Appendix to:
Quantifying the Benefits of Labor Mobility in a Currency Union*

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- *Unemployment rate*: monthly, 1976 - 2015, Source: BLS, Series: Local Area Unemployment Statistics, LASST010000000000003, downloaded: 2/16/17.
- *Bilateral migration*: 1975/'76 - 2014/'15; Source: IRS Statistics of Income Division, data from 1990 onwards downloaded from the IRS website on 2/27/17; data prior to 1990 taken from Molloy, Smith and Wozniak (2011)
- *Population*: as of 1st of July, 1969 - 2016; Source: BEA, Regional Data > GDP & Personal Income > SA1 Personal Income Summary: Personal Income, Population, Per Capita Personal Income, downloaded: 2/16/2017.

A.1.1 More Details on Migration Data.

We use data from the Internal Revenue Service (IRS) to calculate state-to-state migration flows. The IRS has calculated migration rates based on the universe of tax filers. It compares mailing addresses on tax returns and then classifies tax returns as 'migrant' whenever the geographic code changes, and 'non-migrant' otherwise. The IRS then reports the number of tax returns that flow between any two geographical areas (counties or states), including the number of non-migrants. Combining this information allows us to calculate migration rates. The IRS reports numbers for both the number of returns (approximating households) and the number of exemptions claimed (approximating people). We focus on the number of exemptions claimed. The IRS data does not allow us to directly observe migration flows, but we only observe locations of tax filers at certain points in time, e.g. a tax filer lived at some point in 1999 in Ohio and at some point in 2000 in Michigan. Our best guess is that the move between the two states took place between July 1st 1999 and June 30th 2000. So migration in year t refers to migration between July 1st of calendar year $t-1$ and June 30th of calendar year t. To be consistent we also define the unemployment rate in year t as the average unemployment rate between July 1st of calendar year $t-1$ and June 30th of calendar year t.

Another popular source for migration data is the American Community Survey (ACS) (see e.g. Yagan, 2014) and the Annual Social and Economic Supplement of the Current Population

Survey (CPS). Both surveys ask individuals whether their residence in the previous year was in the same state as their current residence, which allows the researcher to calculate migration rates. The ACS survey also includes information on the state of previous residence so that even bilateral migration rates can be calculated. The panel structure of the ACS is a main advantage of this data set, but the small sample size leads to imprecise estimates of net migration rates (the CPS' sample size is even smaller, roughly one third of that of the ACS), especially for small states. This is also illustrated in Figure A2, which display internal net (in)migration rates for six US states based on IRS data and ACS data. The measures are calculated as follows:

$$netmigr^{IRS}_{i,t} = \frac{\sum_{j\in US}\left(v^{IRS}_{i,j,t} - v^{IRS}_{j,i,t}\right)}{\sum_j v^{IRS}_{j,i,t}}$$
$$netmigr^{ACS}_{i,t} = \frac{\sum_{j\in US}\left(v^{ACS}_{i,j,t} - v^{ACS}_{j,i,t}\right)}{pop_{i,t-1}}$$

where $v^{IRS}_{i,j,t}$ is the number of exemptions claimed for individuals that lived in state j in $t-1$ and in state i in t, as reported by the IRS. Summation is over all US states, that is we ignore international migration. We divide by the total number of exemptions claimed for individuals that lived in i in $t-1$. ACS estimates of state-to-state flows are directly expressed in people, so we divide by the mid-year population as of $t-1$. One difference between the two measures is that the IRS figures refer to exemptions claimed, which might not necessarily be representative of the entire population.

We compare these two figures to data provided by the US Census. The Census provides intercensal estimates of the resident population for all US states, including year-to-year components of change. Starting in 1991 these components of change specifically include net migration (both internal and international). The Census partially sources its net migration estimates on IRS data and has calculated, up to 2011, IRS migration rates. The Census complements the IRS data with data on social security payments to better estimate migration patterns of e.g. retired people. Despite these adjustments, the Census estimates of net migration rates are quite similar to the "raw" IRS data. Importantly, ACS time series display larger volatilities, especially for smaller states. These volatilities are even higher when only looking at bilateral migration flows. A more detailed description on the various data sets on internal migration in the US can be found in Molloy, Smith and Wozniak (2011).

Table **??** provides some summary statistics on the U.S. sample.

A.2 Canadian Provinces

- *Unemployment rate:* monthly, 1976 - 2016; Source: Statistics Canada, Series: Labour force survey estimates (LFS), supplementary unemployment rates by sex and age group, unadjusted for seasonality, monthly (rate), Table 282-0085, downloaded: 3/2/17.

- *Bilateral migration:* 1971/'72 - 2015/'16; Source: Statistics Canada, Series: Interprovincial migrants, by province or territory of origin and destination, annual(Persons),1971/1972 to 2015/2016, Table 051-0019, and Components of population growth, Canada, provinces and territories, annual (persons), Table 051-0004, downloaded: 3/2/17.

- *Population:* as of 1st of July, 1971 - 2016; Source: Statistics Canada, Series: Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual (persons), Table 051-0001, downloaded: 3/2/17.

As with US data, migration data is reported for the period July 1st of the previous year till June 30th of the curent year. To be consistent, we also calculate unemployment rates for the same time period. Table **??** provides some summary statistics on the Canadian sample.

A.3 Europe

Data sources on unemployment rates and population are provided in Table A1.

A.3.1 More Details on Migration Data.

Our goal is to create a database of migration flows within Europe that uses a consistent definition of migration across countries. In contrast to the US or Canada, no harmonized migration data is being published at the European level. As a result, we face two challenges:

1. Definitions of what a migrant is differ across countries.

2. 'Mirror' flows of migrants are inconsistent and have to be reconciled

To overcome the first challenge, we adjust data using an adjustment factor based on time periods where data according to both 'national' and 'harmonized' definitions of migrants exist. The second challenge has been tackled in the trade literature and we therefore apply the methodology proposed by one of the most used trade databases (BACI).

For our purpose, 'Europe' encompasses all countries in EU28 + EFTA, excluding Luxembourg, Liechtenstein and Croatia. Table C.4 contains a list of data sources for aggregate migration data. Table C.4 has a list of data sources for bilateral migration data. Tables A4 and A5 provide information on data periods covered by these data sources.

Different Definitions of 'Migrant' across Countries The UN defines a migrant as any person moving in or out of a country for at least 12 months. Eurostat has asked member states to provide data according to this definition starting in 2008 (regulation No. 862/2007), and almost all countries had updated their migration data accordingly by 2015. Previously, countries had used national definitions. In Germany, the Netherlands, Austria and Switzerland, for example, these national definitions include migrants that move for less than 12 months (e.g. seasonal workers, exchange students), and numbers of migrants according to these definitions produce higher numbers. In many Eastern European countries (such as Poland, Slovak Republic, Bulgaria), migrants only refer to those changing their permanent residence, which leads to substantially smaller numbers of migrants compared to the UN definition. The five Scandinavian countries have national definitions that are close to the UN definition. It is important to keep in mind that countries are still free to use various sources to compile migration statistics. Administrative data is used in countries where registration is mandatory (e.g. all Scandinavian countries). Some countries rely on survey data (e.g. in the UK).

Adjusting Data for Different Definitions Tables A4 and A5 display data availability for all 29 countries in our dataset, for both aggregate (i.e. overall immigration and emigration) and bilateral data (i.e. including information on country of previous residence / next residence). For aggregate data, there are two countries that do not report any data on Eurostat according to the UN definition (Estonia and Slovak Republic). Twelve countries either only report through Eurostat or do not have longer time series based on a national definition (Ireland, Greece, France, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Portugal, Romania and United Kingdom)) and for the remaining thirteen countries, national data sources display longer time series than the time frame reported on Eurostat.

Let $\tilde{v}^i_{i,j,t}$ denote the migration flow from j to i at time t reported by country i according to the national definition of country i. The corresponding value using the harmonized definition proposed by the UN and enacted by Eurostat is denoted by $v^i_{i,j,t}$. For time periods with missing values for $v^i_{i,j,t}$, we replace these missing values by $adj^i_{i,j}\tilde{v}^i_{i,j,t}$, where we calculate the adjustment factor $adj^i_{i,j}$ as

$$adj^i_{i,j} = \frac{1}{S}\sum_s \left(\frac{\tilde{v}^i_{i,j,s}}{v^i_{i,j,s}}\right).$$

Here, s indexes all periods for which data according to both 'national' and 'harmonized' definitions of migrants exist, and S is the number of those periods. We apply this factor to both aggregate and bilateral migration data. For some countries bilateral migration data is not reported on Eurostat (in particular, Germany, and to a lesser extent, Spain and Italy), but migration data is available for country groups. In those cases, we calculate the adjustment factor based on either data reported for the EU15 or the EFTA aggregate. Table A5 reports the adjustment factor for all countries with available data.

This procedure provides us with a database for both aggregate and bilateral migration flows. In the main body of the text, we only use the database on aggregate migration flows (except for the statistics on 'internal migration', which require information on bilateral flows), but in the appendix, we also perform regression analyses using bilateral migration flows. We next discuss how we reconcile the bilateral flows observed in the data. Note that we ignore the consequences of these adjustments for the aggregate migration flows.

Reconciling Bilateral Flows Whenever two countries report numbers on the same flow of migrants, we face the challenge of reconciling these two reported numbers because these so-called *mirror flows* rarely coincide across reporting countries. Reconciliation methods used in the literature are the following:

- Only take inflows (immigration is easier to measure than emigration)
- Use BACI method for trade flows: reconciled value is a weighted average of the two reported numbers, with weights corresponding to the 'quality' of a country's reports. Quality is measured as the discrepancy in mirror flows averaged across all partner countries.

Bilateral flows among Scandinavian countries that are fairly consistent among each other, e.g. the number of migrants from Denmark to Norway is almost the same as reported by Denmark and Norway. We opt for the BACI method, as explained in the following paragraph.

Overview BACI method Suppose the true value v for migration from j to i at time t is unobservable. Reported values contain an error e. We assume

$$v_i = ve_i \qquad \text{with} \qquad lne_i \sim N(0, \sigma_i^2),$$

where v_i is the migration value reported by i. We would like to choose weights w to minimize the variance of the reconciled value, $wv_i + (1-w)v_j$, relative to the true value:

$$\min_w Var\left(we_i + (1-w)e_j\right).$$

The solution is[1]

$$w = \frac{Var(e_i)}{Var(e_i) + Var(e_j)} = \frac{e^{\sigma_i^2}(e^{\sigma_i^2} - 1)}{e^{\sigma_i^2}(e^{\sigma_i^2} - 1) + e^{\sigma_j^2}(e^{\sigma_j^2} - 1)}.$$

We estimate σ_i^2 by first regressing the relative distance between reported values, $|\ln v_i - \ln v_j|$, on a set of dummies:

$$|\ln v_{i,j,t}^i - \ln v_{i,j,t}^j| = \alpha_i + \beta_j + \lambda_t + \epsilon_{i,j,t} \qquad \text{with} \quad \sum_i \alpha_i = \sum_j \beta_j = \sum_t \lambda_t = 0. \tag{A.1}$$

Given the assumptions on the error term e_i, we have $\ln e_i - \ln e_j \sim N(0, \sigma_i^2 + \sigma_j^2)$ because the variance of the sum (or difference) of two normal distributions is the sum of their variances. The absolute value of the difference of two normal distributions, $|\ln e_i - \ln e_j|$, is a folded normal distribution with a mean equal to $\sqrt{\frac{2}{\pi}}\sqrt{\sigma_i^2 + \sigma_j^2}$. Denote this mean by $\mu_{i,j}$. Then, the average mean of values reported by i is a weighted average of all bilateral means, with some

[1]Note that the minimization problem can be rewritten as

$$\min_w \left(w^2 Var(e_i) + (1-w)^2 Var(e_j)\right).$$

Also, the variance of the log-normally distributed e_i is $e^{\sigma_i^2}(e^{\sigma_i^2} - 1)$.

weights s_j that sum up to 1:[2]

$$
\begin{aligned}
\mu_i &= \sum_j s_j \mu_{i,j} \\
&= \sum_j \left(s_j \sqrt{\frac{2}{\pi}} \sqrt{\sigma_i^2 + \sigma_j^2} \right) \\
&\approx \sqrt{\frac{2}{\pi}} \sum_j \left(s_j (\sigma_i + \sigma_j) \sqrt{\frac{2}{\pi}} \right) \\
&= \frac{2}{\pi} \sigma_i + K_i,
\end{aligned}
$$

where K_i is some constant. Our estimate of μ_i is $\hat{\alpha}_i$. Then, our estimate of σ_i is

$$
\hat{\sigma}_i = \frac{\pi}{2} \left(\hat{\alpha}_i - \min_j \hat{\alpha}_j + 2stderr(\hat{\alpha}_i) \right),
$$

and similarly for $\hat{\sigma}_j$. Here, $stderr(\hat{\alpha}_i)$ is the estimated standard error of $\hat{\alpha}_i$. The ad-hoc transformation sets $K_i = \min_j \hat{\alpha}_j - 2stderr(\hat{\alpha}_i)$ and is a normalization plus it gives an (arbitrary) penalty term to imprecisely estimated values of α_i.

Intuitively, σ_i is estimated to be large for countries that on average, i) report different values than their partners (either underreport or overreport), i.e. a large $\hat{\alpha}_i$, and ii) are inconsistent in their reports in the sense that some of their reports closely match values reported by their partners and others do not, i.e. a large $stderr(\hat{\alpha}_i)$. The regression (A.1) *cleans* the quality of country i's reports from the quality of its partners, j, and the quality of reports associated with certain time periods.

For some bilateral pairs, we have two reported values for a subset of all years, whereas only one value is reported in all other years. In that case, we calculate an adjustment factor. For example, if j does not report values for all years, but i does, our estimate of v is

$$
v_{i,j,t} = w_{i,j} v_{i,j,t}^i + (1 - w_{i,j}) v_{i,j,t}^i \frac{1}{S} \sum_s \left(\frac{v_{i,j,s}^j}{v_{i,j,s}^i} \right),
$$

where s indexes all periods for which both i and j report, and S is the number of those periods.

[2]The approximation seems to work, but not sure where it comes from.

A.3.2 Additional Data

We require additional data to be used for our model calibration and estimation:

- *Migration stock:* 5-year intervals, 1990 - 2015, number of emigrants and immigrants by country of origin and destination; Source: United Nations (2017), downloaded: 2/7/18.
- *National account variables:* GDP, private consumption, investment, net exports and government purchases. Employment. See Table A1 for data sources. Government purchases are constructed as the sum of government consumption and government gross fixed capital formation. See House, Proebsting and Tesar (2017) for more details.
- *Trade data:* 1995, 2000, 2005, 2008-2011; Source: OECD Trade in Value Added Database, October 2015 edition, Series: Value added content of final demand, by source country and industry, FD_VA; downloaded: 6/14/16.

We calculate the labor force as

$$l_i = \frac{empl_i}{1 - u_i},$$

where $empl_i$ is data on the number of employed and u_i is the unemployment rate. The labor force participation rate is defined as the labor force divided by population. Net exports over GDP are calculated as real net exports over 2005 nominal GDP.

Rest of the World. Our model features a rest-of-the-world (RoW) aggregate that sums up variables across all countries in the world besides those specified in the model. Here, we provide a few more details.

In general, we calculate the number of people born in i as

$$\mathbb{N}^i = \mathbb{N}_i + \sum_{j \neq i} n_j^i \mathbb{N}^i - \sum_{j \neq i} n_i^j \mathbb{N}_i,$$

where $\mathbb{N}_i$ is the population living in i, $\sum_{j \neq i} n_j^i \mathbb{N}^i$ is the number of people born in i, but living abroad (emigrants), and $\sum_{j \neq i} n_i^j \mathbb{N}_i$ is measured as the number of people born abroad, but living in i (immigrants). Data on emigrants and immigrants (both overall and sorted by origin / destination) comes from United Nations (2017). We calculate $\mathbb{N}^i$ for all countries in our sample. Then, the corresponding number for the rest of the world is simply the world population[3] less $\sum_{i \neq RoW} \mathbb{N}^i$.

[3]Source: World Bank, indicator SP.POP.TOTL, downloaded: 2/14/2018.

Information from the OECD TiVA directly allow us to construct trade shares and domestic absorption for RoW because the database includes a rest-of-world aggregate (which we adjust to match our country composition).

We set the labor force participation rate to 50 percent, the unemployment rate to 6 percent and the share of government purchases in domestic absorption to 19 percent, which are in line with data for the US.

