate the model to explain U.S. interstate migration and cross-country migration between a large number of European countries. The model performs well in explaining the total network of labor flow across U.S. and it matches the gross flow of labor with the real data. Interestingly, the model matches the relative flow network for the European countries pretty well but predicts a much higher value of gross flow of labor than is seen in the data. Taking U.S. as a frictionless benchmark, we interpret our findings by recognizing that institutional barriers play an importnat role in intra-Europe migration. Thus this model which is built based on explaining sheer economic incentives of migration, needs to be augmented with institutional frictions in order to meaningfully capture the aggreagte features of migration within a set of heterogenous regions (Europe, in our case).

The predictive power of the model to explains the relative flows of migrants across pairs, lies in the fact that it essentially generates a multilateral gravity equation in labor flow thus capturing the relative weights pretty well. But the gross flow depends not only on economic factors but also on an array of institutional factors that comprises various social, political and linguistic dimensions. The good match of the data with the model in case of U.S. indicates the (institutional) frictionless character of interstate migration. However, when we study the differences between model and data in case of the European countries, several factors emerge as dominant frictions reducing migratory responses even in face of economic incentives. Common language turns out to be an important factor, so are several other social characteristics (individualism and pragmatism). The presence of informality in the form of shadow economy also affects the migration decision to a great extent along with financial stability.

A simplifying assumption made throughout the exercise that makes the model tractable, is that people migrate for economic incentives only. While there are other reasons (for example, family-related or retirement-related), this is broadly consistent with the data (Kennan and Walker [2011]). An important issue was raised by Molloy et al. [2011] regarding the effects of the housing sector on migration. While it is true that there are several instances of sudden increase in country-specific migration due to housing sector boom, in general that does not play an important role. The present model could be easily augmented with a housing sector. But Kaplan and Schulhofer-Wohl [2013] argues that the housing sector shows much more volatility than the process of migration which is highly inertial. Molloy et al. [2011] considered this particular channel and showed that there exists a very weak connections if any, in case of U.S. There are two other simplifications that allows us to solve the model based on the framework provided by Caliendo et al. [2014]. The first is regarding the technical issue that labor is the only mobile factor. Secondly, we have assumed that labor is homogeneous. This assumption implies that labor is perfectly substitutable across countries (islands) and sectors. Thus we do not have to keep track of different types of labor migrating all over the world (the set of islands considered). While this assumption restricts us from discussing other issues like skill-specific migration, we retain it because of the tractability it provides to the model.

Finally, we can ask a seemingly obvious question: why did we take social distances as a friction? Would it be possible to imagine a scenario where a higher social distance actually complements migratory responses rather than substituting it. The answer is, it is possible. In south-to-north migration this may in fact provide an incentive to migrate. For example, people would migrate from low income countries to comparatively prosperous ones but only selectively. Along with economic incentives, migrants also weigh their chances on the socio-political conditions of the receiving countries. Thus a higher distance between a donor country and a receiver country may compel individuals to migrate. However, when the countries are more-or-less similar in these respects, this might hinder the labor reallocation process as is found in case of the European countries.

6 Appendix

6.1 Sources of data

For the European Union we looked into bilateral migration from 2000 to 2007 within Austria, Belgium, Denmark, Spain, Germany, Czech Republic, Finland, France, Italy, Hungary, Ireland, Netherlands, Sweden, Slovenia, United Kingdom and Norway. Migration is defined as movement across different countries of residence in one year. More specifically, if a person was in a different country of residence in the previous year than this year, then we count that person as a migrant.

Table 9: Data Sources

Data	Source
Migration - E.U.	Eurostat
Contiguity - E.U.	CEPII
Cultural Indices	Hofstede et al. [2010]
Economic Indicators	World Bank Reports [2011]
Migration - US	American Community Survey Data [2007]
Financial indices	IMF

Below we present a table showing correlation among a few institutional variables. High correlation is apparent indicating possible multicollinearity problems.

Table 10: Correlation matrix for political stability indices

	Voiceacc	Polstab	Govteffec	Reg quality	Ruleoflaw	Corrupt	Transparency
Voiceacc	1.00						
Polstab	0.83	1.00					
Govteffec	0.83	0.72	1.00				
Regulation quality	0.56	0.53	0.72	1.00			
Ruleoflaw	0.91	0.84	0.94	0.63	1.00		
Corruptcont	0.93	0.84	0.91	0.66	0.96	1.00	
TransparencyCPI	0.91	0.76	0.85	0.56	0.91	0.91	1.00

6.2 Equilibrium conditions

The basic references for solving this types of models are Caliendo and Parro [2014] and Caliendo et al. [2014]. Below, we list the equilibrium conditions. We normalize the population so that $L = 1$ in the following.