B Regressions Based on Bilateral Migration Flows

We run the following regression:

$$100 * \log v_{i,t}^{j} = \beta_{ij} + \beta^{dest} u_{i,t} + \beta^{orig} u_{j,t} + \beta^{trend} t + \epsilon_{ij,t} \tag{B.1}$$

where, $v_{i,t}^{j}$ denotes migration from j to i at time t and $u_{i,t}$ is the unemployment rate in i at time t, demeaned over time. We include pairwise fixed effects β_{ij} and a time trend t. As before, the time period for the North American samples is 1977-2014, and 1991-2014 for the European samples.

Table A10 reports the estimated coefficients with their standard errors clustered at the pair level.[4] For the US, the estimated coefficients for β^{orig} and β^{dest} are around -4.5 and 4.5, implying that a one percentage point increase (decrease) in the unemployment rate of the destination (origin), lowers migration by 4.5 percent. The coefficient on the time trend is statistically insignificant, meaning that the *absolute number* of migrants has not changed over time. This reflects the combined effect of a decrease in migration rates (discussed above) and the counterbalancing population growth. For the Canadian sample, the point estimates on the unemployment rates are not symmetric, with movements in unemployment rates in the destination playing a larger role ($\hat{\beta}^{dest} = 6.9$) than movements in unemployment rates in the origin ($\hat{\beta}^{orig} = 3.5$). Migration in Western Europe displays the lowest sensitivity to movements in unemployment rates, with coefficients around -3.2 and 3.2. Migration in absolute terms has been downward trending in Canada, but substantially increasing in Western Europe, rising by about 3 percent by year.

[4] We cluster standard errors at the pair level to account for possible correlations in $\epsilon_{ij,t}$ over time.

C A Simplified Model

A main result from our quantitative model is that migration can be as powerful as independent monetary policy to reduce cross-sectional variations in unemployment rate differentials, but this comparison depends on some key parameters such as the trade elasticity and the real wage rigidity. Migration is particularly effective in environments with low trade elasticities and strong wage rigidities. Here, we analyze the mechanisms in the model behind this result.

We consider a simplified version of the model that allows for closed-form solutions. The world is populated by two symmetric countries, indexed i and j, that are part of a currency union. Production of the intermediate goods is linear in labor. The model economy is in steady state at $t-1$, and, at the beginning of period t, after shocks are realized, it is revealed to households that the world ends at the end of period t. While this setup does not feature any intertemporal decision margins, it is sufficiently rich to perform some insightful, comparative statics. In particular, we want to understand how a negative terms of trade shock to country i leads to unemployment and how migration affects this transmission.

We organize the equations around the labor market from the firm's perspective. The relevant wage in this market is the real wage paid by firms to HR firms, w^f. The demand for workers describes firms' demand for *matched* workers at a given wage, w^f. The supply of workers relates to the supply of matched workers provided by the HR firms. The supply of matched workers therefore takes into account how different wage rates, w^f, affect HR firms' incentives to create vacancies as well as households' migration decisions. Section C.4 provides a summary and discussion of the main equations.

C.1 Definition of the Unemployment Rate

The definition of the unemployment rate is

$$ur_{i,t} = \frac{\mathbb{N}_{i,t} U_{i,t}}{\mathbb{N}_{i,t}}.$$

Here, $\mathbb{N}_{i,t}$ is the population (which is equal to the labor force), and $U_{i,t}$ is the number of unemployed per capita. The percentage point change in the unemployment rate can then be approximated by the change in the number of unemployed per capita

$$\Delta ur_{i,t} = \Delta U_{i,t}.$$

The number of unemployed is equal to all people in the labor force that are not employed, which, in per capita term can be written as $U_{i,t} = 1 - L_{i,t}$. An increase in the number of unemployed per capita is therefore equivalent to a decrease in the number of employed per capita,$\Delta U_{i,t} = -\Delta \tilde{L}_{i,t}$, so that the unemployment rate is

$$\Delta ur_{i,t} = -\Delta L_{i,t}.$$

It is useful to explicitly write out the change in the number of employed per person using $\frac{\Delta(\mathbb{N}L)_{i,t}}{\mathbb{N}L} = \frac{\Delta \mathbb{N}_{i,t}}{\mathbb{N}} + \frac{\Delta L_{i,t}}{L}$ (and noticing that $L = (1 - ur)$ in steady state and setting $\mathbb{N} = 1$ in steady state), which then yields

$$\Delta ur_{i,t} = (1 - ur)\Delta \mathbb{N}_{i,t} - \Delta \left(\mathbb{N}L\right)_{i,t}. \tag{C.1}$$

This states that an increase in the population, $\mathbb{N}_{i,t}$, or a decrease in total employment, $(\mathbb{N}L)_{i,t}$, raises the unemployment rate. In a model without migration, there is a simple negative relationship between percentage point changes in the unemployment rate and changes in the number of employed workers.

C.2 Supply of Matched Workers

To derive the supply of matched workers, we ask how movements in the wage paid by firms, w^f, lead to changes in the supply of matched workers. We first discuss how movements in the firm wage trickle down to movements in labor market tightness by using the HR firms' and employment agencies' first-order and zero-profit conditions. Labor market tightness is then shown to directly link to changes in employment, keeping a country's population fixed. Finally, we endogenize migration movements and show how they react to changes in the wage level.

C.2.1 Searching and Matching

From changes in the firm's wage to changes in labor market tightness. A change in the firm's real wage automatically affects the value of a filled vacancy for an HR firm, which, in our one-period setting, is equal to the difference between the wage received from the producing firm, w^f and the wage paid to the employment agency, w: $\mathcal{J}_{i,t} = w^f_{i,t} - w_{i,t}$.

Log-linearizing yields

$$\mathcal{J}_i\tilde{\mathcal{J}}_{i,t} = w_i^f \widetilde{w}_{i,t}^f - w_i \widetilde{w}_{i,t}.$$

Similarly, the value of having an employed worker for an employment agency is the difference between the wage received from the HR firm, w, and the wage paid to the household, w^h: $\mathcal{E}_{i,t} = w_{i,t} - w_{i,t}^h$. Log-linearizing yields

$$\mathcal{E}_i\tilde{\mathcal{E}}_{i,t} = w_i \widetilde{w}_{i,t} - w_i^h \widetilde{w}_{i,t}^h. \tag{C.2}$$

HR firms and employment agencies bargain over the wage and share the surplus according to

$$\theta^w w_i \widetilde{w}_{i,t} = \theta^w w_i \widetilde{w}_{i,t-1} + (1-\theta^w)\left[\varrho \mathcal{J}_i \tilde{\mathcal{J}}_{i,t} - (1-\varrho)\left(\mathcal{E}_i\tilde{\mathcal{E}}_{i,t} + w_i^h \widetilde{w}_{i,t}^h\right)\right]$$

Inserting our expressions for $\mathcal{J}_i\tilde{\mathcal{J}}_{i,t}$ and $\mathcal{E}_i\tilde{\mathcal{E}}_{i,t}$ gives

$$\frac{1}{1-\theta^w} w \widetilde{w}_{i,t} = \varrho w^f \widetilde{w}_{i,t}^f. \tag{C.3}$$

This implies for the surplus of the HR firm

$$\mathcal{J}_i\tilde{\mathcal{J}}_{i,t} = \left[1-(1-\theta^w)\varrho\right] w_i^f \widetilde{w}_{i,t}^f.$$

If wages are completely flexible, $\theta^w = 0$, and the bargaining power of HR firms is zero, $\varrho = 1$, then $w\widetilde{w}_{i,t} = w^f \widetilde{w}_{i,t}^f$ and there is no surplus for the HR firm. In that case, the value of having a filled vacancy stays constant, $\tilde{J}_{i,t} = 0$. Otherwise, in response to a negative shock, the value of a filled vacancy goes down because the firm wage (which the HR firm receives) decreases more than the wage paid by the HR firm to the employment agency.

Through the zero profit condition for HR firms, a lower value of a filled vacancy will lead to fewer vacancies created and hence a less tight labor market with a lower $\lambda = \frac{V}{H}$. To see this, start from the zero profit condition for HR firms that the value of a posted vacancy has to be zero in equilibirum. This value equals the probability to fill the vacancy, g, times the value of having a filled vacancy, $\mathcal{J}$, less the (constant) posting cost, ς. In log-linearized form, this gives

$$\tilde{g}_{i,t} = -\tilde{\mathcal{J}}_{i,t},$$

so when the value of having a filled vacancy, $\mathcal{J}$, goes down, HR firms leave the market until the chances of filling a vacancy, g, rises sufficiently to offset the lower value of a filled vacancy. The job filling rate is just the number of matches divided by the number of vacancies, $g = \frac{M}{V}$. Since the matching function is $M = \bar{m}H^{\zeta}V^{1-\zeta}$, this gives

$$\tilde{g}_{i,t} = -\zeta\tilde{\lambda}_{i,t}.$$

Similarly, the job finding rate is the number of matches divided by the number of job hunters $f = \frac{M}{H} = g\lambda$, so that

$$\tilde{f}_{i,t} = -\frac{1-\zeta}{\zeta}\tilde{g}_{i,t}.$$

Combining equations, this yields a link between the job finding rate and the wage paid by firms:

$$\tilde{f}_{i,t} = -\frac{1-\zeta}{\zeta}\tilde{g}_{i,t} = \frac{1-\zeta}{\zeta}\tilde{\mathcal{J}}_{i,t} = \frac{1-\zeta}{\zeta}\left[1-(1-\theta^{w})\varrho\right]\frac{w^{f}}{\mathcal{J}}\widetilde{w}^{f}_{i,t}.$$

In response to a negative shock, the job finding rate falls because HR firms create fewer vacancies. If the number of matches mostly depends on the number of job hunters, $\zeta \approx 1$, then the fall in the job finding rate is smaller.

It is also interesting to look at the term $\frac{w^f}{\mathcal{J}}$, which is the inverse of the markup charged by the HR firms, $\frac{w^f - w}{w^f}$ (because $\mathcal{J} = w^f - w$). In steady state, we have that the real wage, w, is a weighted average of the firm's wage, w^f, and the unemployment benefits, b:

$$w = \varrho w^{f} + (1-\varrho)b,$$

with ϱ denoting the bargaining power of the employment agency. Intuitively, the higher the employment agency's bargaining power, ϱ, the higher the wage w that it receives from the HR firm. Imposing the Hosios condition $\varrho = \zeta$, we obtain

$$\tilde{f}_{i,t} = \frac{1-(1-\theta^{w})\zeta}{\zeta}\frac{w^{f}}{w^{f}-b}\widetilde{w}^{f}_{i,t}. \tag{C.4}$$

This equation describes a positive relationship between the real wage paid by firms and changes in labor market tightness, as a function of parameters describing the labor market, such as the bargaining power of the employment agencies (workers), ϱ, real wage rigidities, w, and unemployment benefits, b. Intuitively, a fall in the wage paid by firms to HR firms lowers the HR firms' profits and their value of having a filled vacancy. Hence, HR firms will leave the markets and fewer vacancies will be created. A key lesson from this equation is that a high real wage rigidity / high unemployment benefits raise the sensitivity of labor market tightness to fluctuations in the real firm wage. The fall in profits is particularly strong if the HR firm cannot pass-through the wage drop to the employment agency, that is if wages are rigid. Similarly, high unemployment benefits reduce the steady-state difference between the firm wage w^f and the wage w. A given fall in w^f by \$x then translates into a larger *percent* reduction in the gap between w^f and w.

Matching Function. We now discuss how changes in labor market tightness relate to changes in employment. The law of motion for the number of employed workers is given by

$$\mathbb{N}_{i,t}L_{i,t} = (1-d)\mathbb{N}_{i,t-1}L_{i,t-1} + \mathbb{N}_{i,t}M_{i,t},$$

where d is the separation rate. So the number of employed at t equals the number of employed at $t-1$, less those that got separated plus new matches. Starting from a steady state, $\Delta\left(\mathbb{N}L\right)_{i,t-1} = 0$ and the change in the number of employed equals the number of matches:

$$\Delta\left(\mathbb{N}L\right)_{i,t} = \Delta\left(\mathbb{N}M\right)_{i,t}.$$

The number of matches is determined by the matching function:

$$\left(\mathbb{N}M\right)_{i,t} = \bar{m}\left(\mathbb{N}H\right)_{i,t}\lambda_{i,t}^{1-\zeta},$$

where $\lambda = \frac{V}{H}$ is the ratio of vacancies to job hunters (labor market tightness) and ζ is the matching weight on the number of job hunters. The number of job hunters is given by its law of motion:

$$\mathbb{N}_{i,t}H_{i,t} = \mathbb{N}_{i,t-1}U_{i,t-1} + d\mathbb{N}_{i,t-1}L_{i,t-1} + \mathbb{N}_{i,t} - \mathbb{N}_{i,t-1}$$

which in deviations from steady state simplies to $\Delta\left(\mathbb{N}H\right)_{i,t} = \Delta\mathbb{N}_{i,t}$, i.e. changes in the number of job hunters move one-to-one with population changes. Inserting this into the log-linearized number of matches and log-linearizing yields

$$\Delta\left(\mathbb{N}L\right)_{i,t} = \Delta\left(\mathbb{N}M\right)_{i,t} = \frac{M}{H}\Delta\mathbb{N}_{i,t} + (1-\zeta)M\tilde{\lambda}_{i,t}$$

Notice that $\frac{M}{H} = f$ is just the job finding rate. Then, we can solve this expression to obtain a very intuitive equation linking changes in employment to changes in the job finding rate and changes in population:

$$\Delta\left(\mathbb{N}L\right)_{i,t} = M\tilde{f}_{i,t} + f\Delta\mathbb{N}_{i,t}.$$

Replacing the job finding rate by equation (C.4) gives

$$\Delta\left(\mathbb{N}L\right)_{i,t} = M\frac{1-(1-\theta^w)\zeta}{\zeta}\frac{w^f}{w^f-b}\widetilde{w}^f_{i,t} + f\Delta\mathbb{N}_{i,t}. \tag{C.5}$$

This function describes the supply of matched function as a positive relationship between employment and the wage paid by firms. A decrease in the wage paid by firms reduces the number of posted vacancies and therefore employment. This supply curve is shifted by changes in population. We next endogenize these changes in population.

C.2.2 Households' Location Choice

We next derive a relationship between net migration, $\Delta\mathbb{N}_{i,t}$, and changes in the firm's wage, $\tilde{w}^f_{i,t}$. In our symmetric two-country model, migration, that is the change in population, $\Delta\mathbb{N}_{i,t}$, is given by

$$\Delta\mathbb{N}_{i,t} = n^1_i\tilde{n}^1_{i,t} + n^2_i\tilde{n}^2_{i,t}.$$

Let us focus on country 1 that receives the shock, $i = 1$, and let us define $n^1_i = n$. Then, $1-n$ is the share of migrants. The migration shares always have to sum up, i.e. $\sum_j n^i_j\tilde{n}^i_{j,t} = 0.$, or: $n\tilde{n}^1_{1,t} = -(1-n)\tilde{n}^1_{2,t}$. Similarly, $n\tilde{n}^2_{2,t} = -(1-n)\tilde{n}^2_{1,t}$. Then, the population change in country $i = 1$ is

$$\Delta\mathbb{N}_{1,t} = -(1-n)\tilde{n}^1_{2,t} + (1-n)\tilde{n}^2_{1,t}.$$

Since countries are symmetric and this shock keeps world resources constant, country 2's response is the mirror image of country 1's response, i.e. $\tilde{n}^2_{1,t} = -\tilde{n}^1_{2,t}$. Then we have

$$\Delta\mathbb{N}_{i,t} = -2(1-n)\tilde{n}^i_{j,t}.$$

The household's first-order condition for the location choice is given by

$$\frac{1}{\gamma u_{1,i}^{i}}\tilde{n}_{j,t}^{i} = w_j^h l_j^i \widetilde{w}_{j,t}^h - w_i^h l_i^i \widetilde{w}_{i,t}^h \qquad \text{for} \quad i \neq j.$$

Normalizing $u_{1,i}^i = 1$ and exploiting the symmetry of the two countries, $\widetilde{w}_{i,t}^h = -\widetilde{w}_{j,t}^h$, we obtain

$$\frac{1}{\gamma}\tilde{n}_{j,t}^{i} = -2w^h \widetilde{w}_{i,t}^h \qquad \text{for} \quad i \neq j.$$

Then, the population changes according to

$$\Delta\mathbb{N}_{i,t} = 4(1-n)\gamma w^h \widetilde{w}_{i,t}^h.$$

Defining $\gamma' = 4(1-n)\gamma$, we have

$$\Delta\mathbb{N}_{i,t} = \gamma' w^h \widetilde{w}_{i,t}^h,$$

so the population is increasing in countries that observe an increase in the household wage.