- Labor mobility conditions (N equations):

$$\hat{L}_{nt} = \frac{(\frac{\hat{\omega}_{nt}}{\hat{P}_{nt}})^{1/\beta}}{\sum_{nt} L_{nt}(\frac{\hat{\omega}_{nt}}{\hat{P}_{nt}})^{1/\beta}} L, \tag{52}$$

  where

$$\hat{P}_{nt} = (\hat{P}^{M}_{nt})^{\alpha}(\hat{P}^{S}_{nt})^{1-\alpha}. \tag{53}$$

- Regional market clearing conditions ($2N$ equations):

$$X^{j'}_{nt} = \alpha^{j}(\hat{\omega}_{nt}(\hat{L}_{nt})^{1-\beta} I_{nt} L_{nt}), \tag{54}$$

  where the index j refers to sectors M and S.

- Price index ($2N$ equations):

$$\hat{P}^{j}_{nt} = (\sum_{i=1}^{N} \pi^{j}_{ni}(\hat{x}^{j}_{i})^{-\theta^{j}}(\hat{Z}^{j}_{i})^{\theta_{j}})^{-1/\theta^{j}}, \tag{55}$$

  where the index j refers to sectors M and S.

- Trade shares ($2N^2$ equations):

$$\pi^{j'}_{ni} = \pi^{j}_{ni}(\frac{\hat{x}^{j}_{i}}{\hat{P}^{j}_{nt}})^{-\theta^{j}}(\hat{Z}^{j}_{i})^{\theta^{j}}, \tag{56}$$

  where the index j refers to sectors M and S.

- Labor market clearing (N equations):

$$\hat{\omega}_{nt}(\hat{L}_{nt})^{(1-\beta)} I_{nt} L_{nt} = \sum_{j}\sum_{i} \pi^{j'}_{in} X^{j'}_{i}, \tag{57}$$

  where the index j refers to sectors M and S.

6.3 Solution algorithm

At any time-point t, the system can be solved block recursively given a set of productivity shocks. We follow the algorithm presented in Caliendo et al. [2014] for solving the labor allocation problem resulting from asymmetric shocks. The algorithm has been modified to suit our purpose. Below we present the steps to be followed for solving the model. Consider exogenous changes in productivity $\hat{Z}^{M}_{nt}$, $\hat{Z}^{S}_{nt}$ for all n. Define an weight $f \in (0, 1)$ to be used to update the guess. In practice, $f = 0.99$ works well. We also ignore the time index t in some cases below implying that the whole calculation is done for each period $t \leq T$.

- Guess relative change in regional factor prices $\hat{\omega}$.

- Set $\hat{x}^j_{nt} = \hat{\omega}_{nt}$ and

$$\hat{P}^j_{nt} = (\sum_{i=1}^{N} \pi^j_{ni} (\hat{x}^j_i)^{-\theta^j} (\hat{Z}^j_i)^{\theta_j})^{-1/\theta^j}. \tag{58}$$

- Find

$$\pi^{j'}_{ni} = \pi^j_{ni} (\frac{\hat{x}^j_i}{\hat{P}^j_{nt}} \hat{\kappa}^j_{ni})^{-\theta^j} (\hat{Z}^j_i)^{\theta^j}. \tag{59}$$

- Find

$$\hat{L}_{nt} = \frac{(\frac{\hat{\omega}_{nt}}{\hat{P}_{nt}})^{1/\beta}}{\sum_{nt} L_{nt} (\frac{\hat{\omega}_{nt}}{\hat{P}_{nt}})^{1/\beta}} L, \tag{60}$$

  where

$$\hat{P}_{nt} = (\hat{P}^M_{nt})^{\alpha} (\hat{P}^S_{nt})^{1-\alpha}. \tag{61}$$

- Find

$$X^{j'}_{nt} = \alpha^j (\hat{\omega}_{nt} (\hat{L}_{nt})^{1-\beta} I_{nt} L_{nt}). \tag{62}$$

- Find

$$\hat{\omega}^{new} = \frac{\sum_i \pi^{j'}_{in} X^{j'}_i}{\hat{L}^{(1-\beta)}_{nt} (I_{nt} L_{nt})} \tag{63}$$

- Update the guess by

$$\hat{\omega}^* = f.\hat{\omega} + (1-f).\hat{\omega}^{new} \tag{64}$$

- Stop if $||\hat{\omega} - \hat{\omega}^*|| \leq \epsilon$, else go back to the first point above.