Relationship between the household wage and the firm wage. We first connect the firm's wage, w^f, to the household's wage using the zero profit condition for employment agencies. The profit from hiring a job hunter is the probability of matching him, f, times the value of a matched worker, $\mathcal{E}$, plus the probability of not matching times the unemployment benefit net of the wage paid to the worker, $b - w^h$: $f_{i,t}\mathcal{E}_{i,t} + (1-f_{i,t})\left(w_{i,t}^h - b_i\right)$. This term has to be zero in equilibrium. This zero-profit condition in log-linearized form is:

$$f_i \mathcal{E}_i \tilde{\mathcal{E}}_{i,t} = (1-f)w^h \widetilde{w}_{i,t}^h - (w^h - b + \mathcal{E})\tilde{f}_{i,t}.$$

Intuitively, if the value of having an employed worker falls, employment agencies leave the market until the chances of finding a job for a worker rises sufficiently, or the wage paid to the household falls sufficiently to offset the lower value of having an employed worker. The value of having an employed worker, $\mathcal{E}$, is given by (C.2). Inserting this expression yields

$$fw\widetilde{w}_{i,t} = w^h \widetilde{w}_{i,t}^h - (w^h - b + \mathcal{E})\tilde{f}_{i,t}.$$

We can get [5]

$$w^h \widetilde{w}^h_{i,t} = [1-(1-f)(1-\theta^w)\zeta]\, w^f \widetilde{w}^f_{i,t}.$$

So there is a fairly simple relationship between the household wage and the firm wage. As long as $\theta^w < 1$ and $f < 1$, the household wage fluctuates less than the firm wage. If wages are rather flexible (θ_w close to 0), the job finding rate f is low, and/or the bargaining power for the employment agencies is high (ζ close to 1) then the household wage is particularly stable compared to the firm wage.

Given the relationship between the household wage and the firm wage, we have the following equation relating migration to the firm wage:

$$\Delta \mathbb{N}_{i,t} = \gamma' [1-(1-f)(1-\theta^w)\zeta]\, w^f \widetilde{w}^f_{i,t}. \tag{C.6}$$

C.2.3 Supply of Matched Workers

Inserting (C.6) into the supply curve (C.5) gives

$$\Delta (\mathbb{N}L)_{i,t} = M \frac{1-(1-\theta^w)\zeta}{\zeta} \frac{w^f}{w^f - b} \widetilde{w}^f_{i,t} + f\gamma' [1-(1-f)(1-\theta^w)\zeta]\, w^f \widetilde{w}^f_{i,t}$$

C.3 Demand for Matched Workers

Demand for matched workers is described by the Phillips curve. This Phillips curve is shifted through changes in inflation and the real exchange rate. The reaction of inflation is described by the monetary policy block, and the real exchange rates results from the equilibrium in the intermediate goods' market (trade equilibrium) and the budget constraint (financial market equilibrium).

[5] We replace $w\widetilde{w}_{i,t}$ using equation (C.3) and exploit that in steady state, $\varrho \mathcal{J} = (1-\varrho)(\mathcal{E} - b + w^h)$. Using the Hosios condition ($\varrho = \zeta$), this yields

$$(1-\theta^w) f \zeta w^f \widetilde{w}^f_{i,t} = w^h \widetilde{w}^h_{i,t} - \frac{\zeta}{1-\zeta} \mathcal{J} \tilde{f}_{i,t}$$

Replacing the job finding rate using (C.4), we obtain

$$\begin{aligned} (1-\theta^w) f \zeta w^f \widetilde{w}^f_{i,t} &= w^h \widetilde{w}^h_{i,t} - [1-(1-\theta^w)\zeta]\, w^f \widetilde{w}^f_{i,t} \\ w^h \widetilde{w}^h_{i,t} &= [1-(1-f)(1-\theta^w)\zeta]\, w^f \widetilde{w}^f_{i,t}. \end{aligned}$$

C.3.1 Phillips Curve

The Phillips curve relationship is described by

$$\tilde{\pi}^p_{i,t} = \xi \left(\widetilde{mc}_{i,t} - \widetilde{\left(\frac{p_{i,t}}{P_{i,t}} \right)} \right) + \beta \tilde{\pi}^p_{i,t+1},$$

where $\xi = \frac{(1-\theta_p)(1-\theta_p\beta)}{\theta_p}$ measures the degree of price stickiness, $\tilde{\pi}^p_{i,t}$ is inflation of the intermediate good, $\tilde{\pi}^p_{i,t} = \tilde{p}_{i,t} - \tilde{p}_{i,t-1}$, and $\widetilde{mc}_{i,t}$ is the deviations from steady-state in real marginal costs:

$$\widetilde{mc}_{i,t} = \alpha \tilde{r}^k_{i,t} + (1-\alpha)\widetilde{w}^f_{i,t}.$$

We can replace the marginal cost expression using the optimal factor employment condition. Firms optimally choose the ratio of employed workers, $\mathbb{N}_{i,t}L_{i,t}$, to capital, $K_{i,t-1}\mathbb{N}_{i,t-1}$, according to the ratio of factor prices:

$$\frac{\alpha}{1-\alpha}\frac{W^f_{i,t}}{R^k_{i,t}} = \frac{\mathbb{N}_{i,t-1}K_{i,t-1}}{\mathbb{N}_{i,t}L_{i,t}},$$

which can be log-linearized to

$$\tilde{r}^k_{i,t} - \widetilde{w}^f_{i,t} = \tilde{\mathbb{N}}_{i,t} + \tilde{L}_{i,t}.$$

Using the production function, $\tilde{\mathbb{N}}_{i,t} + \tilde{Q}_{i,t} = (1-\alpha)\left(\tilde{\mathbb{N}}_{i,t} + \tilde{L}_{i,t}\right)$, this implies that[6]

$$\widetilde{mc}_{i,t} = \alpha\widetilde{(\mathbb{N}L)}_{i,t} + \widetilde{w}^f_{i,t}..$$

Inserting this expression back into the Phillips curve yields the labor demand curve:

$$\widetilde{w}^f_{i,t} = -\alpha\widetilde{(\mathbb{N}L)}_{i,t} + \frac{1}{\xi}\tilde{\pi}^p_{i,t} + \widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)}. \tag{C.7}$$

[6]

$$\begin{aligned} \widetilde{mc}_{i,t} &= \alpha \tilde{r}^k_{i,t} + (1-\alpha)\widetilde{w}^f_{i,t} \\ &= \alpha\left(\tilde{\mathbb{N}}_{i,t} + \tilde{L}_{i,t} + \widetilde{w}^f_{i,t}\right) + (1-\alpha)\widetilde{w}^f_{i,t} \\ &= \alpha\left(\tilde{\mathbb{N}}_{i,t} + \tilde{L}_{i,t}\right) + \widetilde{w}^f_{i,t}. \end{aligned}$$

This demand curve for matched workers is shifted by changes in inflation and the real price of the intermediate good:

C.3.2 Monetary Policy

With fixed exchange rates, monetary policy is described by:

$$\Delta i_{i,t} = \phi_i \Delta i_{i,t-1} + (1-\phi_i) \sum_{j \in CU} weight_j \left(\phi_Q \widetilde{Q}_{j,t} + \phi_\pi \tilde{\pi}_{j,t} \right) \qquad \text{for leader}$$

$$(\tilde{s}_{j,t} - \tilde{s}_{j,t-1}) - \tilde{\pi}_{j,t} = (\tilde{s}_{i,t} - \tilde{s}_{i,t-1}) - \tilde{\pi}_{i,t} \qquad \text{for follower.}$$

The condition for the follower guarantees that the nominal exchange rate between the two countries does not change. Since we consider a purely distributive shock that leaves aggregate output and inflation unchanged, the nominal interest rate does not change. Also, since countries are of equal size and symmetric, it must be that $\tilde{\pi}_{j,t} = -\tilde{\pi}_{i,t}$ and $\tilde{s}_{j,t} = -\tilde{s}_{i,t}$. This implies that the real exchange rate between the two countries fluctuates one-to-one with inflation differentials. Monetary policy is therefore described by

$$\Delta i_{i,t} = 0$$

$$\tilde{s}_{i,t} = \tilde{\pi}_{i,t} = \tilde{\pi}^p_{i,t} - \widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)}. \tag{C.8}$$

C.3.3 Trade Market Equilibrium.

Relationship between real exchange rate and terms of trade We start by deriving the relationship between the real exchange rate and the terms of trade. Country i's demand for intermediate goods produced in j is described by:

$$\psi_y \left(\widetilde{\left(\frac{p_{j,t}}{P_{j,t}}\right)} + \tilde{s}_{j,t} - \tilde{s}_{i,t} \right) = \tilde{Y}_{i,t} + \left(\varepsilon^j_t - \sum_k \bar{\omega}^k_i \varepsilon^k_t \right) - \tilde{y}^j_{i,t} \quad \forall j$$

The left hand side describes the real price of intermediate good j in terms of i's final good, which is composed of the real price in terms of j's final good, $\frac{p_j}{P_j}$, and the bilateral real exchange rate, $\frac{s_j}{s_i}$. Changes in this price translate into changes in demand, especially if the trade elasticity ψ_y is high. The right hand side is composed of country i's demand for intermediate good j, y^j_i, and two demand shifters: its domestic absorption, Y_i, and "preference shocks",

ε_i. We consider a shock $\varepsilon_t^i < 0$ and $\varepsilon_t^j = 0$. Given how we set up the variable Armington weights, this is a purely distributive shock that leaves the aggregate variables unchanged. Since we consider two symmetric countries of equal size, variables indexed by j have generally the opposite sign as those indexed by i, i.e. $\tilde{s}_{j,t} = -\tilde{s}_{i,t}$, $\widetilde{\left(\frac{p_{j,t}}{P_{j,t}}\right)} = -\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)}$, $\tilde{y}_{i,t}^j = -\tilde{y}_{j,t}^i$ and $\tilde{y}_{i,t}^i = -\tilde{y}_{j,t}^j$. We denote by $1-\omega$ the steady-state share of imported intermediate goods in all intermediate goods used for the production of the final good. Then, we obtain

$$\tilde{y}_{i,t}^j = \psi_y \left(\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} + 2\tilde{s}_{i,t} \right) + \tilde{Y}_{i,t} - \omega \varepsilon_t^i$$

$$\tilde{y}_{i,t}^i = -\psi_y \widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} + \tilde{Y}_{i,t} + (1-\omega)\varepsilon_t^i$$

A negative preference shock for its own good raises the demand for imports, but lowers demand for the domestically-produced good, all else being equal. The final good, Y_i, itself is produced using these intermedaite goods. Its production function in log-linearized form is

$$\tilde{Y}_{i,t} = \sum_{j=1}^{\mathcal{N}} \bar{\omega}_i^j \left(\tilde{y}_{i,t}^j + \frac{1}{\psi_y - 1} \left(\varepsilon_t^j - \sum_k \bar{\omega}_i^k \varepsilon_t^k \right) \right)$$

This simplifies to

$$\tilde{Y}_{i,t} = \omega \left(\tilde{y}_{i,t}^i + \frac{1}{\psi_y - 1}(1-\omega)\varepsilon_t^i \right) + (1-\omega) \left(\tilde{y}_{i,t}^j - \frac{1}{\psi_y - 1}\omega\varepsilon_t^i \right) = \omega \tilde{y}_{i,t}^i + (1-\omega)\tilde{y}_{i,t}^j.$$

Then, inserting our expressions for $\tilde{y}_{i,t}^i$ and $\tilde{y}_{i,t}^j$, we obtain[7]

$$\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} = \frac{1-\omega}{\omega - \frac{1}{2}} \tilde{s}_{i,t}. \tag{C.9}$$

[7]

$$\begin{aligned} \tilde{Y}_{i,t} &= \omega \tilde{y}_{i,t}^i + (1-\omega)\tilde{y}_{i,t}^j \\ &= \omega \left(-\psi_y \widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} + \tilde{Y}_{i,t} + (1-\omega)\varepsilon_t^i \right) + (1-\omega) \left(\psi_y \left(\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} + 2\tilde{s}_{i,t} \right) + \tilde{Y}_{i,t} - \omega\varepsilon_t^i \right) \\ 0 &= (1-2\omega) \widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} + 2(1-\omega)\tilde{s}_{i,t} \\ \widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} &= -\frac{2-2\omega}{1-2\omega} \tilde{s}_{i,t}. \end{aligned}$$

There is therefore a simple relationship between the terms of trade and the real exchange rate. Consider the case with some home bias, that is $\omega > \frac{1}{2}$. Then, the terms of trade and the real exchange rate are positively connected. Intuitively, as the price of country i's domestic intermediate good goes up (i.e. a terms of trade improvement), the price of final good i goes up by more than the price of the final good produced by country j because of the home bias. This increase of the final good price in i relative to j is equivalent to saying that i's real exchange rate appreciates.

C.3.4 Financial Market Equilibrium

As in our large-scale model we assume incomplete markets. The budget constraint states that the current account equals net exports, net primary income from abroad and current transfers. Our one-period model is not useful for understanding how migration affects intertemporal decision. We are still interested in how changes in the current account or net exports shift the demand for matched workers. We therefore start from the definition of net exports

Net exports is equal to the value of production less the value of final goods:

$$NX_{i,t} = \mathbb{N}_{i,t} p_{i,t} Q_{i,t} - \mathbb{N}_{i,t} P_{i,t} Y_{i,t}$$

Log-linearizing yields

$$\Delta NX_{i,t} = \widetilde{\frac{p_{i,t}}{P_{i,t}}} + \widetilde{Q}_{i,t} - \widetilde{Y}_{i,t}.$$

We next replace Y by Q using the market clearing for intermediate goods

$$\mathbb{N}_{i,t} Q_{i,t} = \sum_{j=1}^{\mathcal{N}} \mathbb{N}_{j,t} y^i_{j,t}$$

$$\left(\tilde{\mathbb{N}}_{i,t} + \tilde{Q}_{i,t}\right) = \sum_{j=1}^{\mathcal{N}} \bar{\omega}^j_i \left(\tilde{\mathbb{N}}_{j,t} + \tilde{y}^i_{j,t}\right)$$

Given our symmetry assumptions, this simplifies to[8]

$$\tilde{Q}_{i,t} = \omega \tilde{y}^i_{i,t} - (1-\omega)\tilde{y}^j_{i,t} - 2(1-\omega)\tilde{\mathbb{N}}_{i,t}.$$

We can use the FOC with respect to y^j_i and y^i_i to get[9]

$$\tilde{Y}_{i,t} = \frac{1}{2\omega-1}\tilde{Q}_{i,t} + \frac{1-\omega}{\omega-\frac{1}{2}}\left(\tilde{\mathbb{N}}_{i,t} - \omega\epsilon^i_t\right) + \frac{\omega\psi_y}{\omega-\frac{1}{2}}\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)}.$$

Assuming some home bias, $\omega > \frac{1}{2}$, demand for the intermediate good i, Q_i, is increasing in country i's domestic absorption, Y_i, increasing in trade preference shocks for country i, ϵ^i, and decreasing in its price $\frac{p_i}{P_i}$. Immigration has the same effect as a negative trade preference shock and lowers *per capita* production of the intermediate good.[10]

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[8]

$$\begin{aligned}
\tilde{\mathbb{N}}_{i,t} + \tilde{Q}_{i,t} &= \omega\left(\tilde{\mathbb{N}}_{i,t} + \tilde{y}^i_{i,t}\right) + (1-\omega)\left(\tilde{\mathbb{N}}_{j,t} + \tilde{y}^i_{j,t}\right) \\
&= \omega\left(\tilde{\mathbb{N}}_{i,t} + \tilde{y}^i_{i,t}\right) - (1-\omega)\left(\tilde{\mathbb{N}}_{i,t} + \tilde{y}^j_{i,t}\right)
\end{aligned}$$

[9]

$$\begin{aligned}
\tilde{Q}_{i,t} &= \omega\left(-\psi_y\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} + \tilde{Y}_{i,t} + (1-\omega)\varepsilon^i_t\right) - (1-\omega)\left(\psi_y\left(\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} + 2\tilde{s}_{i,t}\right) + \tilde{Y}_{i,t} - \omega\varepsilon^i_t\right) - 2(1-\omega)\tilde{\mathbb{N}}_{i,t} \\
&= (2\omega-1)\tilde{Y}_{i,t} - \omega\psi_y\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} - (1-\omega)\psi_y\left(\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} + 2\tilde{s}_{i,t}\right) + 2\omega(1-\omega)\epsilon^i_t - 2(1-\omega)\tilde{\mathbb{N}}_{i,t} \\
&= (2\omega-1)\tilde{Y}_{i,t} - \omega\psi_y\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} - (1-\omega)\psi_y\left(\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} + \frac{2\omega-1}{1-\omega}\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)}\right) + 2\omega(1-\omega)\epsilon^i_t - 2(1-\omega)\tilde{\mathbb{N}}_{i,t} \\
&= (2\omega-1)\tilde{Y}_{i,t} - 2\omega\psi_y\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} + 2\omega(1-\omega)\epsilon^i_t - 2(1-\omega)\tilde{\mathbb{N}}_{i,t}
\end{aligned}$$

[10] Although net immigration raises demand for the intermediate product because immigrants will switch their consumption from their home country's basket to their host country's basket, this increase in demand is more than offset by the increase in population, especially if the home bias is small. Replacing the terms of trade, $\frac{p_i}{P_i}$, by the real exchange rate, s_i, using $\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} = \frac{1-\omega}{\omega-\frac{1}{2}}\tilde{s}_{i,t}$, we observe that an increase in net immigration by 1 percent of a country's population has the same effect as a real exchange rate appreciation by $\frac{\omega-\frac{1}{2}}{\omega\psi_y}$ percent.

Inserting this into our net export definition above and doing some algebra gives[11]

$$\tilde{Q}_{i,t} + \tilde{\mathbb{N}}_{i,t} = \omega\epsilon_t^i + \left(1 - \frac{\omega\psi_y}{\omega - \frac{1}{2}}\right)\tilde{s}_{i,t} + \frac{\omega - \frac{1}{2}}{1-\omega}\Delta NX_{i,t}.$$

We can rewrite the LHS using the production function of the intermediate good, $\tilde{\mathbb{N}}_{i,t} + \tilde{Q}_{i,t} = (1-\alpha)\left(\tilde{\mathbb{N}}_{i,t} + \tilde{L}_{i,t}\right)$,

$$(1-\alpha)\widetilde{(\mathbb{N}L)}_{i,t} = \omega\epsilon_t^i + \left(1 - \frac{\omega\psi_y}{\omega - \frac{1}{2}}\right)\tilde{s}_{i,t} + \frac{\omega - \frac{1}{2}}{1-\omega}\Delta NX_{i,t}. \tag{C.10}$$

C.3.5 Demand for Matched Workers

The demand block is described by the following four equations:

- Phillips curve (C.7)

$$\widetilde{w}_{i,t}^f = -\alpha\widetilde{(\mathbb{N}L)}_{i,t} + \frac{1}{\xi}\tilde{\pi}_{i,t}^p + \widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)}.$$

- Monetary policy (C.8)

$$\tilde{s}_{i,t} = \tilde{\pi}_{i,t} = \tilde{\pi}_{i,t}^p - \widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)}.$$

- Trade equilibrium (C.9)

$$\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} = \frac{1-\omega}{\omega - \frac{1}{2}}\tilde{s}_{i,t}$$

- Financial market equilibrium (C.10)

$$(1-\alpha)\widetilde{(\mathbb{N}L)}_{i,t} = \omega\epsilon_t^i + \left(1 - \frac{\omega\psi_y}{\omega - \frac{1}{2}}\right)\tilde{s}_{i,t} + \frac{\omega - \frac{1}{2}}{1-\omega}\Delta NX_{i,t}.$$

[11]

$$\begin{aligned}
\widetilde{\frac{p_{i,t}}{P_{i,t}}} + \tilde{Q}_{i,t} &= \frac{1}{2\omega - 1}\tilde{Q}_{i,t} + \frac{1-\omega}{\omega - \frac{1}{2}}\left(\tilde{\mathbb{N}}_{i,t} - \omega\epsilon_t^i\right) + \frac{\omega\psi_y}{\omega - \frac{1}{2}}\widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)} + \Delta NX_{i,t} \\
\Delta NX_{i,t} &= \frac{1-\omega}{\omega - \frac{1}{2}}\left(\tilde{Q}_{i,t} + \tilde{\mathbb{N}}_{i,t} - \omega\epsilon_t^i\right) + \frac{\omega(\psi_y - 1) + \frac{1}{2}}{\omega - \frac{1}{2}}\widetilde{\frac{p_{i,t}}{P_{i,t}}} \\
\tilde{Q}_{i,t} + \tilde{\mathbb{N}}_{i,t} &= \omega\epsilon_t^i - \frac{\omega(\psi_y - 1) + \frac{1}{2}}{1-\omega}\widetilde{\frac{p_{i,t}}{P_{i,t}}} + \frac{\omega - \frac{1}{2}}{1-\omega}\Delta NX_{i,t} \\
&= \omega\epsilon_t^i + \frac{\omega - \frac{1}{2} - \omega\psi_y}{\omega - \frac{1}{2}}\tilde{s}_{i,t} + \frac{\omega - \frac{1}{2}}{1-\omega}\Delta NX_{i,t}.
\end{aligned}$$

Inserting the second and third equations into the first equation yields[12]

$$\widetilde{w}^f_{i,t} = -\alpha\widetilde{(\mathbb{N}L)}_{i,t} + \frac{\frac{1}{2\xi} + 1 - \omega}{\omega - \frac{1}{2}}\tilde{s}_{i,t}$$

We can replace the real exchange rate using the equation describing the financial market equilibrium:[13]

$$\widetilde{w}^f_{i,t} = -\left(\alpha + (1-\alpha)\frac{\frac{1}{2\xi} + 1 - \omega}{\frac{1}{2} + \psi_y\omega - \omega}\right)\widetilde{(\mathbb{N}L)}_{i,t} + \frac{\frac{1}{2\xi} + 1 - \omega}{\frac{1}{2} + \psi_y\omega - \omega}\left(\omega\epsilon^i_t + \frac{\omega - \frac{1}{2}}{1-\omega}\Delta NX_{i,t}\right). \quad \text{(C.11)}$$

The labor demand curve describes a negative relationship between the firm's wage and employment. Negative preference shocks or net imports shift the labor demand curve inwards.[14]

C.4 Summary and Discussion

We now discuss the effect of migration on unemployment rates. Recall that we can rewrite the change in the unemployment rate as (see equation (C.1)):

$$\Delta ur_{i,t} = -\Delta\left(\mathbb{N}L\right)_{i,t} + (1-ur)\Delta\mathbb{N}_{i,t}. \quad \text{(C.12)}$$

[12]

$$\widetilde{w}^f_{i,t} = -\alpha\widetilde{(\mathbb{N}L)}_{i,t} + \frac{1}{\xi}\left(\tilde{s}_{i,t} + \widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)}\right) + \widetilde{\left(\frac{p_{i,t}}{P_{i,t}}\right)}$$
$$\widetilde{w}^f_{i,t} = -\alpha\widetilde{(\mathbb{N}L)}_{i,t} + \left\{\frac{1}{\xi}\left(1 + \frac{1-\omega}{\omega - \frac{1}{2}}\right) + \frac{1-\omega}{\omega - \frac{1}{2}}\right\}\tilde{s}_{i,t}$$

[13]Rewriting (C.10)

$$\left(1 - \frac{\omega\psi_y}{\omega - \frac{1}{2}}\right)\tilde{s}_{i,t} = (1-\alpha)\widetilde{(\mathbb{N}L)}_{i,t} - \omega\epsilon^i_t - \frac{\omega - \frac{1}{2}}{1-\omega}\Delta NX_{i,t}$$
$$\frac{\frac{1}{2} - \omega(1-\psi_y)}{\omega - \frac{1}{2}}\tilde{s}_{i,t} = -(1-\alpha)\widetilde{(\mathbb{N}L)}_{i,t} + \omega\epsilon^i_t + \frac{\omega - \frac{1}{2}}{1-\omega}\Delta NX_{i,t}.$$

Inserting this to replace the real exchange rate:

$$\widetilde{w}^f_{i,t} = -\alpha\widetilde{(\mathbb{N}L)}_{i,t} + \frac{\frac{1}{2\xi} + 1 - \omega}{\frac{1}{2} + \psi_y\omega - \omega}\left(-(1-\alpha)\widetilde{(\mathbb{N}L)}_{i,t} + \omega\epsilon^i_t + \Delta NX_{i,t}\right)$$

[14]As long as $\psi_y > 1 - \frac{1}{2\omega}$, which is satisfied unless the trade elasticity is close to 0.

In a model without migration and a constant labor force, a decrease in employment translates one-for-one into an increase in unemployment. Similarly, in-migration also raises the unemployment rate. Equation (C.12) is illustrated in the lower panel of Figure A6a, with the unemployment rate ur on the y-axis and total employment $\mathbb{N}L$ on the x-axis. The upper panel of Figure A6a illustrates the market for the employed, that is the market for *matched* workers, by plotting both the demand and supply curve, with the wage w^f on the y-axis and total employment $\mathbb{N}L$ on the x-axis.

As laid in equation (C.11), the demand for matched workers describes a negative relationship between this wage and the total number of matched workers, $(\mathbb{N}L)_{i,t}$. Here, we reproduce this labor demand curve for the special case where production has constant returns to scale in labor ($\alpha = 0$):

$$\widetilde{w}^f_{i,t} = -\frac{\frac{\theta^{p'}}{2} + 1 - \omega}{\frac{1}{2} + \psi_y \omega - \omega} \left(\frac{\Delta\left(\mathbb{N}L\right)_{i,t}}{1 - ur} - \omega \epsilon^i_t - \frac{\omega - \frac{1}{2}}{1 - \omega} \Delta N X_{i,t} \right), \tag{C.13}$$

where $\theta^{p'} = \frac{\theta_p}{(1-\theta_p)(1-\theta_p\beta)}$ measures the degree of price stickiness. Negative terms-of-trade shocks ($\epsilon < 0$) shift this demand curve inwards, as illustrated by the dashed line in Figure A6a. Net imports have a similar effect because they remove demand from the domestic economy.[15] In a neoclassical, closed economy $\theta^{p'} = 0, \omega = 1$, the slope of the labor demand curve is zero, which reflects our assumption of constant returns to scale in labor. Moving away from this benchmark, the demand for labor becomes less elastic because both price stickiness and openness lower the elasticity of demand for the traded intermediate goods produced by labor, as long as the trade elasticity, ψ_y, is finite.

The labor supply curve is given by equation (C.5):

$$\widetilde{w}^f_{i,t} = \frac{1}{M} \frac{\zeta}{1 - (1 - \theta^w)\zeta} \frac{w^f - b}{w^f} \left(\Delta\left(\mathbb{N}L\right)_{i,t} - f \Delta \mathbb{N}_{i,t} \right), \tag{C.14}$$

Consider first the case without wage rigidity, $\theta^w = 0$, equal bargaining power of employment agencies and HR firms, $\zeta = .5$, no unemployment, $b = 0$, and no migration, $\Delta\mathbb{N}_{i,t} = 0$. In that case, $\widetilde{w}^f_{i,t} = \frac{1}{M}\Delta\left(\mathbb{N}L\right)_{i,t} = \frac{1}{d}\left(\mathbb{N}L\right)_{i,t}$, that is a percent increase in the firm's wage raises

[15] Notice that the household's budget constraint requires a zero current account in this one-period model, but, in contrast to the standard open economy model, the current account reflects not only net exports, but also net primary income flows in form of "remittances" from migrants. That is, net exports are not necessarily zero even in the one-period model. While we could solve for net exports as a function of the underlying shock, this relationship is unlikely to hold in a multi-period setting, where net exports very much reflect inter-temporal choices.

employment by d percent. This value is typically low ($d \leq 0.10$ in most calibrations), resulting in a "steep" labor supply curve. Consequently, the search-and-matching framework initially received criticism that it does not generate sufficient volatility in unemployment rates over the business cycles unless shocks of implausibly large magnitude were assumed (Shimer, 2005).

Subsequent studies have adressed the "Shimer puzzle" by noting that wage rigidity $\theta^w > 0$, unemployment benefits $b > 0$, and a low bargaining power for workers can substantially raise the elasticity of (un)employment to shocks, effectively flattening the labor supply curve. For example, Hall (2005) chooses a model with perfectly rigid real wages ($\theta^w = 1$), whereas Hagedorn and Manovskii (2008) argue for a calibration that sets the worker's bargaining power to 0.05 and the replacement value to $b = 0.95w$. In both cases, the models generate unemployment fluctuations consistent with the data.[16]

In our model, migration plays a similar role, but there are important differences. From the first-order condition for households' optimal location choice, we know that population positively co-moves with wages (see equation (C.6)): Wage increases attract migrants. This raises the elasticity of aggregate employment to shocks, leading to a flatter labor supply curve, denoted by $L^{s'}$ in Figure A6a. Intuitively, migration makes labor supply more elastic, similar to a high Frisch elasticity of labor supply in a plain-vanilla RBC model. As a consequence of migration, the equilibrium in the labor market resulting from a negative terms-of-trade shock features a higher wage and less employment, compared to an environment without migration (compare point C vs. B). Moving to the lower panel that depicts equation (C.12), we see that the negative terms-of-trade shock gives rise to unemployment by lowering employment (point b). Although the envrionment with migration features fewer employed workers, outmigration sufficiently reduces the labor force to dampen the rise in unemployment rate (compare point c vs. b). Outmigration out of the depressed country therefore improves the outcome of stayers by reducing their unemployment rate. These positive spillovers on stayers have recently been discussed by Farhi and Werning (2014).

Our analysis suggests that the magnitude of these spillovers depend on several parameters that pin down the slopes of the labor demand and supply curves. Graphically speaking, migration is an effective tool to dampen movements in unemployment rates if the labor demand curve is steep and the labor supply curve is flat, that is demand for matched workers is

[16]Parameter values for our benchmark calibration ($M = 0.056$, $\zeta = 0.72$, $\theta^w = 0.90$ and $b = 0.59w$) imply an elasticity of about 0.2. This is lower than the implied elasticity by Hall (2005) (0.5) and Hagedorn and Manovskii (2008) (23.3).

insensitive, but supply of matched workers is very sensitive to changes in the real wage. This reduces the fall in employment resulting from outmigration because employment is demand- rather than supply-determined. Figure A6b illustrates this case.

On the labor demand side (equation (C.13)), parameter values that are conducive to a low elasticity are a low trade elasticity, trade openness and high price rigidity. These parameter values ensure that demand for workers is rather insensitive to changes in the wage rate. To illustrate the relevance of the slope of the labor demand curve, the left panel of Figure A7 displays the cross-sectional standard deviation for the high labor mobility case as a function of the assumed trade elasticity. For every dot in the figure, we re-estimate the model conditional on the assumed trade elasticity. As we increase the trade elasticity, migration becomes less effective in reducing unemployment differentials across countries. As discussed above, outmigration from a depressed countries pushes wages up and hence the price of the country's produced good will increase. With a high trade elasticity, this increase in the price leads to a stronger fall in demand for the country's produced good, counteracting the benefits of labor mobility on employment.

This result on the interaction of migration and the trade elasticity is different from the finding in Farhi and Werning (2014) that migration out of a depressed region improves the outcome of stayers the more countries trade with each other. In an extreme case, where consumption displays no home bias, demand for a country's good is independent of a household's residence, so that outmigration does not *directly* lower demand for a good's product. This same interaction between trade openness and migration is also present in our model, as shown by the home bias term ω in equation (C.13). Here, we show that migration will also affect factor prices, wages in particular, which, in general equilibrium, will lead to movements labor demanded by firms. This link between wages and labor demanded by firms is governed, among other things, by the trade elasticity.

Moving to the labor supply side (equation (C.14)), we observe that parameter values that have been advocated to solve the "Shimer puzzle" (Hall, 2005; Hagedorn and Manovskii, 2008), i.e. strong wage rigidity, high unemployment benefits and a low bargaining power for workers, make labor supply more elastic and hence, migration more effective. The right panel of Figure A7 shows that a higher wage rigidity makes migration more effective in reducing unemployment differentials. Intuitively, as wages become more rigid, they will go up less in response to outmigration, which will keep prices for the country's produced good low.

In summary, if countries' labor markets are 'demand-determined', fluctuations in the labor force through migration will have little effects on total employment. Outmigration will therefore translate into changes in unemployment rates, rather than changes in the number of employed.

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Table A1a: POPULATION (ANNUAL)

#	Series Name	Source	Unit	Download
(2)	Population	Eurostat: Population on 1 January by age and sex [demo_pjan]	-	02/22/17

Notes: Linking method: growth.