- Find net labor inflow,

$$F_{nt} = (\hat{L}_{nt} - 1) L_{nt}. \tag{65}$$

- Construct the network of labor flow,

$$F_{ij} = -\left(\frac{(\hat{L}_j - 1) L_j}{\sum_{n \in \mathcal{N}^{out}} (\hat{L}_{nt} - 1) L_{nt}} \right) (\hat{L}_i - 1) L_i, \tag{66}$$

  where $\mathcal{N}^{out}$ is the set of countries from which labor migrates to other countries and $j \in \mathcal{N}^{out}$. This process generates an directed labor flow network.

- Define a new matrix, $F = triu(abs(F + F'))$ where the operator $triu(.)$ gives the upper triangular part and $abs(.)$ denotes absolute value of their respective arguments.

Thus one would generate the directed, weighted network between N islands. With repeated shocks for T periods, one would have T networks each for each period. Summing over them one can generate the final network. We have averaged the final network thus produced over $O(10)$ realizations to arrive at a stable network free of fluctuations in the edge weights.

6.4 Robustness

In this section, we present the robustness checks. Table 11 shows the OLS results for explanatory power of the model in nominal terms for the E.U. countires. Table 12 shows the same for relative migration. Finally, table 13 shows combines both results for U.S. The OLS results on the effects of frictions on the missing mass of migrants are presented in table 14.

Table 11: Regression results for E.U. - Nominal

	TFP driven migration	Contiguity	Intercept	Adjusted R^2
	(Std Err)	(Std Err)	(Std Err)	
2000	0.05836***	0.00001***	0.00000	0.77380
	(0.00397)	(0.00000)	(0.00000)	
2001	0.05870***	0.00002***	0.00000	0.76270
	(0.00413)	(0.00000)	(0.00000)	
2002	0.06118***	0.00001***	0.00000	0.77240
	(0.00415)	(0.00000)	(0.00000)	
2003	0.05456***	0.00001***	0.00000	0.63560
	(0.00516)	(0.00000)	(0.00000)	
2004	0.05709***	0.00001**	0.00000	0.58090
	(0.00602)	(0.00001)	(0.00000)	
2005	0.06132***	0.00001**	0.00000	0.66860
	(0.00536)	(0.00001)	(0.00000)	
2006	0.06376***	0.00001***	0.00000	0.68340
	(0.00531)	(0.00000)	(0.00000)	
2007	0.06030***	0.00001***	0.00000	0.73690
	(0.00467)	(0.00000)	(0.00000)	

Note: *p<.1, **p<.05, ***p<0.01.

Table 12: Regression results for E.U. - Relative

	TFP driven migration (Std Err)	Contiguity (Rob Std Err)	Intercept (Rob Std Err)	Adjusted R^2
2000	0.84328***	0.01700***	-0.00046	0.77380
	(0.05742)	(0.00416)	(0.00193)	
2001	0.83180***	0.01779***	-0.00042	0.76270
	(0.05853)	(0.00434)	(0.00200)	
2002	0.85237***	0.01418***	-0.00013	0.77240
	(0.05777)	(0.00426)	(0.00197)	
2003	0.79403***	0.01494***	0.00063	0.63560
	(0.07507)	(0.00551)	(0.00255)	
2004	0.77543***	0.01344**	0.00116	0.58090
	(0.08171)	(0.00597)	(0.00277)	
2005	0.81675***	0.01351**	0.00052	0.66860
	(0.07144)	(0.00532)	0.00245)	
2006	0.75724***	0.01441***	0.00122	0.68340
	(0.06309)	(0.00530)	(0.00232)	
2007	0.71356***	0.01980***	0.00104	0.73690
	(0.05532)	(0.00466)	(0.00208)	

Note: *p<.1, **p<.05, ***p<0.01.

Table 13: Regression results for US

	TFP driven migration	Contiguity	Intercept	Adjusted R^2
Nominal	0.82695***	0.00006***	0.00000	0.62990
	(0.02146)	(0.00000)	(0.00000)	
Relative	0.68521***	0.00243***	0.00004	0.62990
	(0.01778)	(0.00009)	(0.00003)	

Note: *p<.1, **p<.05, ***p<0.01.