Data sets used by time and country

Belgium: 1960:2016 (2); *Bulgaria*: 1998:2016 (2); *Czech Republic*: 1960:2016 (2); *Denmark*: 1960:2016 (2); *Germany*: 1991:2016 (2); *Estonia*: 1960:2016 (2); *Ireland*: 1960:2016 (2); *Greece*: 1960:2016 (2); *Spain*: 1960:2016 (2); *France*: 1960:2016 (2); *Italy*: 1960:2016 (2); *Cyprus*: 1960:2016 (2); *Latvia*: 1995:2016 (2); *Lithuania*: 1995:2016 (2); *Luxembourg*: 1960:2016 (2); *Hungary*: 1960:2016 (2); *Malta*: 1960:2016 (2); *Netherlands*: 1960:2016 (2); *Austria*: 1960:2016 (2); *Poland*: 1960:2016 (2); *Portugal*: 1960:2016 (2); *Romania*: 1998:2016 (2); *Slovenia*: 1960:2016 (2); *Slovak Republic*: 1960:2016 (2); *Finland*: 1960:2016 (2); *Sweden*: 1960:2016 (2); *United Kingdom*: 1960:2016 (2); *Norway*: 1960:2016 (2); *Switzerland*: 1960:2016 (2); *Iceland*: 1960:2016 (2);

Table A1b: UNEMPLOYMENT RATE (ANNUAL)

#	Series Name	Source	Unit	Download
(2)	Unemployment rate: total :- Member States: definition EUROSTAT (ZUTN)	AMECO: 1.3 Population and Employment: Unemployment	Percent	10/16/17
(3)	Unemployment rate: total	ILOSTAT: Employment office records	Percent	02/25/17

Notes: Linking method: linear.

Data sets used by time and country

Belgium: 1960:2016 (2); *Bulgaria*: 1998:2016 (2); *Czech Republic*: 1993:2016 (2); *Denmark*: 1960:2016 (2); *Germany*: 1991:2016 (2); *Estonia*: 1993:2016 (2); *Ireland*: 1960:2016 (2); *Greece*: 1960:2016 (2); *Spain*: 1960:2016 (2); *France*: 1960:2016 (2); *Italy*: 1960:2016 (2); *Cyprus*: 1992:1996 (3), 1997:2016 (2); *Latvia*: 1995:2016 (2); *Lithuania*: 1995:2016 (2); *Luxembourg*: 1960:2016 (2); *Hungary*: 1995:2016 (2); *Malta*: 1990:2016 (2); *Netherlands*: 1960:2016 (2); *Austria*: 1960:2016 (2); *Poland*: 1992:2016 (2); *Portugal*: 1960:2016 (2); *Romania*: 1998:2016 (2); *Slovenia*: 1995:2016 (2); *Slovak Republic*: 1995:2016 (2); *Finland*: 1960:2016 (2); *Sweden*: 1960:2016 (2); *United Kingdom*: 1960:2016 (2); *Norway*: 1960:2016 (2); *Switzerland*: 1960:2016 (2); *Iceland*: 1960:2016 (2);

Table A1c: EMPLOYMENT (ANNUAL)

#	Series Name	Source	Unit	Download
(1)	Total employment domestic concept	Eurostat: National Accounts ¿ Auxiliary indicators ¿ Population and employment (nama_aux_pem), ESA 2010	Thousand persons	10/15/17
(2)	Total employment domestic concept	Eurostat: National Accounts ¿ Auxiliary indicators ¿ Population and employment (nama_aux_pem), ESA 95	Thousand persons	12/02/16
(3)	Employment, persons: all domestic industries (National accounts) (NETD)	AMECO: 1.2 Population and Employment: Labour force statistics	Thousands	06/26/18

Notes: Linking method: growth.

Data sets used by time and country

Belgium: 1961:2017 (3), 1995:2015 (1); *Bulgaria*: 1998:2015 (1), 2016:2017 (3); *Czech Republic*: 1993:1994 (2), 1995:2015 (1), 2016:2017 (3); *Denmark*: 1961:2017 (3), 1975:2015 (1); *Germany*: 1991:2016 (1), 2017:2017 (3); *Estonia*: 1991:2017 (3), 1995:2015 (1); *Ireland*: 1961:2017 (3), 1998:2015 (1); *Greece*: 1961:2017 (3), 1995:2015 (1); *Spain*: 1961:2017 (3), 1995:2015 (1); *France*: 1960:1974 (2), 1975:2015 (1), 2016:2017 (3); *Italy*: 1961:2017 (3), 1992:1994 (2), 1995:2015 (1); *Cyprus*: 1995:2015 (1), 2016:2017 (3); *Latvia*: 1995:2015 (1), 2016:2017 (3); *Lithuania*: 1995:2015 (1), 2016:2017 (3); *Luxembourg*: 1961:2017 (3), 1995:2015 (1); *Hungary*: 1995:2015 (1), 2016:2017 (3); *Malta*: 1991:2017 (3), 1995:2015 (1); *Netherlands*: 1961:2017 (3), 1995:2016 (1); *Austria*: 1961:2017 (3), 1988:1994 (2), 1995:2015 (1); *Poland*: 1993:2017 (3), 2000:2015 (1); *Portugal*: 1961:2017 (3), 1995:2015 (1); *Romania*: 1998:2015 (1), 2016:2017 (3); *Slovenia*: 1995:2015 (1), 2016:2017 (3); *Slovak Republic*: 1995:2015 (1), 2016:2017 (3); *Finland*: 1961:2017 (3), 1975:1979 (2), 1980:2015 (1); *Sweden*: 1961:2017 (3), 1993:2015 (1); *United Kingdom*: 1961:2017 (3), 1994:1994 (2), 1995:2016 (1); *Norway*: 1961:2017 (3), 1970:1974 (2), 1975:2016 (1); *Switzerland*: 1961:2017 (3), 1995:2015 (1); *Iceland*: 1964:2017 (3);

Table A1d: NOMINAL GDP (ANNUAL)

#	Series Name	Source	Unit	Download
(2)	Gross domestic product at market prices	Eurostat: GDP and main components (output, expenditure and income) [nama_10_gdp], ESA 2010	Million units of national currency	10/14/17
(3)	Gross domestic product - expenditure approach, CARSA	OECD: Quarterly National Accounts	Million units of national currency	10/17/17
(4)	Gross domestic product at market prices	Eurostat: GDP and main components - volumes [nama_gdp_k], ESA 95	Million units of national currency	12/11/15

Notes: Linking method: growth.

Data sets used by time and country

Belgium: 1960:1994 (3), 1995:2016 (2); *Bulgaria*: 1998:2016 (2); *Czech Republic*: 1995:2016 (2); *Denmark*: 1960:1974 (3), 1975:2016 (2); *Germany*: 1991:2016 (2); *Estonia*: 1995:2016 (2); *Ireland*: 1960:1994 (3), 1995:2016 (2); *Greece*: 1960:1994 (3), 1995:2016 (2); *Spain*: 1960:1994 (3), 1995:2016 (2); *France*: 1960:1974 (3), 1975:2016 (2); *Italy*: 1960:1994 (3), 1995:2016 (2); *Cyprus*: 1995:2016 (2); *Latvia*: 1995:2016 (2); *Lithuania*: 1995:2016 (2); *Luxembourg*: 1960:1994 (3), 1995:2016 (2); *Hungary*: 1993:1994 (4), 1995:2016 (2); *Malta*: 1995:2016 (2); *Netherlands*: 1960:1994 (3), 1995:2016 (2); *Austria*: 1960:1994 (3), 1995:2016 (2); *Poland*: 1995:2016 (2); *Portugal*: 1960:1994 (3), 1995:2016 (2); *Romania*: 1998:2016 (2); *Slovenia*: 1992:1994 (4), 1995:2016 (2); *Slovak Republic*: 1992:1992 (4), 1993:1994 (3), 1995:2016 (2); *Finland*: 1960:1979 (3), 1980:2016 (2); *Sweden*: 1960:1992 (3), 1993:2016 (2); *United Kingdom*: 1960:1974 (3), 1975:2016 (2); *Norway*: 1960:1974 (3), 1975:2016 (2); *Switzerland*: 1960:1979 (3), 1980:2016 (2); *Iceland*: 1960:1994 (3), 1995:2016 (2);

Table A1e: REAL GDP (ANNUAL)

#	Series Name	Source	Unit	Download
(2)	Gross domestic product at market prices	Eurostat: GDP and main components (output, expenditure and income) [nama_10_gdp], ESA 2010	Chain linked volumes (2010), million euro	10/14/17
(3)	Gross domestic product - expenditure approach, VPVOBARSA[1]	OECD: Quarterly National Accounts	US Dollar, millions, 2010	10/17/17
(4)	Gross domestic product at market prices	AMECO: 6.1 Gross domestic product at constant prices	Million units of national currency, chain-linked volumes, reference year 2010	10/17/17

Notes: Linking method: growth.
[1] Data has been converted into 2010 million euro using the conversion factor 0.85687.

Data sets used by time and country

Belgium: 1960:1994 (3), 1995:2016 (2); *Bulgaria*: 1998:2016 (2); *Czech Republic*: 1990:1994 (4), 1995:2016 (2); *Denmark*: 1960:1974 (3), 1975:2016 (2); *Germany*: 1991:2016 (2); *Estonia*: 1993:1994 (4), 1995:2016 (2); *Ireland*: 1960:1994 (3), 1995:2016 (2); *Greece*: 1960:1994 (3), 1995:2016 (2); *Spain*: 1960:1994 (3), 1995:2016 (2); *France*: 1960:1974 (3), 1975:2016 (2); *Italy*: 1960:1994 (3), 1995:2016 (2); *Cyprus*: 1990:1994 (4), 1995:2016 (2); *Latvia*: 1995:2016 (2); *Lithuania*: 1995:2016 (2); *Luxembourg*: 1960:1994 (3), 1995:2016 (2); *Hungary*: 1991:1994 (4), 1995:2016 (2); *Malta*: 1991:1999 (4), 2000:2016 (2); *Netherlands*: 1960:1994 (3), 1995:2016 (2); *Austria*: 1960:1994 (3), 1995:2016 (2); *Poland*: 1990:1994 (4), 1995:2016 (2); *Portugal*: 1960:1994 (3), 1995:2016 (2); *Romania*: 1998:2016 (2); *Slovenia*: 1990:1994 (4), 1995:2016 (2); *Slovak Republic*: 1992:1992 (4), 1993:1994 (3), 1995:2016 (2); *Finland*: 1960:1979 (3), 1980:2016 (2); *Sweden*: 1960:1992 (3), 1993:2016 (2); *United Kingdom*: 1960:1974 (3), 1975:2016 (2); *Norway*: 1960:1974 (3), 1975:2016 (2); *Switzerland*: 1960:1979 (3), 1980:2016 (2); *Iceland*: 1960:1994 (3), 1995:2016 (2);

Table A1f: REAL EXPORTS (ANNUAL)

#	Series Name	Source	Unit	Download
(2)	Exports of goods and services	Eurostat: GDP and main components (output, expenditure and income) [nama_10_gdp], ESA 2010	Chain linked volumes (2010), million euro	10/14/17
(3)	Exports of goods and services, VPVOBARSA[1]	OECD: Quarterly National Accounts	US Dollar, millions, 2010	10/17/17
(4)	Exports of goods and services[2]	Eurostat: GDP and main components - Current prices [nama_gdp_c], ESA 95	Million euro, chain-linked volumes, reference year 2005 (at 2005 exchange rates)	12/11/15

Notes: Linking method: growth.
[1] Data has been converted into 2010 million euro using the conversion factor 0.85687.
[2] Data has been converted into 2010 million euro using the conversion factor 1.0854.

Data sets used by time and country

Belgium: 1960:1994 (3), 1995:2016 (2); *Bulgaria*: 1998:2016 (2); *Czech Republic*: 1993:1994 (4), 1995:2016 (2); *Denmark*: 1960:1974 (3), 1975:2016 (2); *Germany*: 1991:2016 (2); *Estonia*: 1993:1994 (4), 1995:2016 (2); *Ireland*: 1960:1994 (3), 1995:2016 (2); *Greece*: 1960:1994 (3), 1995:2016 (2); *Spain*: 1960:1994 (3), 1995:2016 (2); *France*: 1960:1974 (3), 1975:2016 (2); *Italy*: 1960:1994 (3), 1995:2016 (2); *Cyprus*: 1995:2016 (2); *Latvia*: 1995:2016 (2); *Lithuania*: 1995:2016 (2); *Luxembourg*: 1960:1994 (3), 1995:2016 (2); *Hungary*: 1995:2016 (2); *Malta*: 2000:2016 (2); *Netherlands*: 1960:1994 (3), 1995:2016 (2); *Austria*: 1960:1994 (3), 1995:2016 (2); *Poland*: 1995:2016 (2); *Portugal*: 1960:1994 (3), 1995:2016 (2); *Romania*: 1998:2016 (2); *Slovenia*: 1990:1994 (4), 1995:2016 (2); *Slovak Republic*: 1992:1992 (4), 1993:1994 (3), 1995:2016 (2); *Finland*: 1960:1979 (3), 1980:2016 (2); *Sweden*: 1960:1992 (3), 1993:2016 (2); *United Kingdom*: 1960:1994 (3), 1995:2016 (2); *Norway*: 1960:1974 (3), 1975:2016 (2); *Switzerland*: 1960:1979 (3), 1980:2016 (2); *Iceland*: 1960:1994 (3), 1995:2016 (2);

Table A1g: REAL IMPORTS (ANNUAL)

#	Series Name	Source	Unit	Download
(2)	Imports of goods and services	Eurostat: GDP and main components (output, expenditure and income) [nama_10_gdp], ESA 2010	Chain linked volumes (2010), million euro	10/14/17
(3)	Imports of goods and services, VPVOBARSA[1]	OECD: Quarterly National Accounts	US Dollar, millions, 2010	10/17/17
(4)	Imports of goods and services[2]	Eurostat: GDP and main components - Current prices [nama_gdp_c], ESA 95	Million euro, chain-linked volumes, reference year 2005 (at 2005 exchange rates)	12/11/15

Notes: Linking method: growth.
[1] Data has been converted into 2010 million euro using the conversion factor 0.85687.
[2] Data has been converted into 2010 million euro using the conversion factor 1.0854.

Data sets used by time and country

Belgium: 1960:1994 (3), 1995:2016 (2); *Bulgaria*: 1998:2016 (2); *Czech Republic*: 1993:1994 (4), 1995:2016 (2); *Denmark*: 1960:1974 (3), 1975:2016 (2); *Germany*: 1991:2016 (2); *Estonia*: 1993:1994 (4), 1995:2016 (2); *Ireland*: 1960:1994 (3), 1995:2016 (2); *Greece*: 1960:1994 (3), 1995:2016 (2); *Spain*: 1960:1994 (3), 1995:2016 (2); *France*: 1960:1974 (3), 1975:2016 (2); *Italy*: 1960:1994 (3), 1995:2016 (2); *Cyprus*: 1995:2016 (2); *Latvia*: 1995:2016 (2); *Lithuania*: 1995:2016 (2); *Luxembourg*: 1960:1994 (3), 1995:2016 (2); *Hungary*: 1995:2016 (2); *Malta*: 2000:2016 (2); *Netherlands*: 1960:1994 (3), 1995:2016 (2); *Austria*: 1960:1994 (3), 1995:2016 (2); *Poland*: 1995:2016 (2); *Portugal*: 1960:1994 (3), 1995:2016 (2); *Romania*: 1998:2016 (2); *Slovenia*: 1990:1994 (4), 1995:2016 (2); *Slovak Republic*: 1992:1992 (4), 1993:1994 (3), 1995:2016 (2); *Finland*: 1960:1979 (3), 1980:2016 (2); *Sweden*: 1960:1992 (3), 1993:2016 (2); *United Kingdom*: 1960:1994 (3), 1995:2016 (2); *Norway*: 1960:1974 (3), 1975:2016 (2); *Switzerland*: 1960:1979 (3), 1980:2016 (2); *Iceland*: 1960:1994 (3), 1995:2016 (2);

Table A1h: REAL CONSUMPTION (ANNUAL)

#	Series Name	Source	Unit	Download
(2)	Household and NPISH final consumption expenditure	Eurostat: GDP and main components (output, expenditure and income) [nama_10_gdp], ESA 2010	Chain linked volumes (2010), million euro	10/14/17
(3)	Private final consumption expenditure, VPVOBARSA[1]	OECD: Quarterly National Accounts	US Dollar, millions, 2010	10/17/17
(4)	Household and NPISH final consumption expenditure[2]	Eurostat: GDP and main components - Current prices [nama_gdp_c], ESA 95	Million euro, chain-linked volumes, reference year 2005 (at 2005 exchange rates)	12/11/15

Notes: Linking method: growth.
[1] Data has been converted into 2010 million euro using the conversion factor 0.85687.
[2] Data has been converted into 2010 million euro using the conversion factor 1.0854.

Data sets used by time and country

Belgium: 1960:1994 (3), 1995:2016 (2); *Bulgaria*: 1998:2016 (2); *Czech Republic*: 1993:1994 (4), 1995:2016 (2); *Denmark*: 1960:1974 (3), 1975:2016 (2); *Germany*: 1991:2016 (2); *Estonia*: 1993:1994 (4), 1995:2016 (2); *Ireland*: 1960:1994 (3), 1995:2016 (2); *Greece*: 1960:1994 (3), 1995:2016 (2); *Spain*: 1960:1994 (3), 1995:2016 (2); *France*: 1960:1974 (3), 1975:2016 (2); *Italy*: 1960:1994 (3), 1995:2016 (2); *Cyprus*: 1995:2016 (2); *Latvia*: 1995:2016 (2); *Lithuania*: 1995:2016 (2); *Luxembourg*: 1960:1994 (3), 1995:2016 (2); *Hungary*: 1995:2016 (2); *Malta*: 2000:2016 (2); *Netherlands*: 1960:1994 (3), 1995:2016 (2); *Austria*: 1960:1994 (3), 1995:2016 (2); *Poland*: 1995:2016 (2); *Portugal*: 1960:1994 (3), 1995:2016 (2); *Romania*: 1998:2016 (2); *Slovenia*: 1990:1994 (4), 1995:2016 (2); *Slovak Republic*: 1993:1994 (3), 1995:2016 (2); *Finland*: 1960:1979 (3), 1980:2016 (2); *Sweden*: 1960:1992 (3), 1993:2016 (2); *United Kingdom*: 1960:1994 (3), 1995:2016 (2); *Norway*: 1960:1974 (3), 1975:2016 (2); *Switzerland*: 1960:1979 (3), 1980:2016 (2); *Iceland*: 1960:1994 (3), 1995:2016 (2);

Table A1i: REAL GOVERNMENT CONSUMPTION (ANNUAL)

#	Series Name	Source	Unit	Download
(2)	Final consumption expenditure of general government	Eurostat: GDP and main components (output, expenditure and income) [nama_10_gdp], ESA 2010	Chain linked volumes (2010), million euro	10/14/17
(3)	General government final consumption expenditure, VPVOBARSA[1]	OECD: Quarterly National Accounts	US Dollar, millions, 2010	10/17/17
(4)	Final consumption expenditure of general government[2]	Eurostat: GDP and main components - Current prices [nama_gdp_c], ESA 95	Million euro, chain-linked volumes, reference year 2005 (at 2005 exchange rates)	12/11/15

Notes: Linking method: growth.
[1] Data has been converted into 2010 million euro using the conversion factor 0.85687.
[2] Data has been converted into 2010 million euro using the conversion factor 1.0854.

Data sets used by time and country

Belgium: 1960:1994 (3), 1995:2016 (2); *Bulgaria*: 1998:2016 (2); *Czech Republic*: 1993:1994 (4), 1995:2016 (2); *Denmark*: 1960:1974 (3), 1975:2016 (2); *Germany*: 1991:2016 (2); *Estonia*: 1993:1994 (4), 1995:2016 (2); *Ireland*: 1960:1994 (3), 1995:2016 (2); *Greece*: 1960:1994 (3), 1995:2016 (2); *Spain*: 1960:1994 (3), 1995:2016 (2); *France*: 1960:1974 (3), 1975:2016 (2); *Italy*: 1960:1994 (3), 1995:2016 (2); *Cyprus*: 1995:2016 (2); *Latvia*: 1995:2016 (2); *Lithuania*: 1995:2016 (2); *Luxembourg*: 1960:1994 (3), 1995:2016 (2); *Hungary*: 1995:2016 (2); *Malta*: 2000:2016 (2); *Netherlands*: 1960:1994 (3), 1995:2016 (2); *Austria*: 1960:1994 (3), 1995:2016 (2); *Poland*: 1995:2016 (2); *Portugal*: 1960:1994 (3), 1995:2016 (2); *Romania*: 1998:2016 (2); *Slovenia*: 1990:1994 (4), 1995:2016 (2); *Slovak Republic*: 1992:1992 (4), 1993:1994 (3), 1995:2016 (2); *Finland*: 1960:1979 (3), 1980:2016 (2); *Sweden*: 1960:1992 (3), 1993:2016 (2); *United Kingdom*: 1960:1994 (3), 1995:2016 (2); *Norway*: 1960:1974 (3), 1975:2016 (2); *Switzerland*: 1960:1979 (3), 1980:2016 (2); *Iceland*: 1960:1994 (3), 1995:2016 (2);

Table A1j: REAL GROSS FIXED CAPITAL FORMATION (ANNUAL)

#	Series Name	Source	Unit	Download
(1)	Gross fixed capital formation	Eurostat: GDP and main components (output, expenditure and income) [nama_10_gdp], ESA 2010	Chain linked volumes (2010), million euro	10/14/17
(2)	Gross fixed capital formation, VPVOBARSA[1]	OECD: Quarterly National Accounts	US Dollar, millions, 2010	10/17/17
(3)	Gross fixed capital formation[2]	Eurostat: GDP and main components - Current prices [nama_gdp_c], ESA 95	Million euro, chain-linked volumes, reference year 2005 (at 2005 exchange rates)	12/11/15

Notes: Linking method: growth.
[1] Data has been converted into 2010 million euro using the conversion factor 0.85687.
[2] Data has been converted into 2010 million euro using the conversion factor 1.0854.

Data sets used by time and country

Belgium: 1960:1994 (2), 1995:2016 (1); *Bulgaria*: 1998:2016 (1); *Czech Republic*: 1993:1994 (3), 1995:2016 (1); *Denmark*: 1960:1974 (2), 1975:2016 (1); *Germany*: 1991:2016 (1); *Estonia*: 1993:1994 (3), 1995:2016 (1); *Ireland*: 1960:1994 (2), 1995:2016 (1); *Greece*: 1960:1994 (2), 1995:2016 (1); *Spain*: 1960:1994 (2), 1995:2016 (1); *France*: 1960:1974 (2), 1975:2016 (1); *Italy*: 1960:1994 (2), 1995:2016 (1); *Cyprus*: 1995:2016 (1); *Latvia*: 1995:2016 (1); *Lithuania*: 1995:2016 (1); *Luxembourg*: 1960:1994 (2), 1995:2016 (1); *Hungary*: 1995:2016 (1); *Malta*: 2000:2016 (1); *Netherlands*: 1960:1994 (2), 1995:2016 (1); *Austria*: 1960:1994 (2), 1995:2016 (1); *Poland*: 1995:2016 (1); *Portugal*: 1960:1994 (2), 1995:2016 (1); *Romania*: 1998:2016 (1); *Slovenia*: 1990:1994 (3), 1995:2016 (1); *Slovak Republic*: 1992:1992 (3), 1993:1994 (2), 1995:2016 (1); *Finland*: 1960:1979 (2), 1980:2016 (1); *Sweden*: 1960:1992 (2), 1993:2016 (1); *United Kingdom*: 1960:1994 (2), 1995:2016 (1); *Norway*: 1960:1974 (2), 1975:2016 (1); *Switzerland*: 1960:1979 (2), 1980:2016 (1); *Iceland*: 1960:1994 (2), 1995:2016 (1);

Table A2: DATA SOURCES: AGGREGATE MIGRATION

Country	Immigration	Emigration	Download
Bulgaria	Infostat > Demographic and social statistics > International Migration by sex and age	Infostat > Demographic and social statistics > International Migration by sex and age	2/22/17
Czech Republic	Czech Statistical Office > Population - Annual Time series > Table 1 Population and vital statistics of the Czech Republic: 1785 - 2015, absolute figures (code: 130070-16);	Czech Statistical Office > Population - Annual Time series > Table 1 Population and vital statistics of the Czech Republic: 1785 - 2015, absolute figures (code: 130070-16);	2/22/17
United Kingdom	Long-term International Migration (LTIM), Table 2.02, Country of Last or Next Residence, all countries;	Long-term International Migration (LTIM), Table 2.02, Country of Last or Next Residence, all countries;	2/22/17
Spain	INE > Demography and Population > Municipal Register: Population by municipalities > Residential Variations Statistics > 2.15 New registers by country of origin and age;	INE > Demography and Population > Municipal Register: Population by municipalities > Residential Variations Statistics¿ 2.8 Cancellations by country of destination and age;	2/22/17
Germany	Zuzge ber die Grenzen Deutschlands nach Herkunftsland (excel file sent by email from Fortschreibung@destatis.de);	Fortzge ber die Grenzen Deutschlands nach Zielgebieten (excel file sent by email from Fortschreibung@destatis.de);	2/22/17
Netherlands	since 1995: CBS database > Migratie; land van herkomst / vestiging, geboorteland en geslacht; up to 1994: excel files in email from infoservice@cbs.nl;	since 1995: CBS database > Migratie; land van herkomst / vestiging, geboorteland en geslacht; up to 1994: excel files in email from infoservice@cbs.nl;	2/22/17
Austria	Statistics Austria > Population > Migration > Table 'Results (overview): Migration (immigration and emigration)';	Statistics Austria > Population > Migration > Table 'Results (overview): Migration (immigration and emigration)';	2/22/17
Finland	Statistics Finland > Population > Migration > Vital statistics and population 1749 - 2015;	Statistics Finland > Population > Migration > Vital statistics and population 1749 - 2015;	2/22/17

Sweden	Statistics Sweden > Population > Migration - internal and external > Migration by region, age and sex. Year 1968-1996 and Year 1997-2016;	Statistics Sweden > Population > Migration - internal and external > Migration by region, age and sex. Year 1968-1996 and Year 1997-2016;	2/22/17
Norway	Statistics Norway > Table: 07822: Immigration, emigration and net migration, by country of emigration/immigration	Statistics Norway > Table: 07822: Immigration, emigration and net migration, by country of emigration/immigration	2/22/17
Denmark	Statbank > INDVAN: IMMIGRATION BY SEX, AGE, COUNTRY OF ORIGIN AND CITIZENSHIP	Statbank > UDDVAN: EMIGRATION BY SEX, AGE, COUNTRY OF DESTINATION AND CITIZENSHIP	2/22/17
Switzerland	BFS > Internationale Wanderungen der stndigen Wohnbevlkerung nach Staatsangehrigkeit, Geschlecht und Alter;	BFS > Internationale Wanderungen der stndigen Wohnbevlkerung nach Staatsangehrigkeit, Geschlecht und Alter;	2/22/17
Italy	since 2002: Istat > Populations > Migration (Transfer of residence) Countrys of previous residence, 1990 - 2002: Eurostat, before 1990: Istat > Serie storichi > Movimento migratorio della popolazione residente : iscrizioni e cancellazioni anagrafiche, espatri e rimpatri 1990;	since 2002: Istat > Populations > Migration (Transfer of residence) Countrys of previous residence, 1990 - 2002: Eurostat, before 1990: Istat > Serie storichi > Movimento migratorio della popolazione residente : iscrizioni e cancellazioni anagrafiche, espatri e rimpatri 1990;	2/22/17
Iceland	Statistics Iceland > Population and elections > Migration > External migration > External migration by sex and citizenship 1961-2015;	Statistics Iceland > Population and elections > Migration > External migration > External migration by sex and citizenship 1961-2015;	2/22/17
Slovenia	Statistics Slovenia > SI-Stat > Demography and social statistics > International migration by sex, Slovenia, annually	Statistics Slovenia > SI-Stat > Demography and social statistics > International migration by sex, Slovenia, annually	1/16/18
Belgium	Statistics Belgium > Population > Migrations > Totale internationale migratie (Belgen en vreemdelingen), only data based on Entries and Exits of people (consistent with Eurostat data prior to 2008);	Statistics Belgium > Population > Migrations > Totale internationale migratie (Belgen en vreemdelingen), only data based on Entries and Exits of people (consistent with Eurostat data prior to 2008);	2/22/17

Slovak Republic	Statistics Slovakia > Slovstat > Demographic Statistics > Foreign migration > Immigrants registered for usual residence in the SR by country of next residence, age and sex;	Statistics Slovakia > Slovstat > Demographic Statistics > Foreign migration > Emigrants deregistered from usual residence in the SR by country of next residence, age and sex;	2/22/17

Table A3: DATA SOURCES: BILATERAL MIGRATION

Country	Series	Download
Austria	Statistics Austria: International migrations and migrations within Austria; Country of origin/destination (Data prior to 2002 received by email)	3/3/17
Germany	Destatis: Zu- und Fortzge ber die Grenzen Deutschlands nach Herkunfts-bzw. Zielgebieten (Additional data received by email)	2/14/17
Denmark	StatBank Denmark: INDVAN: IMMIGRATION BY SEX, AGE, COUNTRY OF ORIGIN AND CITIZENSHIP; UDDVAN: EMIGRATION BY SEX, AGE, COUNTRY OF DESTINATION AND CITIZENSHIP	3/6/17
Spain	INE > Demography and Population > Municipal Register: Population by municipalities > Residential Variations Statistics: 2.8 Cancellations by country of destination and age; 2.15 New registers by country of origin and age	3/3/17
Finland	Statistics Finland: Population > Migration > Immigration / Emigration (Data prior to 1990: UN global migration database)	3/6/17
United Kingdom	ONS: Long-term international migration (LTIM), passenger survey	2/15/17
Iceland	Statistics Iceland > Population and elections>Migration>External migration: External migration by sex, countries and citizenship 1986-2015	3/28/17
Italy	Istat database > Migration (Transfer oresidence) Country of origin, Country of next residence	2/15/17
Netherlands	CBS: Migratie; land van herkomst / vestiging, geboorteland en geslacht	2/20/17
Norway	Statistics Norway: Table: 07822: Immigration, emigration and net migration, by country of emigration/immigration	3/6/17
Sweden	Statistics Sweden > Statistical database>Population > Population statistics > Migration - internal and external: Immigrations and emigrations by country of emi-/immigration and sex. Year 2000 - 2016. Data prior to 2000: UN Global migration database; Data prior to 1980: Historical Statistics Sweden	3/6/17

Table A4: AVAILABILITY OF AGGREGATE MIGRATION DATA

	Inflow			Outflow		
Country	NSO	Eurostat	Adj	NSO	Eurostat	Adj
Belgium	1960	2011	1.18	1960	2011	1.15
Bulgaria	2007	2007	1.00	2007	2012	1.00
Czech Republic	1991	2008	0.85	1991	2008	0.43
Denmark	1960	2008	1.31	1960	2008	1.29
Germany	1991	2009	1.88	1991	2009	2.80
Estonia	2004	-	-	2004	-	-
Ireland	-	1998	-	-	1998	-
Greece	-	1998	-	-	1998	-
Spain	1998	2008	1.25	1998	2008	0.92
France	-	2006	-	-	2006	-
Italy	1988	1998	0.99	1988	1998	0.97
Cyprus	-	1998	-	-	2002	-
Latvia	-	1998	-	-	1998	-
Lithuania	-	1998	-	-	1998	-
Hungary	-	2008	-	-	2008	-
Malta	-	2005	-	-	2006	-
Netherlands	1987	2009	1.24	1987	2012	1.04
Austria	1996	2007	1.51	1996	2007	1.76
Poland	-	2009	-	-	2009	-
Portugal	-	1998	-	-	1998	-
Romania	-	2008	-	-	2008	-
Slovenia	1961	2008	1.00	1961	2008	1.00
Slovak Republic	2004	-	-	2004	-	-
Finland	1980	1998	1.00	1980	1998	1.00
Sweden	1960	1998	1.00	1960	1998	1.00
United Kingdom	2000	1998	0.96	2000	1998	0.96
Iceland	1986	2009	1.31	1986	2009	1.41
Norway	1967	2008	1.11	1967	2008	1.44
Switzerland	1991	2011	1.17	1991	2011	1.00

Notes: Table displays the starting year for the unilateral migration data based on either the national definition (NSO) or the Eurostat definition (Eurostat). The adjustment factor, $adj^i_{i,j}$, is used to transform migration data based on national definitions into migration data based on the Eurostat definition. It is calculated as the ratio of migration data based on the national definition to migration data based on the Eurostat definition, averaged over all time periods where data from both sources overlap.