Table 14: Regression results for E.U. - frictions

	Contiguity	LangIndex	Indivi	Pragm	E.U.ro	ShadowEco	Intercept	R^2
2000	0.23***	0.43***	-0.12***	-0.11***	-0.06	-0.01**	0.72***	0.4383
	(0.08)	(0.15)	(0.04)	(0.04)	(0.06)	(0.01)	(0.18)	
2001	0.26***	0.44***	-0.13***	-0.12***	-0.06	-0.01**	0.77***	0.4406
	(0.08)	(0.16)	(0.04)	(0.04)	(0.06)	(0.01)	(0.19)	
2002	0.21**	0.45***	-0.13***	-0.12***	-0.07	-0.01**	0.78***	0.4269
	(0.08)	(0.16)	(0.04)	(0.04)	(0.06)	(0.01)	(0.18)	
2003	0.21**	0.46***	-0.13***	-0.12***	-0.07	-0.02**	0.78***	0.4233
	(0.08)	(0.17)	(0.04)	(0.04)	(0.06)	(0.01)	(0.19)	
2004	0.18**	0.49***	-0.13***	-0.13***	-0.07	-0.01*	0.78***	0.4050
	(0.08)	(0.17)	(0.04)	(0.04)	(0.06)	(0.01)	(0.19)	
2005	0.18**	0.44***	-0.11***	-0.10***	-0.06	-0.01*	0.66***	0.3965
	(0.08)	(0.15)	(0.04)	(0.03)	(0.06)	(0.01)	(0.17)	
2006	0.18**	0.53***	-0.08*	-0.09**	-0.09	-0.01*	0.57***	0.3394
	(0.09)	(0.17)	(0.04)	(0.04)	(0.06)	(0.01)	(0.18)	
2007	0.15*	0.59***	-0.09**	-0.10**	-0.15**	-0.02**	0.67***	0.3865
	(0.09)	(0.17)	(0.04)	(0.04)	(0.06)	(0.01)	(0.19)	

Note: *p<.1, **p<.05, ***p<0.01.

6.5 Additional Plots

We would like to understand the influence of each variable which is used as friction. We use the post-estimation tool partial regression plot for this. In the dyadic regression the dependent variable is the ratio of bilateral migration as seen in data to bilateral migration which is TFP driven (simulated). We try to understand the importance of each variable, for example language index - for this we first regress the dependent variable on the remaining regressors (not including language index) and plot the residuals on the Y-axis. Next we regress language index on the remaining regressors and plot the residuals on the X-axis. These plots show relation between the dependent variable and each friction variable (Fig. 7 and 8 for the year 2000 and 2007 respectively).

We use the component plus residual plot (partial residual plot) to get more clarity on the functional form of the relation between the dependent variable and friction variables 1-by-1. For example to understand the relation between the ratio of bilateral migration in data to TFP driven bilateral migration (y-variable) to language index we first regress y on all the x variables. Then we subtract the effect of all the other regressors (not language index) from the y-variable and plot that on the Y-axis. We call this component plus residual. We compare it with the language index which is plotted on the X-axis in Fig. 9.

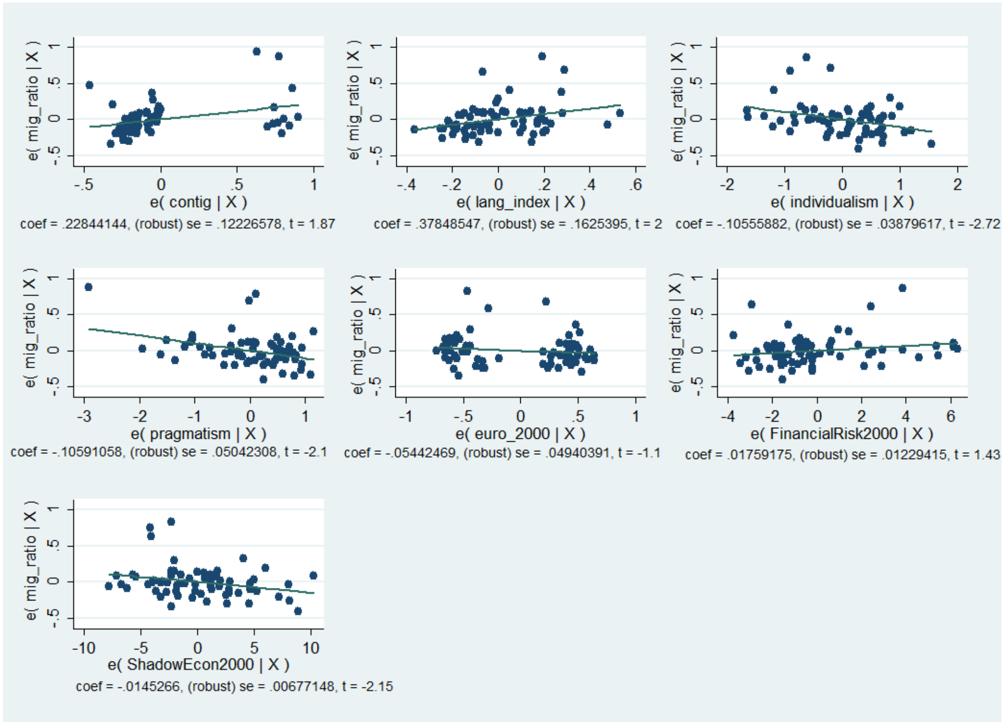


Figure 7: The partial regression plot for all the variables in 2000

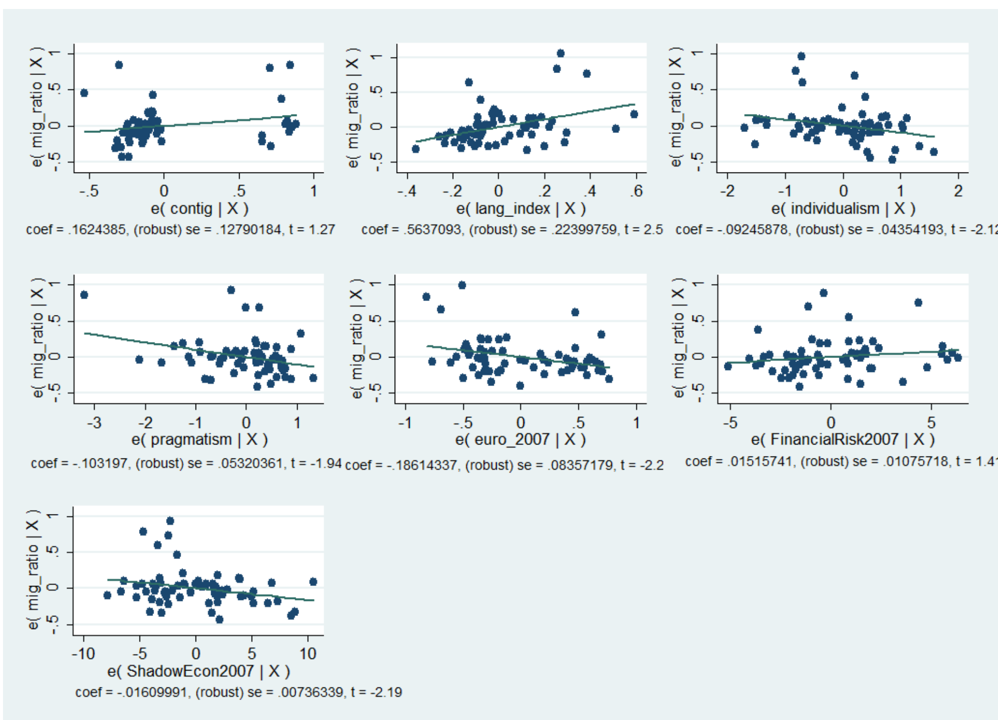


Figure 8: The partial regression plot for all the variables in 2007

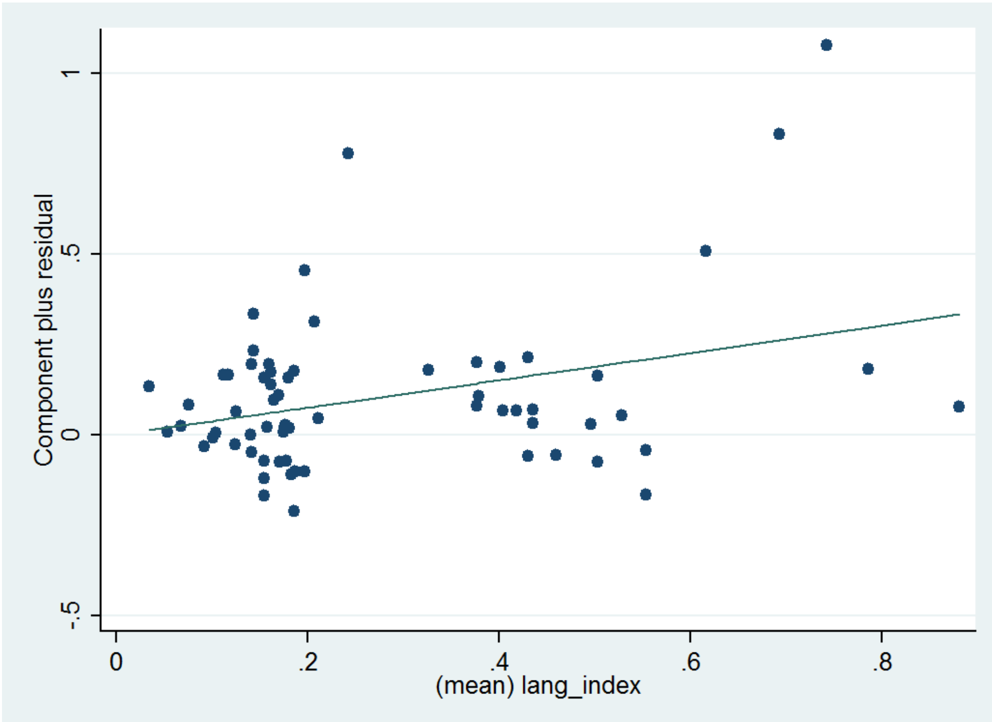


Figure 9: The partial residual plot for language index in 2007

6.6 Additional tables

Here we present two tables showing that contiguity has very little little explanatory power for migration within Europe (tables 15 and 16).

Table 15: Regression results for E.U. - Nominal w/ Contiguity

	Contiguity (Rob Std Err)	Intercept (Rob Std Err)	R^2
2000	0.00001	0.00001***	0.0303
	(0.00001)	(0.00000)	
2001	0.00001	0.00001***	0.0327
	(0.00001)	(0.00000)	
2002	0.00001	0.00001***	0.0169
	(0.00001)	(0.00000)	
2003	0.00001	0.00001***	0.0194
	(0.00001)	(0.00000)	
2004	0.00001	0.00001***	0.013
	(0.00001)	(0.00000)	
2005	0.00001	0.00001***	0.0124
	(0.00001)	(0.00000)	
2006	0.00001	0.00001***	0.0218
	(0.00001)	(0.00000)	
2007	0.00001*	0.00001***	0.0718
	(0.00001)	(0.00000)	

Note: *p<.1, **p<.05, ***p<0.01.

Table 16: Regression results for E.U. - Relative w/ Contiguity

	Contiguity (Rob Std Err)	Intercept (Rob Std Err)	R^2
2000	0.01225	0.01311***	0.0303
	(0.00846)	(0.00355)	
2001	0.01296	0.01299***	0.0327
	(0.00896)	(0.00358)	
2002	0.00933	0.01360***	0.0169
	(0.00784)	(0.00373)	
2003	0.01023	0.01345***	0.0194
	(0.00834)	(0.00378)	
2004	0.00845	0.01374***	0.013
	(0.00824)	(0.00384)	
2005	0.00828	0.01377***	0.0124
	(0.00841)	(0.00384)	
2006	0.01147	0.01266***	0.0218
	(0.00933)	(0.00375)	