Table A5: Availability of Bilateral Migration Data

	Inflow			Outflow		
Country	NSO	Eurostat	Adj	NSO	Eurostat	Adj
Belgium	-	2011	1.18 (0.07)	-	2011	1.15 (0.05)
Bulgaria	-	2007	1.00 (0.00)	-	2012	1.00 (0.00)
Czech Republic	-	-	-	-	-	-
Denmark	1960	2008	1.38 (0.07)	1960	2008	1.21 (0.15)
Germany	1991	-	1.79 (0.11)	1991	-	2.46 (0.17)
Estonia	-	-	-	-	-	-
Ireland	-	2006	-	-	2006	-
Greece	-	-	-	-	-	-
Spain	1998	2008	0.97 (0.04)	1998	2008	0.32 (0.05)
France	-	-	-	-	-	-
Italy	1998	2008	0.97 (0.05)	1998	2008	0.92 (0.12)
Cyprus	-	-	-	-	-	-
Latvia	-	1998	-	-	1998	-
Lithuania	-	1998	-	-	2001	-
Hungary	-	-	-	-	-	-
Malta	-	-	-	-	-	-
Netherlands	1987	2009	1.35 (0.07)	1987	2012	1.22 (0.09)
Austria	1996	2007	1.49 (0.11)	1996	2007	1.85 (0.19)
Poland	-	-	-	-	-	-
Portugal	-	-	-	-	-	-
Romania	-	-	-	-	-	-
Slovenia	-	2008	1.00 (0.00)	-	2008	1.00 (0.00)
Slovak Republic	-	-	-	-	-	-
Finland	1980	1998	1.00 (0.00)	1980	1998	1.00 (0.00)
Sweden	1960	1998	1.00 (0.00)	1960	1998	1.00 (0.00)
United Kingdom	2000	1998	0.95 (0.14)	2000	1998	0.97 (0.04)
Iceland	1986	2009	1.34 (0.27)	1986	2009	1.72 (0.42)
Norway	1967	2008	1.12 (0.07)	1967	2008	1.29 (0.45)
Switzerland	-	2011	1.17 (0.05)	-	2011	1.00 (0.00)

Notes: See Notes to Table A4. The adjustment factor reported in the table is a simple average of adjustment factors across partner countries. The value in the parentheses is the standard deviation of the adjustment factor, $std\left(\frac{\tilde{v}^i_{i,j,s}}{v^i_{i,j,s}}\right)$, calculated over time for each partner country. It is then averaged across all partner countries. Germany: No bilateral data available in Eurostat. Italy: Bilateral data available in Eurostat starting in 2008. Spain: Bilateral data available in Eurostat for only some countries.

Table A6: ADDITIONAL MIGRATION STATISTICS EUROPE 2012

Country	Western Europe			Europe		
	Ave	In	Out	Ave	In	Out
Belgium	0.43	0.40	0.47	0.64	0.64	0.65
Denmark	0.36	0.33	0.40	0.59	0.59	0.59
Germany	0.29	0.24	0.42	0.56	0.65	0.47[a]
Ireland	0.28	0.32	0.25	0.56	0.57	0.54
Greece	–	–	–	0.63	0.63	0.63[a]
Spain	0.24	0.23	0.24	0.39	0.38	0.39
France	–	–	–	0.38	0.48	0.29[a]
Italy	0.23	0.09	0.70	0.48	0.35	0.62
Netherlands	0.38	0.35	0.42	0.60	0.60	0.61
Austria	0.30	0.27	0.36	0.63	0.66	0.60[a]
Portugal	–	–	–	0.64	0.61	0.66[a]
Finland	0.38	0.27	0.62	0.63	0.56	0.70
Sweden	0.36	0.29	0.50	0.51	0.44	0.58
United Kingdom	0.24	0.23	0.26	0.37	0.38	0.36[a]
Iceland	0.64	0.60	0.69	0.82	0.78	0.86
Norway	0.37	0.29	0.64	0.61	0.62	0.60
Switzerland	0.48	0.52	0.42	0.60	0.67	0.54
Average	0.36	0.32	0.46	0.57	0.57	0.57

Notes: Tables displays the shares of Western Europe and Europe in overall immigration (In) and emigration in 2012 by country. Western Europe encompasses EU15+EFTA less Luxembourg and Liechtenstein. Europe refers to EU27+EFTA+4 candidate countries in 2010 (Croatia, Turkey, Montenegro and Macedonia. For countries marked with [a], Europe refers to EU27 only. Values as reported by the country.

Table A7: MIGRATION STATISTICS: UNITED STATES

State	pop	migr	dom	sd(netm)	State	pop	migr	dom	sd(netm)
Alabama	4.3	2.8	96.1	0.24	Nebraska	1.7	3.1	96.7	0.32
Arizona	4.6	5.0	96.8	0.85	Nevada	1.7	6.6	97.7	1.38
Arkansas	2.6	3.4	97.7	0.36	New Hampshire	1.2	4.1	97.9	0.76
California	31.4	2.0	93.3	0.45	New Jersey	8.1	2.4	96.0	0.20
Colorado	3.9	4.7	96.0	0.68	New Mexico	1.7	4.9	95.9	0.55
Connecticut	3.4	2.7	95.9	0.25	New York	18.5	1.9	94.5	0.25
Delaware	0.7	3.8	97.0	0.47	North Carolina	7.6	3.3	95.3	0.34
Florida	14.6	4.0	95.6	0.86	North Dakota	0.7	3.8	94.8	0.88
Georgia	7.5	3.6	94.3	0.41	Ohio	11.2	1.9	96.7	0.26
Idaho	1.2	4.6	97.5	0.85	Oklahoma	3.4	3.6	95.6	0.82
Illinois	12.1	2.1	96.3	0.21	Oregon	3.2	3.5	97.8	0.62
Indiana	5.9	2.3	97.6	0.33	Pennsylvania	12.2	1.8	96.5	0.21
Iowa	2.9	2.5	97.7	0.46	Rhode Island	1.0	3.0	96.3	0.41
Kansas	2.6	3.8	95.7	0.22	South Carolina	3.8	3.4	95.9	0.26
Kentucky	3.9	2.9	96.2	0.27	South Dakota	0.7	3.6	96.9	0.49
Louisiana	4.4	2.7	96.0	0.95	Tennessee	5.4	3.2	97.5	0.31
Maine	1.2	2.8	96.3	0.37	Texas	19.6	2.7	93.9	0.54
Maryland	5.1	3.1	94.7	0.32	Utah	2.1	3.5	97.0	0.58
Massachusetts	6.2	2.3	94.8	0.30	Vermont	0.6	3.4	97.5	0.30
Michigan	9.6	1.7	95.9	0.34	Virginia	6.7	4.0	92.2	0.26
Minnesota	4.7	2.0	97.1	0.22	Washington	5.4	3.5	94.1	0.53
Mississippi	2.7	3.1	96.8	0.23	West Virginia	1.9	2.7	98.4	0.48
Missouri	5.4	2.8	97.1	0.23	Wisconsin	5.2	1.8	97.5	0.26
Montana	0.9	4.1	97.3	0.74	Wyoming	0.5	6.2	97.6	1.63

Notes: Table displays average population (in millions), the average migration rate, the share of internal migration in total migration, and the standard deviation across time of the net-migration rate. Time period: 1977-2014

Table A8: MIGRATION STATISTICS: CANADA

Province	pop	migr	dom	sd(netm)	Province	pop	migr	dom	sd(netm)
N'foundland & Labr	0.6	1.9	94.0	0.55	Ontario	11.0	1.3	44.6	0.33
P Edward Island	0.1	2.4	87.0	0.49	Manitoba	1.1	2.0	73.2	0.44
Nova Scotia	0.9	2.1	87.7	0.20	Saskatchewan	1.0	2.2	86.2	0.73
New Brunswick	0.7	1.9	90.1	0.22	Alberta	2.9	2.9	77.5	0.94
Quebec	7.2	0.8	47.8	0.28	Brit Columb	3.7	2.2	61.1	0.61

Notes: Table displays average population (in millions), the average migration rate, the share of internal migration in total migration, and the standard deviation across time of the net-migration rate. Time period: 1977-2014

Table A9: MIGRATION STATISTICS: EUROPE

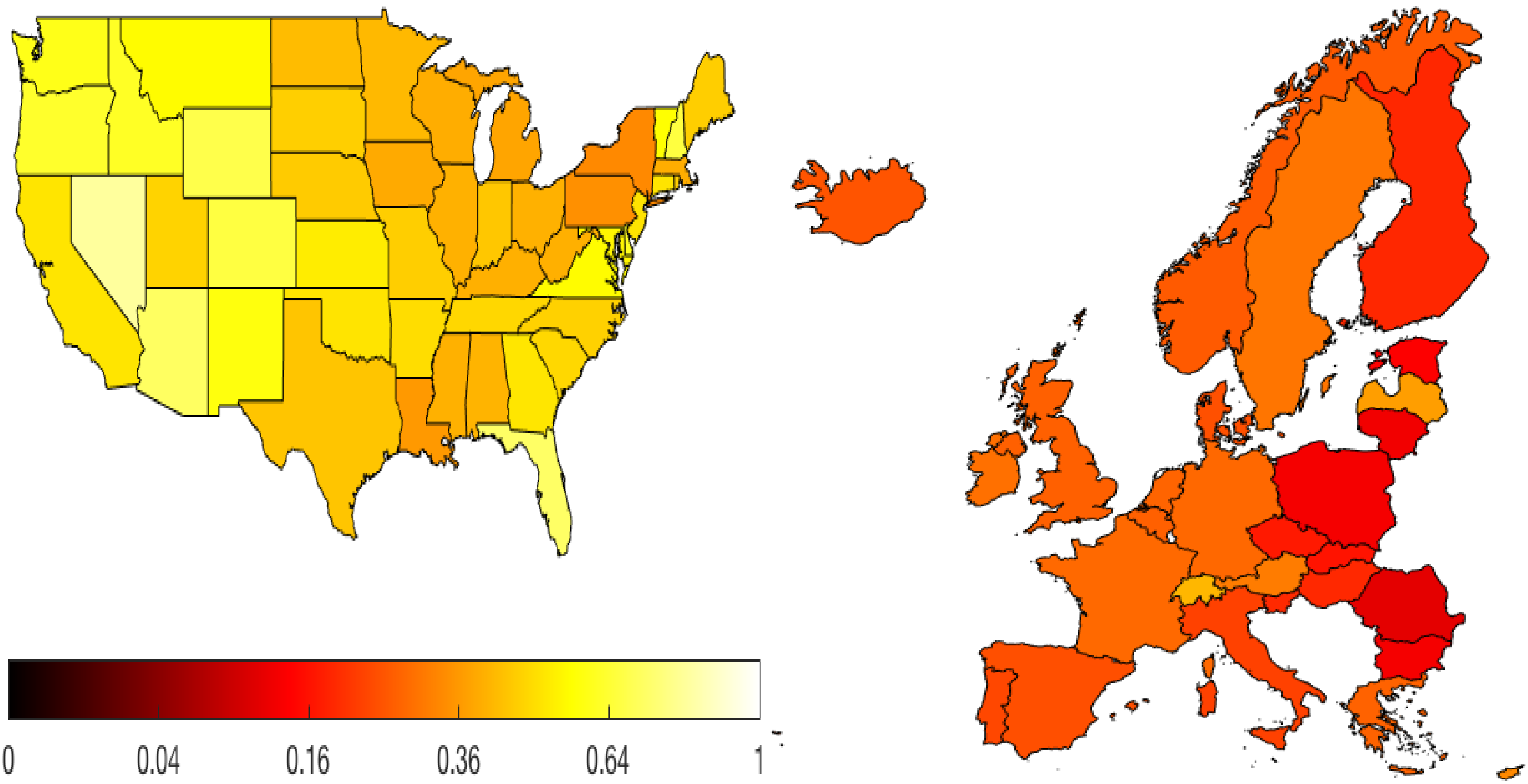
Country	pop	migr	dom	sd(netm)	Country	pop	migr	dom	sd(netm)
Belgium	10.5	0.8	0.6	0.18	Malta	0.4	1.3	–	0.29
Bulgaria	7.8	0.2	0.7	0.01	Netherlands	16.0	0.5	0.3	0.06
Czech Republic	10.3	0.4	–	0.26	Austria	8.1	0.7	0.4	0.19
Denmark	5.4	0.7	0.4	0.09	Poland	38.4	0.6	–	0.06
Germany	81.8	0.5	0.3	0.23	Portugal	10.3	0.3	–	0.31
Estonia	1.4	–	–	–	Romania	21.4	0.9	–	0.28
Ireland	4.0	1.4	0.9	0.93	Slovenia	2.0	0.5	0.2	0.37
Greece	10.9	0.6	–	0.36	Slovak Republic	5.4	–	–	–
Spain	42.4	0.8	0.4	0.38	Finland	5.2	0.3	0.2	0.10
France	60.1	0.5	–	0.04	Sweden	9.0	0.6	0.3	0.19
Italy	57.8	0.3	0.2	0.20	United Kingdom	60.0	0.7	0.3	0.09
Cyprus	0.7	1.4	–	1.31	Iceland	0.3	1.3	1.1	0.58
Latvia	2.3	0.6	0.1	0.43	Norway	4.6	0.6	0.4	0.10
Lithuania	3.3	0.7	0.5	0.52	Switzerland	7.4	1.4	0.9	0.06
Hungary	10.2	0.3	–	0.07					

Notes: Table displays average population (in millions), the average migration rate, the share of internal migration in total migration, and the standard deviation across time of the net-migration rate. Time period: 1991-2014

Table A10: REGRESSION: GROSS FLOWS

	United States		Canada		Western Europe	
β^{dest}	−4.45	−5.17	−6.89	−8.02	−3.19	−3.46
	(0.13)	(0.11)	(0.84)	(0.89)	(0.40)	(0.48)
β^{orig}	4.49	4.70	3.54	4.53	3.16	2.77
	(0.13)	(0.11)	(0.73)	(0.74)	(0.42)	(0.43)
β^{trend}	−0.04		−1.25		3.18	
	(0.03)		(0.13)		(0.23)	
State trend	No	Yes	No	Yes	No	Yes
$R^2_{partial}$	0.08	0.11	0.12	0.16	0.07	0.06
No. Obs.	85,700	85,700	3,420	3,420	5,537	5,537

Notes: Table displays the regression coefficient of the regression $100 * \log v^j_{i,t} = \beta_{ij} + \beta^{dest} u_{i,t} + \beta^{orig} u_{j,t} + \beta^{trend} t + \epsilon_{ij,t}$ (columns (1), (3) and (5). For columns (2), (4) and (6), we use state-specific time trends for both origin and destination: $100 * \log v^j_{i,t} = \beta_{ij} + \beta^{dest} u_{i,t} + \beta^{orig} u_{j,t} + \beta^{trend}_i t + \beta^{trend}_j t + \epsilon_{ij,t}$. Dependent variable: Log of gross migration (times 100). Independent variables: Unemployment rates (in percent). Time period: 1977 - 2014 for US and Canada, 1991 - 2014 for Western Europe. Standard errors are clustered at the pair level. Partial R^2 is calculated as one minus the ratio of the residual sum of square of the full model to the residual sum of square of the model without $u_{i,t}$ and $u_{j,t}$. It gives the share of the variation explained by $u_{i,t}$ and $u_{j,t}$ that cannot be explained by the fixed effects and the time trend.



(a) U.S. 1990, 2000

(b) Europe, 1995 - 2015

Figure A1: Share of Residents Born Abroad

Note: For the U.S., "born abroad" means born outside the U.S. or in a different state. Averages taken over 1990, 2000 for the U.S., and 1995, 2000, 2005, 2010, 2015 for Europe.

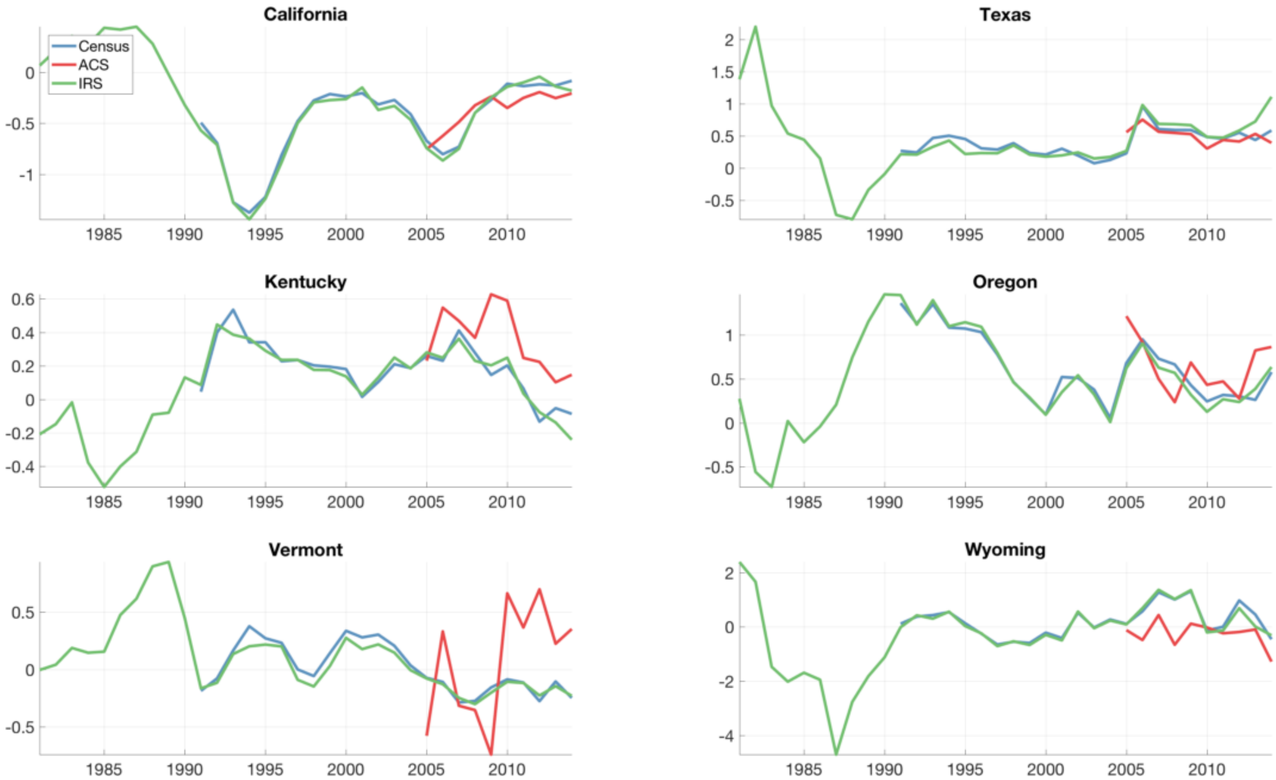


Figure A2: Internal Net Migration Rates in US States: Different Sources

Note: The figure displays internal net migration rates for six US States based on different data sources. Net migration rates are total immigration less total emigration divided by population.

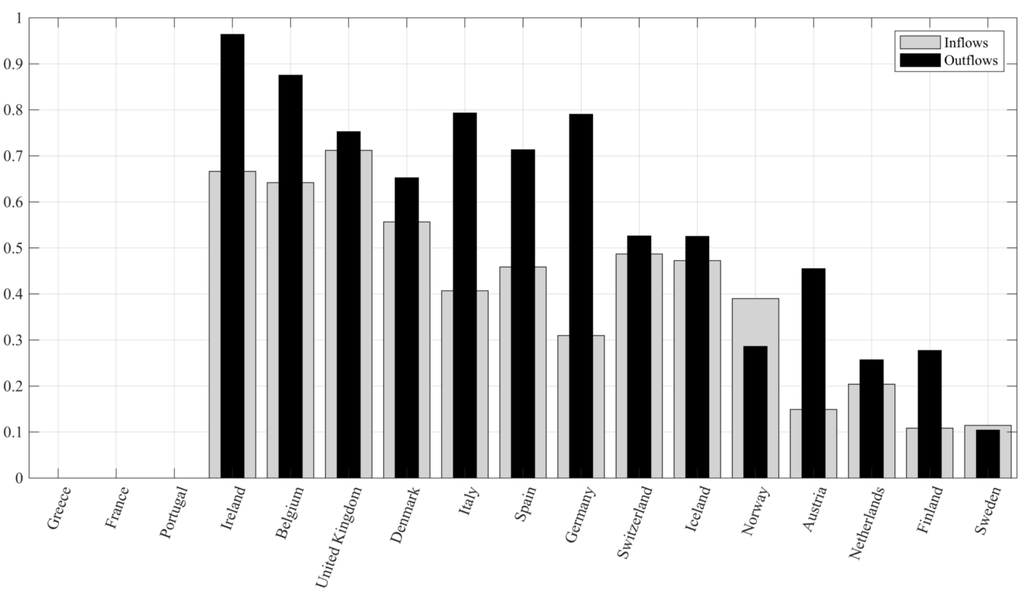


Figure A3: Estimated Standard Deviation of Reporting Error

Note: The figure plots estimates of the standard deviation of the reporting errors, σ_i and σ_j. Estimation of these standard deviations are explained in the Appendix section on reconciling bilateral data flows.

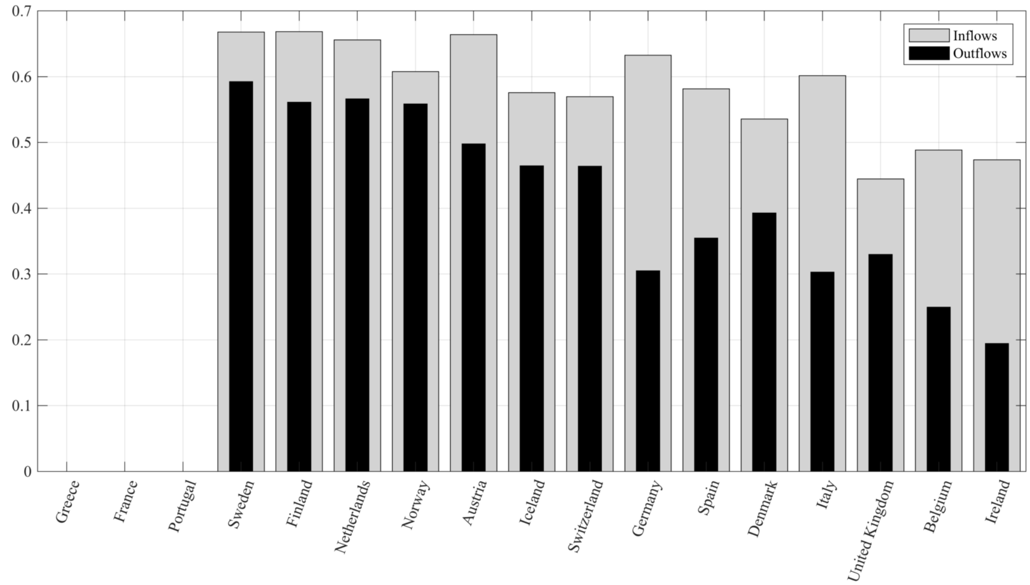


Figure A4: Average Weights for Reconciling Bilateral Migration Data

Note: The figure plots estimates of the weights $w_{i,j}$ used to reconcile bilateral data. The weights are simple averages across partner countries, $\frac{1}{N}\sum_j w_{i,j}$ for inflows of country i and $1 - \frac{1}{N}\sum_i w_{i,j}$ for outflows of country j. See the Appendix section on reconciling bilateral data flows for more information on how these weights are estimated.

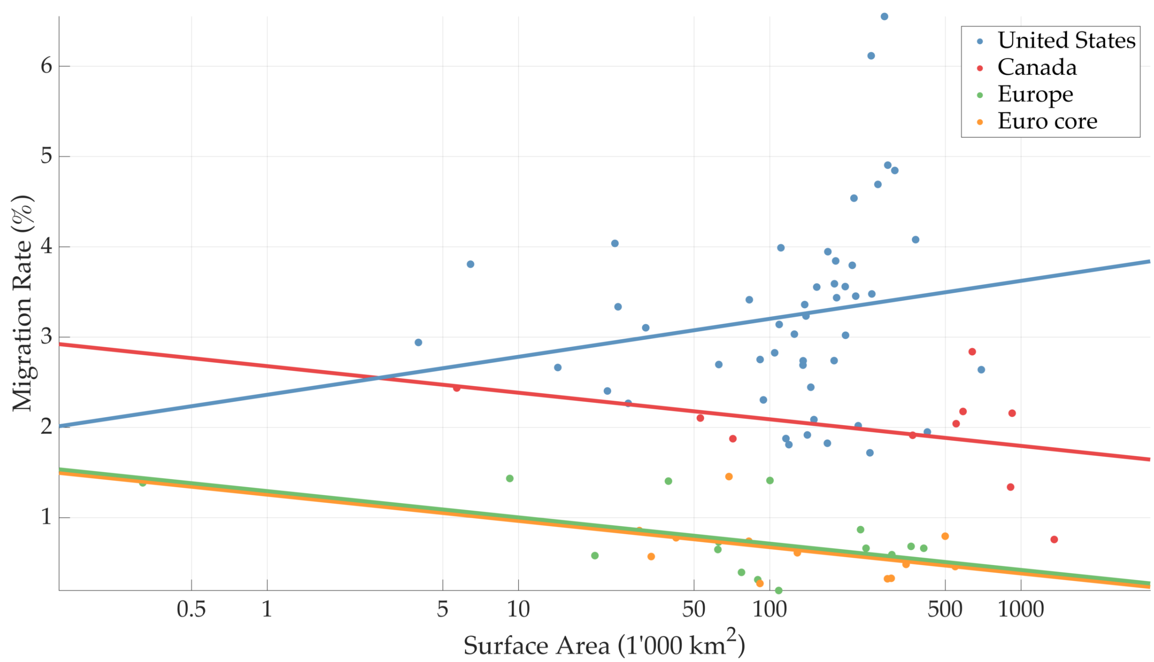
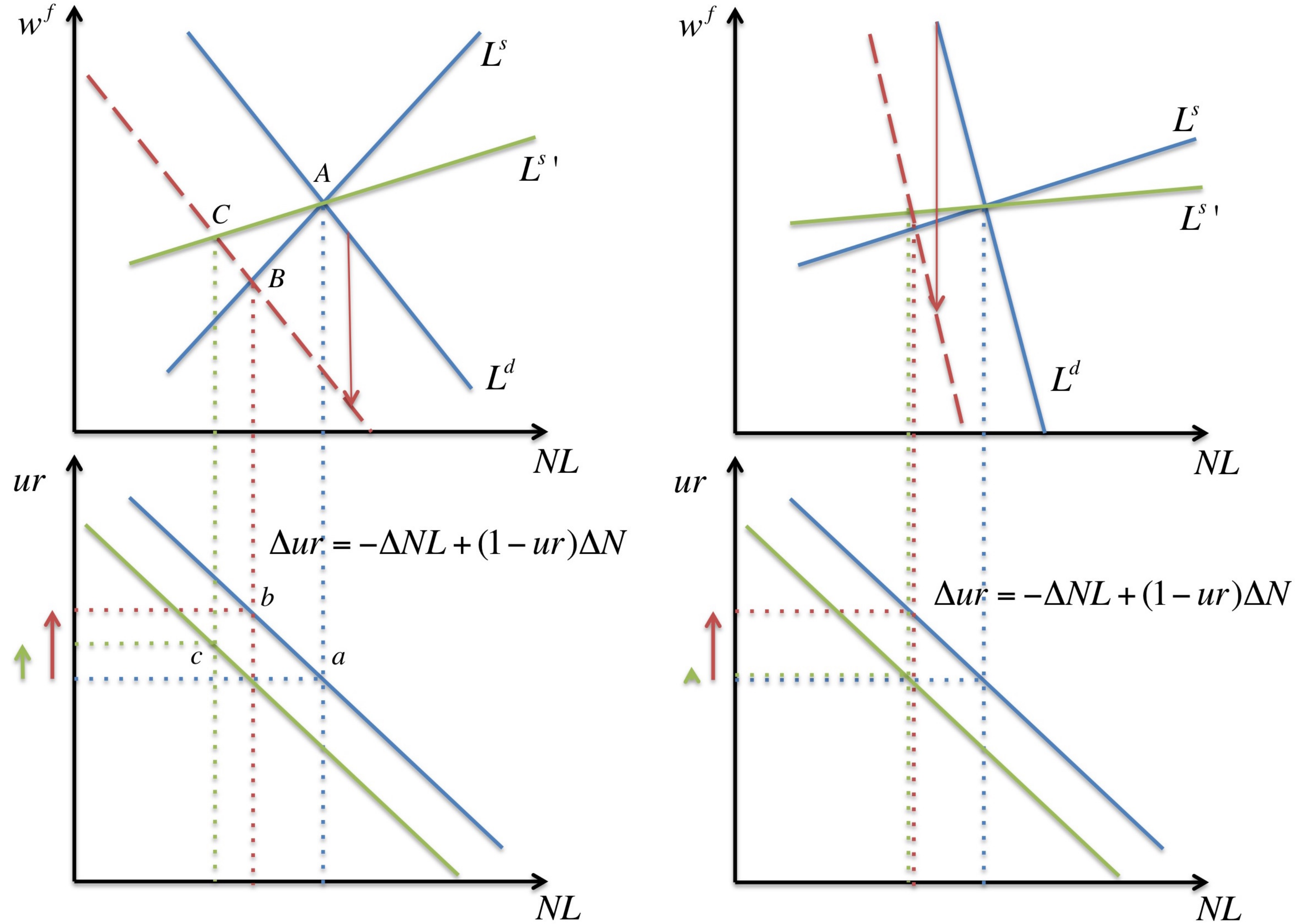


Figure A5: Migration Rates vs. Surface Area

Note: The figure plots the migration-to-population ratio against population (a) and surface area (b) for US States, Canadian Provinces, and Western European countries. Migration is measured as the average of immigration and emigration. Values are averages over 1995 - 2015.



(a) Case 1

(b) Case 2

Figure A6: Market for Matched Workers in Simplified Model

Notes: The market for matched workers (upper panel) is described by a demand and a supply curve. The initial equilibrium is at 'A'. A negative shock to the labor demand curve (red, dashed line), moves this equilibrium to 'B'. With migration, the supply curve flattens, resulting in equilibrium 'C'. The lower panel maps these equilibria into changes in the unemployment rate using the definition of the unemployment rate. The initial equilibrium is at 'a'. A negative shock to the labor demand curve movest the equilibrium to 'b', resulting in a higher unemployment rate. With migration, this increase in the unemployment rate is dampened ('c'). Figure (b) depicts a case with elastic supply and inelastic demand curves, making outmigration a more effective tool in dampening the rise in unemployment rates.

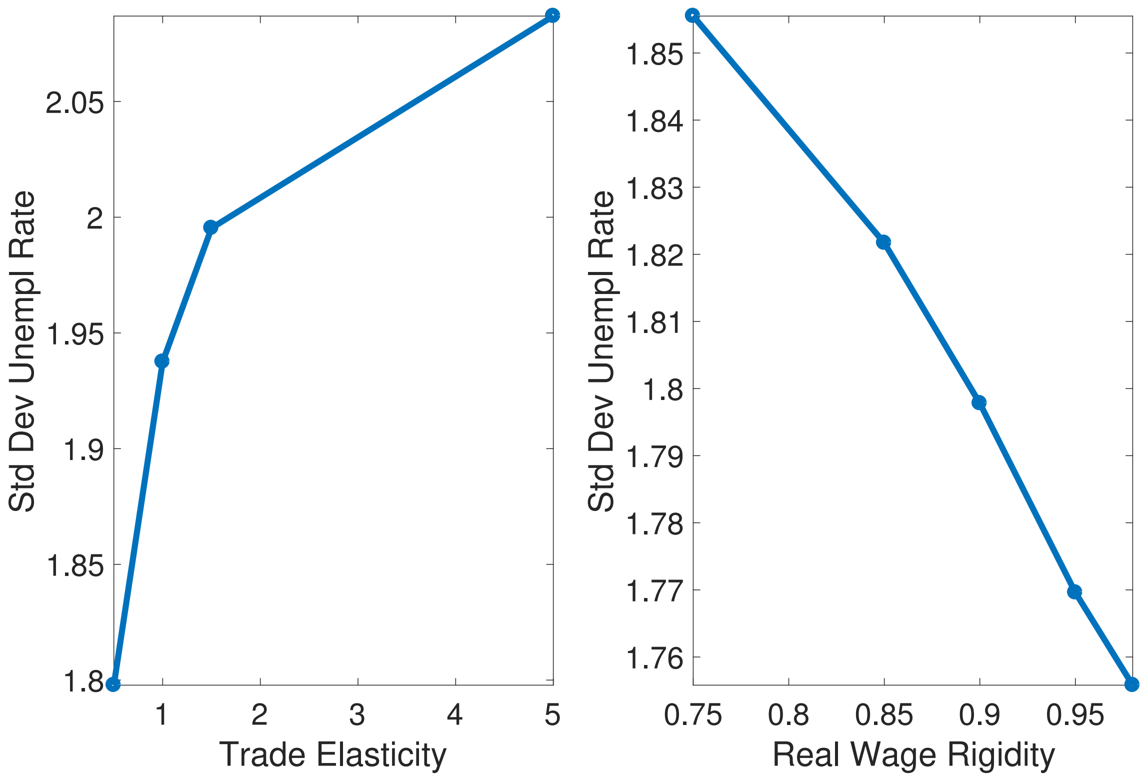


Figure A7: Effect of Migration on Unemployment Rate Differentials

Note: The figure plots the model-implied cross-sectional standard deviation of the unemployment rate for the high-labor-mobility case as a function of assumed parameters for the trade elasticity (left) and the real wage rigidity (right).