2007	0.01961*	0.01188***	0.0718
	(0.01144)	(0.00328)	

Note: *p<.1, **p<.05, ***p<0.01.

6.7 Measuring cultural differences

We use the Hofstede index Hofstede et al. [2010] to measure cultural differences in the European countries. We consider the following indices [4] -

- Indulgence - *It stands for a society that allows relatively free gratification of basic and natural human drives related to enjoying life and having fun.*
- Pragmatism - *Every society has to maintain some links with its own past while dealing with the challenges of the present and the future. Societies prioritize these two existential goals differently.*
- Uncertainty Avoidance - *The Uncertainty Avoidance dimension expresses the degree to which the members of a society feel uncomfortable with uncertainty and ambiguity.*
- Masculinity - *The Masculinity side of this dimension represents a preference in society for achievement, heroism, assertiveness and material rewards for success.*
- Individualism - *The high side of this dimension, called individualism, can be defined as a preference for a loosely-knit social framework in which individuals are expected to take care of only themselves and their immediate families.*

[4] Source URL - http://geert-hofstede.com/national-culture.html

- Power distance - *This dimension expresses the degree to which the less powerful members of a society accept and expect that power is distributed unequally.*

Out of these 'Pragmatism' and 'Individualism' most meaningfully explained the frictions.

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